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„Ways of Knowing in Animal Husbandry"

An Actor-Network Theory Perspective on the Knowledge and Interactions of Farmers and Scientists in Livestock Research

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Chapter 1 - Introduction

1.1. Technological Blueprints for Development

In the field of (agricultural) development, be it in academia or among implementing agencies, the guiding narrative usually describes poor, rural populations in so-called 'developing' countries being faced with difficult conditions that are often exacerbated by climate change. It is then specific organisations' duty to help these populations in overcoming their adversities through 'development'. In agriculture this usually implies practising farming in a different, 'better' way, one that is usually imbued by the science-based agricultural practices originating in industrialised countries.

The origin of this narrative can be traced back to the Industrial Revolution in Europe and the United States. During this period the diverse actors in agriculture in industrialising countries - farmers, research institutions, private companies - used the output of scientific research to continuously improve farming methods, introducing new technologies that promised higher and more efficient productivity as well as cheaper food. Their production methods spread to other industrialising countries, boosting agricultural production and enabling growing urbanisation and further industrialisation. More recently, however, the environmental impact of these modern production methods came to light. From then on scientific research in agriculture strived both to improve agricultural productivity in order to provide a continuously growing world population with cheap food, fibre and fuel, while at the same time limiting its environmental impact and preserving natural resources.

As the narrative implies, this global spread of science-based agriculture was not to be limited to industrialised countries. Also in so-called 'developing' countries a range of actors strives to change agricultural production methods following the paradigm of increasing production and productivity while maintaining the available natural resources. Combined with the additional challenges of poverty and hunger, governments and international research- and donor-organisations in these countries strive to emulate the agricultural development history of their industrialised counterparts in mobilising science-based, modern agricultural production methods as a way out of poverty and towards 'development'.

This idea of using the technological blueprint from industrialised countries on developing ones has a long history.[1] While to some extent the previous period of colonisation already entailed the colonisers' understanding that they were bringing civilisation to the 'savages' (Livingstone, 2003; Preston, 1996), the thinking of industrialised countries holding the technologies required to solve the developing world's woes especially took off after World War II. In this period the industrialised world was faced with the challenge to rebuild the post-war economy amidst a growing desire for independence of their colonies. As these colonies were gaining independence, the predominant view was that they would need the support from industrialised countries - in many cases their former colonial masters - to realise their potential in the growing world economy. This view resulted in the emergence of a whole set of international and national institutions, organisations and companies geared towards the provision of 'development' to what would first be known as the 'Third World'

[1] The terms 'developing' and 'developed' in themselves are already inspired by this thinking.

and later as ‘developing countries’, most notably through the transfer of funds, know-how and technologies from industrialised countries. These form part of what Appadurai describes as the grand trajectory of science and the West (Appadurai, 2012), which views Western, industrialised modernity as the final destination of a linear process to which all countries would ultimately progress. Far from being a universal and transcendent truth, he describes it as a uniquely Western endeavour that ‘requires global expansion in order to be justified’ (p.27).

This effort has been ongoing ever since, with mixed results (Easterly, 2006; Moyo, 2010). Nevertheless, developing countries are still seen as lagging behind their industrialised counterparts, most notably exemplified by their still high rates of poverty and hunger especially in sub-Saharan Africa. The effort to achieve ‘development’ has thus not abated. This has been exemplified more recently by the so-called Millennium Development Goals, which are now being replaced by the Sustainable Development Goals. These are sets of goals to whose achievement all United Nations (UN) member states and 23 international organisations agreed to contribute in order to eliminate poverty and achieve development for all. Here, too, the idea of using blueprints from industrialised countries can be found again. The eighth Millennium Development Goal, for instance, envisions the establishment of a ‘global partnership for development’ in which industrialised countries help developing ones to reduce poverty, again through, among other things, the transfer of science-based technologies from the former to the latter.

1.1.1. The Role of Agriculture in Development

Agriculture is understood to play a key role in this ‘development’, especially in Africa where the majority of the population on the continent still lives in rural areas and has agriculture as its main source of income. The leading example of how the transfer of science-based agricultural technologies was used to achieve development and ensure food security is the Green Revolution, which prevented widespread famine in Southeast Asia in the 1960s and 1970s. It did so predominantly through the provision of improved rice varieties and the introduction of farming practices using synthetic inputs. Based on its success, a number of research institutes were founded - later brought together under the umbrella of the Consultative Group of International Agricultural Research Institutes (CGIAR) - whose aim it is to co-ordinate research on agriculture in developing countries to help these develop their agriculture and achieve food security. Together with research institutions and universities in both industrialised and developing countries, they strive to use scientific means to generate agricultural production technologies that should enable farmers in developing countries to increase their production and productivity while protecting their natural resources.

However, this concerted effort notwithstanding, attempts at replicating the Green Revolution in other regions have had mixed results. In Brazil, for instance, the widespread introduction of industrial agricultural production methods have led to the exodus of millions of smallholder farmers to the slums of the cities (Oberthür, 2002), while in Africa farmers failed to adopt many of the ‘Green Revolution’ technologies promoted by the CGIAR and other (inter)national development institutions (Frankema, 2014). These failures notwithstanding, and despite a temporary loss of interest in the 1980s and 1990s, the international development community still sees the modernisation of agriculture as crucial for African development (Diao, Hazell, Resnick, & Thurlow, 2007), with e.g. AGRA, the Alliance for a Green

Revolution in Africa funded by the Rockefeller and Bill and Melinda Gates Foundation[2] aiming to increase the productivity of African smallholder farmers through science and technology. The underpinning idea is that by helping them to produce not only what is required for their subsistence but also generating a surplus and providing access to markets, this will provide them with a means to increase their income and escape from the poverty trap.

1.1.2. The Livestock Revolution

This view of agricultural development through science and technology also includes the livestock sector. With the trend of growing urban populations - and to some extent also growing middle-classes - in developing countries, international research institutions have observed a corresponding growth in the demand for livestock-based products such as milk, meat and eggs. Accordingly, there is a strong 'pull' from the markets for farmers in both industrialised and developing countries to increase the productivity and overall production of their livestock to meet this demand.

The term 'Livestock Revolution' has been coined to describe this growing demand and corresponding increasing production in the livestock sector (Delgado, Rosegrant, Steinfeld, Ehui, & Courbois, 1999). As opposed to the Green Revolution, it is driven by the demand of urban populations rather than new technologies. It is also global - i.e. encompassing both developing and industrialised countries - with a major increase in the share of developing countries in both the production and the consumption of livestock products. Given these trends, Delgado et.al. see great potential for farmers to organise themselves with the support of governments and increase their production through the use of 'modern' livestock production technologies, thus integrating themselves vertically into markets and generating more income. The authors see opportunities in livestock production especially for the poorer farmers, as they earn a proportionally larger part of their cash income through livestock. In their words, '[it] offers one of the few rapidly growing markets that poor, rural people can join even if they lack substantial amounts of land, training, and capital.' (p.40) At the same time, however, they also highlight its potential risks, especially to public health and the environment.

Kosgey and Okeyo (2007) argue along similar lines, seeing opportunities for development by integrating smallholder farmers into markets and having governments and scientific institutions support them in their development. Along with Rege et. al. (Rege, Marshall, Notenbaert, Ojango, & Okeyo, 2011) as well as Juma (Juma, 2011), they see a key role for science-based technologies in supporting this process, providing means to increase agricultural (livestock) production and productivity in order to meet market needs and increase farmer income, while simultaneously limiting the risks this process might entail. In essence, as with agriculture in general, their proposal is for these farmers to follow a development process similar to the ones industrialised farmers have been undergoing throughout the 20th century, with scientists providing them with adapted tools and technologies from the fields of animal genetics, nutrition and health that would enable them to partake in 'development'.

[2] Note that the Green Revolution in Asia also began through funding of agricultural research by the Rockefeller Foundation.

1.2. Agricultural Development as the Travel of Western Technoscience

These ideas of supporting farmers through scientific means and integrating them into wider - even global - technoscientific networks and markets is part of the long history of the globalisation of western technoscience and its corresponding modes of ordering society. Science and technology, initially used as tools for colonial exploitation and control (Livingstone, 2003), later also became part and parcel of the colonisers' calling to bring 'civilisation' to the world. Thus, most colonies also saw the introduction of formal schooling and the building of universities following the European model in order to train their 'native' elites and have them man colonial administration structures. Far from being a value-neutral tool for the advancement of mankind, science and technology were instead closely intertwined with the colonisers' political goals. Scientific and technological knowledge were thus both a reflection of the societies from which they came, as well as a means to order the peoples and environments in the colonies according to these societies' structures and values (Jasanoff, 2004).

This 'travel' of technoscience (Anderson & Adams, 2008; Livingstone, 2003) led to a rapid multiplication of scientific institutions (governmental agencies, universities, research centres) throughout the world, creating a network of structures and processes that enacted science on a global scale, and meant that Western scientific thought and practice were increasingly seen as universal, and 'kept sharply distinct from [the] Non-Western, premodern or indigenous knowledge systems' (Drori, Meyer, Ramirez, & Schofer, 2003, p.6) of the countries to which it was traveling. What was originally a means of direct colonial control thus eventually turned into what many saw as a globally enacted 'standard' for the generation of knowledge and technology.

The efforts to achieve agricultural development through science-based technologies described above can be viewed as being part of the same process. In Africa, for instance, the 20th century saw the establishment of a large number of agricultural universities, faculties and colleges throughout the continent, training local experts in the use of Western, technoscientific methods and practices. Together with partner institutions in industrialised countries and with international research institutions such as the CGIAR they now form a 'global' network that tries to search for ways in which these methods and practices can be brought to bear on the livelihoods of African smallholder farmers - including on their livestock production - to help them improve their productivity and overcome their poverty (Rege et al., 2011).

1.2.1. The Farmers Themselves

This invariably leads to the question of who these farmers actually are. In sub-Saharan Africa, most of them belong to the majority of the population that still lives in rural areas and for whom farming is still the basis of their livelihood. They derive both their food and their income from the produce they obtain from their land, and in many - if not most - cases the societies of which they are a part will have lived in the same area for centuries. In this period they may have gone through turbulent histories of political and social change, at times even upheaval and war, may have survived droughts and epidemics, all the while either maintaining their farming system as a source of stability and subsistence or adapting it to the changing conditions to ensure its function as foundation of their livelihood. These farmers' farming systems and livelihoods have thus evolved to closely match the situation and requirements of the environment the farmers find themselves in.

In most cases, this environment differs significantly from those in which most Western technoscience emerged: infrastructure and integration to markets may be limited, support networks are usually based on kin or ethnicity rather than state structures, and many farmers largely rely on their own environment to supply fodder and means for medical treatment. Many farmers have also not had access to a formal schooling that teaches the basics - reading and writing, mathematics, accounting etc. - that much of Western technoscience requires for its use. At the same time, many of these farmers do not live in technological isolation. Science-based agricultural technologies were introduced to Africa a long time ago, and, to a greater or lesser extent, many farmers have already been exposed to several of them. 'Modern' livestock production technologies such as high-yielding livestock breeds or synthetic drugs are thus often already known, and to some extent some farmers have even already integrated (some of) them into their own farming practices. There are even 'extreme' cases whereby usually wealthy farmers have adopted whole technological packages and transformed their farms following industrial models. Thus, as a result of their historical background, setting and exposure to a range of technologies and practices, there is a large diversity of farming systems in Africa. They range from e.g. large-scale industrialised dairy farms via small-scale mixed crop-livestock farming systems to cattle ranching and pastoralism.

1.2.2. A Meeting at the Frontlines of Scientific Travel

It is this variety of farming systems that can be seen as the ultimate 'destination' of the travel of Western agricultural technoscience targeted by the agricultural development organisations and institutes mentioned above. This 'destination' is as much geographical - the farms as physical entities - as it is a vision of these farms integrating themselves into specific societal orders and networks. The idea that many scientists have is that once the farmers have adopted (more of) the understandings and practices developed using scientific means, and once they have established or strengthened their linkages with external actors (e.g. research and extension institutions, input suppliers) and markets they – ideally - will be in a position to have stable sources of cash income and will thus have 'developed' and improved their livelihood.

These scientists are of course aware of the fact that the settings in which most African farmers live are very different from those of industrialised countries. Delgado et.al. for instance point out that '[r]ather than emphasizing output maximization above all else (…) [t]he design of public investment must (…) go beyond a strict technical orientation and consider the social, economic, and ecological dimensions of the interaction of livestock with the betterment of livelihoods.' (Delgado et al., 1999, p.65). Rege et al. too, when describing the possible contribution of science to help poor farmers in improving the performance of their livestock, highlight the need to consider 'socio-economic underpinnings' and 'intangibles' when defining breeding objectives for smallholder farmer livestock (Rege et al., 2011, p.22). Kosgey and Okeyo have a similar agenda, and also argue that there is a need for identifying 'existing structures, institutions and indigenous breeding practices, and to build upon these (…)' (Kosgey & Okeyo, 2007).

Nevertheless, the underlying aim is still one of introducing farmers to science-based methods of farming and thus 'enrolling' them into this travel of Western technoscience. Understanding the farmers' context is a means to this end. The societal orders and values underlying Western technoscience itself, however, are not examined.

1.2.3. Underlying Paradigms

A range of authors have criticised what they see as a neo-modernist paradigm inherent in such attempts. Leach, Scoones, and Wynne (Leach, Scoones, & Wynne, 2005) for instance point out how modernist development and new technologies are linked to global networks of science, policy and technology, trade and commerce. In this way, science has become an integral part of politics, deploying its own cultural framings and boundaries. Introducing farmers to science-based technologies is therefore not merely about farmers changing their ways of knowing as a result of training, as the scientists usually assume. Instead, given how knowledge is closely intertwined with the knower's socio-cultural and physical context, it implies a thorough rearrangement in the farmers' livelihood that goes beyond the mere adoption of a specific technology.

Drori et. al. think along the same lines, arguing that the application of science entails the adherence to 'an expanded and intensive cultural package of ideas and assumptions about the lawful and comprehensive character of nature, including human and social nature' (Drori et al., 2003, p.1), or - put differently - a way of ordering knowledge and society (Jasanoff, 2004). In agricultural terms it entails an understanding of farmers as profit-maximising agents, a primary focus on increasing agricultural production and productivity and the use of numbers-based technologies and tools to improve a farmer's control over biological processes. It also means that farmers should become directly or indirectly involved with external actors and institutions such as traders, national, regional and even global markets, scientific institutions and extension services. All in all, it entails an attempt to have farmers adhere to a (for them) new way of understanding and performing their livelihood in general and their farming specifically, while integrating themselves in a wider network that links them up with a number of external actors and structures.

Authors in Postcolonial Technoscience highlight the situatedness of the technological solutions being proposed (Anderson, 2002; Turnbull, 1997; Watson-Verran & Turnbull, 1995). Most of the approaches and methods introduced in African contexts originate(d) in the research institutions of their former colonial masters, the Soviet Union and/or the United Staes. In the livestock sector many of these are based on breeds developed with industrialised farming systems in mind. These breeds require inputs and devices produced in industrialised countries in order to function, and they are developed and transferred through institutions and activities funded by these same countries often with the involvement of 'local' professionals trained in these countries as well. And while their basis in scientific thinking carries with it the stamp of universality, they are nevertheless shaped by and based on the values and contexts they were developed in, are 'situated', 'local' forms of knowledge and (agricultural) practice. Their transfer to new contexts is therefore not merely a matter of having farmers adopt a 'neutral entity', but about integrating themselves into new and different networks and societal orders.

Mike Powell in turn points to one crucial aspect of this underlying order. According to him, (Powell, 2006), one arguably relatively pervasive notion of knowledge in relation to development is the notion of there being some kind of 'global knowledge' that includes most of the 'modern' scientific canon, and that can be distinguished from 'local' or 'indigenous' knowledge, 'which can be accorded greater or lesser degrees of respect, depending on the context in question' (p.521). He points out two dangers inherent in this understanding: 'One is that it is essentially hierarchical, so that it is hard to avoid condescension in the relationship between the global and the local. The other is that, as 'global' is usually understood to mean current Euro-North American, it contains the delusion that Euro-North American is not itself 'local'' (p. 521). He goes on to say that '[m]ost development organisations have (…) failed to recognise the fundamental significance of conceptions of knowledge, and use of knowledge, to development; they have failed also to recognise how contested are the choices involved, and how the pursuit of other priorities can affect organisational effectiveness in this area' (p. 530).

1.3. Topic of the Dissertation

It is this 'blind spot' regarding conceptions of knowledge that is meant to be addressed through this dissertation, taking up the call of Scoones, Leach et. al. (Scoones et al., 2007) for a 'reflexive turn' in development towards a stronger focus on complexities and issues of power and equity in knowledge-creation. To do so, the ways of knowing of both farmers and scientists will be looked at - including the social orders and heterogeneous actor-networks underlying them - as they meet and interact during agricultural (livestock) research interventions in a smallholder farmer setting. The analysis will include the face-to-face meetings among and between farmers and scientists, striving to describe and understand the processes taking place, their complexities and power dynamics.

This dissertation features two case studies. Both involve on-farm research projects in animal breeding, implemented by scientists from the same research institutions (to some extent even the same people). The research objectives were different, however. The first case study - taking place in Uganda - involved the meeting of a team of scientists with farmers from the Bahima, a tribe of former pastoralists who have settled down and taken up dairy farming. This shift towards milk production entails radical changes on the Bahimas' farms and farming practices. The scientists in turn aimed to model and analyse their new dairy-based farming system. The second case study took place in Ethiopia, where smallholder farmers in the Menz Region had been maintaining a mixed crop-livestock farming system for centuries. Due to changes in the region's rainfall patterns the system is at risk, however, and sheep become increasingly important for the farmers' maintenance of their livelihood. Here the team of scientists tried to join forces with farmers to introduce a community-based breeding programme aiming to increase the sheep's performance.

The purpose of this dissertation is not to compare these two cases in a classical sense, but rather to combine or contrast them with each other in order to highlight different aspects of the same process in the 'travel' of technoscience. While observing the interactions between farmers and scientists in both cases, a conceptual 'step back' will be taken in order to look at the ways of knowing of farmers and of scientists symmetrically, i.e. by not making the usual distinctions between 'local'/'indigenous' farmer knowledge and 'scientific' knowledge, viewing them instead as similar and comparable; and by not limiting the analysis to people's minds, but by acknowledging the importance of non-human actants such as livestock, tools and documents in positioning and stabilising ways of knowing (Latour, 1992). The focus of the analysis is on understanding the farmers' and scientists' respective ways of knowing, their origins, materiality and underlying social orders (Jasanoff, 2004), as well as the implications these have as they meet and interact with each other.

1.3.1. Research Questions

To guide the research as outlined above, the following research question will be used:

Main question

How do the materialities and social orders underlying the ways of knowing of farmers and animal breeding scientists influence their interactions in livestock research projects?

The focus of this question is on understanding the farmers' and scientists' ways of knowing as such, as well as the dynamics that can be observed when they meet and interact. The subquestions highlight the specific aspects to be considered.

Subquestions

What are the contexts within which the farmers' and scientists' respective ways of knowing were co-produced?

What are the actor-networks, their (both human and non-human) elements (actants) and the associations between them through which the ways of knowing of farmers and scientists are enacted and stabilised?

What social orders, values and imaginations guide the farmers' and scientists' ways of knowing in general, and their enactment of livestock specifically?

How do scientists and farmers attempt to enrol/integrate each other into each other's respective ways of knowing and social orders as they work with each other and interact in on-farm livestock research?

1.3.2. Structure of the Dissertation

Following this introduction, Chapter 2 will provide the State of the Art on the subjects related to the topic of the dissertation, by outlining the key literature in which the dissertation inserts itself.

This will be followed by Chapter 3 - The Theoretical Framework - which will describe the literature and concepts through which 'Ways of Knowing' as understood in this dissertation are defined.

Chapter 4 will describe the research methodology used in data collection, as well as the approach in its analysis.

Chapter 5 then introduces the two case studies upon which the dissertation is based by 'setting the stage' for the meeting of the farmers and scientists observed during field research. It gives an overview of the historical background of science-based breeding, the farming system of the Bahima in Uganda as well as of the Menzei in Ethiopia, describing through an ANT-perspective the evolution of the underlying processes and networks up to the moment in which the scientists decided to implement a research project at that specific site.

Following this prelude, Chapters 6 and 7 then provide the bulk of the research findings respectively of the Ugandan and Ethiopian case studies, based on an analysis of the observations made at the 'frontlines' where scientists and farmers interacted with each other in livestock research projects. As the analysis is guided by Actor-Network Theory and the elements that it focuses on, and given how interactions of farmers and scientists are a complex affair, there are innumerable ways in which ‘the social’ can be ‘traced’ in a given situation (Latour, 2005). In order to account for this complexity, this dissertation will describe the case studies through ‘small stories’. These are to be understood as a literary device, based on John Law’s observation that ‘(…) we may need to give up single narratives in favour of many small stories. Indeed, (…) it may sometimes make sense to give up small stories in favour of patterns and the art of describing those patterns.’ (Law, 1999). Each ‘small story’ in this dissertation is therefore to be understood as highlighting one specific aspect or even pattern of a given case study, with the combination of these small stories providing a more comprehensive picture of the ways of knowing of farmers and scientists as they meet and interact.

Finally, chapter 8 will synthesise the findings from these small stories into a number of reflections and recommendations on farmer-scientist interactions in agricultural research for development.

Chapter 2 - State of the Art

Ever since industrialised countries strived to assist countries of the ’Third World’ in achieving ‘development’, this effort has been researched by a number of academic disciplines including Anthropology, Sociology, the various agricultural sciences and especially by Development Studies. Eventually Science and Technology Studies, too, would contribute to this field of research. The present chapter will give an overview of some of this work, focusing on those writings with direct relevance to the topic of this dissertation. In doing so it will cover three broader themes.

The first will cover writings that have strived to conceptualise what is described as the ‘travel’ of Western technoscience from its origins in industrialised countries to the rest of the world. The second theme addresses literature about what could arguably be described as the ‘front-lines’ of this travel of technoscience in agriculture, that is the attempts that have been made to understand and even harness the ‘indigenous’ knowledge of the farmers in developing countries, to contrast it with scientific knowledge and to integrate the two. The ethnographic and sociological description of these attempts *as attempts* forms the subject of the third theme that is covered. Special emphasis is made here on work using Actor-network Theory, as this theory forms the backbone of the theoretical framework of this dissertation. The chapter closes with a positioning of the dissertation within this wider body of literature.

2.1. Conceptualising the ’Travel’ of Technoscience

The first element to be looked at is the ‘travel’ of (techno)science especially to so-called ‘developing’ countries, a topic that has been addressed most notably by Postcolonial Technoscience Studies. While not explicitly established as a field of study, the term has been used to capture a number of works that deal with aspects of modernisation and globalisation in former colonial territories, thus overcoming the hitherto rather Western bias found in much of Science and Technology Studies[3] (Anderson & Adams, 2008; Anderson, 2002; McNeil, 2005). Postcolonial Technoscience can be viewed as a critique of Modernisation Theory. The latter assumes the existence of a technological impulse inherent in industrialised countries - the 'centre' - that is expected to diffuse to the 'periphery', i.e. to former colonies/‘developing’ countries. Postcolonial Technoscience’s critique is directed at Modernisation Theory's inherent linearity and assumed homogeneity, and the resulting ignorance of the complex political dimensions of science and of technologies. In an attempt at countering these shortcomings, some scholars have begun examining processes of globalisation by looking more in detail at how science and technology travel between cultures. For the purpose of this dissertation, three aspects are worth looking at more in detail.

A first approach is through the use of geography, as exemplified by Livingstone (Livingstone, 2003). His work highlights how ‘place matters’ in the study of science, focusing on the history of early European science (I.e. 16th to 19th centuries, briefly touching the first half of the 20th century) to do so. Going against the often-implicit assumption that science is universal and ‘placeless’, he traces the different localities in and through which it is performed, subdividing them in sites, regions and tools for circulation. Note that in his analysis he does not limit himself to physical locations and objects, but also refers to the

[3] Note that while Ethiopia was never colonised as such, it has become one of the main recipients of development aid after World War II, thus making it a valid subject of study nonetheless.

abstract or metaphorical spaces that shape society (such as social classes; think here e.g. of how in the past only genteels were seen as reliable sources of knowledge - see also Shapin & Schaffer, 1985).

Of special interest here are his tools for circulation, i.e. the analysis of how science moves in space and time. Looking at how in the past science was brought to different locales, or how far-flung areas were bound into the scientific endeavour, he shows that this was not merely a matter of objects being moved, but also a matter of the transfer of craft through people (see also Collins, 2001). In addition, a seminal role was played by what he calls 'techniques of trust', i.e. devices, documents and trained people used to collect data throughout the world and bring them 'back' to scientific centres such as museums, universities etc. (see also Law, 1986). Examples of these are maps - which can be viewed as 'controlled fiction' - and even scientific theories and their function as 'repositories of trust'. Overall, his work shows how science is not a universal body of knowledge standing loose from culture and space, but rather a form of local knowledge transferred through space to create another.

Drori et al. in turn delve deeper into the authority of science in today's world (Drori et al., 2003). According to their analysis, science has become a 'rationalising force' that has '[spread] throughout world society as an expanded and intensive cultural package of ideas and assumptions about the lawful and comprehensible character of nature, including human and social nature.' (p.1) It is 'a system that is accepted as legitimate and valuable and that structures reality and activity for individuals and groups in society' (p.3.). They go on to demonstrate this spread by illustrating how scientific publications and even ministries of science have grown almost exponentially in number. Of interest here is their argument that the global authority of science is not so much as a result of its value as an instrument; as they show throughout the book, the impact of science on the development of societies is not necessarily positive. Progress - if understood in terms of economic growth - is not given through increased research. Rather, the authority of science is based on its cultural value as a 'vector of (Western) modernity' which one must follow if one wants to participate in its modernisation project. One consequence of this need to follow this 'modernisation vector' through global scientific culture is an increased standardisation and homogenisation of the societies involved in and/or affected by science.

Anderson and Adams pursue a similar aim by wanting to 'provide an analytic roadmap to approach this phenomenon of travel in an age of globalised science, noting the need for more connections to the histories and political relations that enable such travel' (Anderson & Adams, 2008, p.181). Drawing on a wide range of work on postcolonial relations in science, they point to a number of aspects to consider when analysing the travel of Western technoscience. They highlight how 'global' technoscience in essence comes down to structures and processes that are bound to specific localities. Its operations are characterised by transactions between places (labs, universities' in different countries, the field'…), whose locality is deleted through science's claims and enactments of universality. Nevertheless, under such an 'invisibility cloak' political actions still take place: hierarchies and social orders are reconstituted and identity politics negotiated in and through 'technoscientific imaginaries'. Overall, they emphasise how there is a need to 'be sensitive to dislocation, transformation and resistance' taking place throughout this travel (p.184).

Appadurai finally adds to the debate by introducing what he calls the thinking-trap of 'trajectorism', i.e. the tendency inherent in the spread of Western influence throughout the world - including through technoscience - to think in terms of trajectories (Appadurai, 2012).

He argues that European Enlightenment's claim of universality went hand-in-hand with its imperial strivings to dominate the globe, resulting in that Europe's post-Renaissance idea of modernity required 'complete global expansion for its own inner logic to be revealed and justified.' (p.27). He writes:

Empire, specifically European imperialism of the last three centuries is a transverse spatial enactment of a defective vision of temporality in which time's arrow always has a single direction and a known destination. That destination is the world written in the image of Europe. (p.28).

He then goes on to argue that this unidimensional and monolithic understanding of modernisation fails to match the lived realities in the many countries that it touches. He calls for a 'reassessment of Europe's trajectorism' that promotes 'dialogue rather than dominion' (p.30ff.)

Generally speaking, the authors above offer interesting avenues to think about and conceptualise the 'travel' of science from industrialised to 'developing' countries. They show how science is spatial in that it is linked to specific geographic locations, and how tools and processes are put in place that enable the gathering of data, the exertion of authority, political control and even the reordering of societies. They are limited however in that their focus is on science itself, and do not address the knowledge systems that are found in the places to which science travels. These 'indigenous' forms of knowledge and their relation to science have been the subject of another body of work to which we turn next.

2.2. Perspectives on 'Indigenous' and Scientific Knowledge

Before looking at the literature covering issues of 'indigenous' knowledge, a quick observation is in order. After all, the term 'indigenous' in itself already reminds of colonial times, as it was a term - just like 'native' or even 'savage' - frequently associated with the people of the Colonies, with often somewhat pejorative connotations. In addition to this, it implies a degree of homogeneity that accounts neither for the multitude of different knowledge traditions that exist throughout the world, nor for the constant change and exchange that exists within and between them. The authors from Postcolonial Technoscience introduced above argued that science itself is not universal, but emerged from within a specific, local setting and spread through empire building and the contemporary global efforts towards modernisation and development. As a consequence - and as some authors will argue below - any differentiation between 'indigenous' and 'scientific' knowledge is not justified, since any knowledge tradition is tied to specific localities and requires specific people, tools and organisational structures in order to function. Such a view is also shared within this dissertation. The review of the literature on 'indigenous' knowledge that will follow is therefore not to be understood as an agreement with the dichotomy between indigenous and scientific knowledge that it implies, but as a review of existing perspectives on farmer knowledge that this dissertation hopes to transcend.

2.2.1. Conceptualising Indigenous and Scientific Knowledge

Especially Development Studies have had a long-standing tradition in engaging with 'indigenous' knowledge. Briggs gives a comprehensive overview, which will form the backbone of this section (Briggs, 2005). In the initial days of development co-operation, scientific knowledge was viewed as 'the way forward' in line with the modernisation project of having former colonies develop following the blueprint of industrialised countries. Science was viewed as being universally applicable and 'rational', as opposed to the knowledge of the farmers in developing countries, which was viewed as ‘emotional’ and ‘backward’ (Agrawal, 1995). With the mounting number of failures of this modernisation project, resistance to its orthodoxy emerged. The move towards more ‘participation’ of the poor was the most visible reflection of this (R. Chambers, 1983). In a similar vein, indigenous knowledge of farmers became a subject of attention with the seminal work of authors such as Paul Richards (Richards, 1985), who observed the experimentation practices of farmers in Nigeria and Sierra Leone. Rather than describing the farmers’ shifting cultivation practices as primitive and backward, he found them to be highly adapted to their social and ecological conditions, and the farmers themselves to be highly innovative and open to experimentation. Through his and others’ work, farmers’ indigenous knowledge was welcomed as a new knowledge resource to tap from, as complement or even alternative to the top-down, centralised scientific knowledge that had hitherto more often than not failed to translate in African contexts (see e.g. World Bank, 1998).

The focus of this renewed interest in indigenous knowledge was not so much on the underlying epistemology and world views, but rather on the content and corresponding practices of soil management, water conservation etc. Attempts were thus made to understand underlying, sometimes implicit classification systems (e.g. Lamers & Feil, 1995; in Briggs, 2005), or even develop taxonomies and systems of structuring it for purposes of recording and transmission (Brodt, 2001). Such a focus on practices and on the instrumentalisation of indigenous knowledge soon led to the critique that it disconnected this knowledge from the context from which it emerged and in which it was rooted (Ellen & Harris, 2000, p.15; (Sikana & Mwanbazi, 1996, p.108; in Briggs, 2005). Such critiques highlight the contextual nature of indigenous knowledge, pointing out how it emerges from a specific setting and as a response to its demands. According to these authors it is this contextuality in which the strength of indigenous knowledge can be found, and taking it out of this context inevitably results in failure. As a consequence, they argue, indigenous knowledge should not be ‘scientised’ (Briggs, 2005, p.22).

Another critique raised at the renewed interest in indigenous knowledge was that it in itself was not problematised, and was instead viewed as a ‘given’ and optimised solution in a given context until it was displaced by the often maladapted solutions based on scientific knowledge. As such it was viewed as static and ‘untainted’, a view that entailed the risk of replacing the hegemony of scientific knowledge with another one (Cleaver, 1999, p.605; in Briggs, 2005). Authors holding such romanticised views of indigenous knowledge, labelled as ‘neo-indigenistas’ by Agrawal (1995) thus implicitly described indigenous societies as being conservative and static, overlooking their potential dynamism and heterogeneity in integrating new concepts and practices.

Last but not least, the point was made that much of the research and debate on indigenous knowledge overlooked the power dimension of knowledge, instead perceiving it as homogeneous and equally distributed among the members of a given community (Agrawal, 1995). There might be differences within communities, however, with for instance men and women having knowledge on different aspects of their livelihoods and the men’s side of the story being more often heard (Cleaver, 1999; in Briggs, 2005, p.17). Even the intervention of external actors implies certain shifts in power in relation to knowledge. Indigenous farming knowledge might discredit science-based forms of agricultural knowledge, for instance, and the reaction might be that the former is discredited through crisis-narratives (Mackenzie, 1995; in Briggs, 2005, p.16). Or indigenous knowledge might be included in specific development measures, but kept under managerial control by the 'experts' (Schroeder, 1999a, 1999b; in Briggs, 2005, p.17)

Bringing Scientific Knowledge Into the Fold

The authors mentioned so far have kept a distinction between scientific and indigenous knowledge, considering them to be separate epistemologies with different origins and foundations (Agrawal, 2005). Following this understanding science is viewed as context-free, whereas indigenous knowledge is seen as context-specific. The question of the context-specificity of scientific knowledge is not explicitly addressed by them (Briggs, 2005). It was through the feminist critique in Science and Technology Studies that first forays into the 'situatedness' of scientific knowledge were first made (Haraway, 1988), which would eventually influence attempts at conceptualising the situatedness of both 'indigenous' and 'scientific' knowledge.

This can most notably be found in the work of Turnbull (Turnbull, 1997, 2000, 2006; Watson-Verran & Turnbull, 1995). His attempt is one of dissolving the dichotomy between scientific and indigenous knowledge, treating science as one example of a 'local' knowledge system among many. More specifically, he attempts to show that indigenous knowledge traditions are more mobile - and thus less 'local' - than is commonly assumed, and that the 'universal' knowledge of science is more 'local' than usually thought. He does so by analysing a number of different knowledge traditions, such as - amongst others - the 'organic' building processes underpinning Chartres cathedral, the mobility of the knot-based Inca recording system, Polynesian navigation as well as the politics and finances underlying malaria vaccine research.

In doing so he coins the concept of 'Knowledge Spaces', which he views as heterogeneous assemblages of people, skills and equipment linked together by a number of strategies and devices. Following this concept, 'objectivity' is not a disembodied and transcendent characteristic of a given knowledge system, but rather the result of a collective performance by knowledge producers in a specific knowledge space. Accordingly, '[t]he difference between science and other knowledge systems is the result of differences in the effectiveness of technologies of surveillance.' (Watson-Verran & Turnbull, 1995).

Overall, treating science in this way as a set of local practices, it becomes possible to 'decentre' it and enable an equitable assessment of the characteristics of all knowledge systems. Turnbull's aim is however not one of deciding for one knowledge tradition and against another. Rather, he argues that we need both: "the joint preservation of the liberatory elements of the enlightenment project and a wide diversity of other knowledge traditions" (Turnbull, 2000, p. 14).

2.2.2 Farmer Participation in Research

In parallel with the growing interest in Indigenous Knowledge, researchers and development professionals also wanted to harness the 'beneficiaries' knowledge in their work, to have them actively participate in development efforts. This 'participation' - as it would eventually be referred to - had its origins in the failure of many development programmes whose solutions were understood to have been imposed 'from outside'. Especially through the seminal work of Robert Chambers (R. Chambers, 1983, 1997) the need was brought to the fore to 'put the last first' by listening to the poor and having them become active participants in any development initiative.

A range of tools to do so was developed and applied. Participation was however not limited to development work. It also found its way into agricultural research, where it became known as 'farmer participatory research'. First efforts in this direction could already be found in the mid- to late 1970s, where farmers were involved in some of the CGIAR centres' plant breeding activities (Biggs, 2008). The following decade saw a continuation of the work initiated by the CGIAR, including FAO's work with Farmer Field Schools in Integrated Pest Management, as well as ITDG's introduction of the Participatory Technology Development methodology.

In the 1990s the move towards participation in development in general and in research in particular continued, with existing methods being refined and new ones developed. Implicit in the discourse underlying these efforts was the understanding that 'the more participation, the better' (Pretty, 1995). As such, participatory approaches tended to be very much inward-looking and managerial, and did not show any reflection on their own underlying assumptions and stances. Around this time critical voices began to be heard questioning the effectiveness of 'participation' (Neef & Neubert, 2010), pointing out for instance the challenges of implementing Farmer Participatory research given the difficulties in understanding farmers' social processes (Okali, Sumberg, & Farrington, 1994; see also Scoones & Thompson, 1994).

This would later turn into a more general critique against participation. This critique was not directed at the general principle of having the poor participate in development efforts, but rather against the whole discourse that had emerged around it. In a seminal book, Kothari et. al. for instance criticised how participation was usually done in a 'ritualistic' manner. If questioned at all, it was usually in relation to the 'how' rather than the 'why' of the approaches (Cooke & Kothari, 2001). According to them, 'a misunderstanding of power underpins much of the participatory discourse' (p.14). This point is echoed by Mosse (2001), who argues how in participatory approaches the 'knowledge' of farmers is usually integrated in or made compatible with pre-existing agendas. As a result, Participation has become 'a way of talking rather than doing things', with implementing organisations wanting the benefits of participation without paying its costs.

This critique has shown some effects on the theory and practice of participatory research. It is no longer viewed as a 'counter-concept to conventional research' (Neef & Neubert, 2010). Instead, scientists highlight the need to see the comparative advantage of different forms of knowledge (Powell, 2006), critically review the different processes and elements entailed in participatory research (Cornwall, 2008; Neef & Neubert, 2010; Stirling, 2005) or argue for the necessity to place research in its social and political context (van Asten, Kaaria, Fermont, & Delve, 2009). According to Biggs (2008) this can be viewed as the main challenge that farmer participatory research faces nowadays.

2.3. Unravelling the Frontlines of Technoscientific Travel

The literature reviewed so far offers a number of perspectives on science's spread to developing countries, from the way Western technoscience has travelled throughout the world via the attempts at contrasting or comparing it with 'indigenous' forms of knowledge to the analysis of methodologies for integrating the two. Each of those perspectives come with an inherent 'blind spot' that prevents it from providing an accurate account of what happens when Western technoscience spreads to new territories. The literature on the travel of technoscience for instance focuses exclusively on technoscience as such. While the literature on indigenous knowledge does consider other forms of knowledge, its distinction between scientific and indigenous knowledge blinds it to the ways in which these two may overlap and even combine. Turnbull provides a way out here with his concept of 'knowledge spaces', but this concept remains relatively static in that it does not encompass the dynamics that may be found when different forms of knowledge meet and interact. Arguably, Farmer Participatory Research can be viewed as a method trying to bring indigenous and scientific knowledge together, but being as it is a method and not a concept, it is a bit of a odd-one out. However, the critiques of the method reviewed here highlight how though its managerial approach it has so far more been about integrating indigenous knowledge into science rather than a synthesis.

Altogether, this literature does not provide a look at the interaction between scientists and farmers as they meet and work together (or not), i.e. at the day-to-day activities and struggles of science in (agricultural) development. This work has been done about development policy and projects in general though so-called ethnographies of aid (Mosse & Lewis, 2006), which is the literature to which we turn next.

2.3.1. Ethnographies of Aid

In their book 'Brokerage and Translation' Mosse and Lewis introduce these ethnographies, describing them as an arguably relatively new genre in development studies (Mosse & Lewis, 2006). According to the authors, they '[p]rovide (…) valuable reflective insights into the operations and effectiveness of international development as a complex set of local, national, and cross-cultural social interactions.' (p.1). They are an 'anthropology of the global' (p.2) that looks at aid not through abstract, structural representations, but instead takes as its starting point the nitty-gritty of the actual day-to-day interpersonal processes, interactions, struggles and contestations. In so doing it helps to investigate what Mosse and Lewis call the 'multiple rationalities of development' (p.15), including the scripts and processes that are 'hidden' and exist alongside the official narratives of aid.

A good example of the explanatory power of this approach can be found in Mosse's ethnographic account of the British Rainfed Farming Project in India, in which he worked for some time as consultant (Mosse, 2005). Following the progress of the project through its various stages, he describes how throughout its implementation 'policy' in its many guises shaped the aid effort by legitimising rather than orientating practice. The project was thus better understood as a 'system of representation', with the representation being the end rather than the means for development, and enabling the maintenance of relationships between development actors. Following this analysis, the success - or failure - of a project is therefore not based on its actual impact on the ground, but is a 'policy-oriented judgment' based on its possible contribution to current policy-discourse and networking.

The discrepancy between the ongoings on the ground and their representation at higher levels of organisation is also the topic of the ethnography written by Richard Rottenburg (Rottenburg, 2009). His starting point is the parable of a waterworks development project in 'Ruritania' funded by the 'Normland' development bank.[4] In describing the activities of and interactions between bank, implementing consultant(s) and Ruritanian counterparts through

[4] While his findings are based on an existing project, he chooses the format of a parable in order to more explicitly address the inconsistencies and irregularities of aid, focusing less on personal failures and more on the underlying structural processes.

the perspective of several of its implementing actors, he analyses "the role of technologies of inscription and representation in development cooperation as an organizational process" (p. xiv). Most notably he describes how the intervention is borne by an 'original script' - including the rhetoric of having the Ruritanians being the main decision-makers regarding implementation - whereas in practice an 'unofficial script' is being followed where the implementation is rather guided by the necessities of the Bank having its money spent according to plan. His analysis shows the difference between the rhetoric of development co-operation and its actual realisation in the field. In so doing he addresses the 'intricacies and inconsistencies' of the translation of what happens on the ground to the reports and numbers used to generate 'objective' facts that create legitimacy and guide decisions on success, failure and further actions at Headquarters level.

2.3.2. Actor-Network Theory in (Agricultural) Development

A key concept used in both ethnographies - and even in the title of Mosse and Lewis' book cited above - is the concept of 'translation'. It's a concept drawn from Actor-Network Theory, which has its origins in Woolgar and Latour's ethnography of a microbiology lab (Latour & Woolgar, 1979) and was further refined with seminal work by Latour, Callon and Law (e.g. Callon, 1986; Latour, 1992, 1993, 2005; Law, 1992, 1999). While it soon reached the sociological mainstream and established itself as one of its main contemporary theories, it has so far hardly found any acceptance in the field of Development Studies. Heeks and Stanforth (2013), in a review of Development Studies journals from 2000 to 2012 found no paper using ANT as its core framework. Similarly, while approaching journal editors with the proposal of a special issue on ANT in development he was repeatedly rejected, on reasons that the theory had not been used previously in the field, in some cases even felt to be 'too old', and with no clear understanding of the special contribution that ANT could make to Development Studies.

These setbacks notwithstanding, the theory offers a number of areas of potential for Development Studies. According to Heeks, '*ANT offers a new perspective on all aspects of development: its concepts, structures and processes. It is a view that disputes linear and objectivist visions of development and which moves beyond the dualities of technology vs. society, macro vs. micro; instead offering a more complex and emergent view that, arguably, adheres more closely to the lived experiences of development projects and processes.'* (p.2). It is due to this potential that ANT was eventually chosen as the backbone of the Theoretical Framework of this dissertation. Accordingly, a review will be given of those authors who have analysed processes of 'development' - including agricultural development - using ANT. While their work is located more in the field of Science and Technology Studies than in Development Studies as such, they do illustrate the contributions that the theory can make to the latter, and have therefore been a valuable source of inspiration for my own analyses. Two specific subject areas were of particular interest, and will be covered here.

ANT in Processes of Technological Change

The first subject area addresses the use and/or transfer of technologies. The most notable example are the numerous studies on the translation of technologies from their context of origin to another. Akrich's analyses of diverse technologies such as photoelectric lighting kits, a generator, an electricity network (Akrich, 1992) and a gazogene (Akrich, 1993) for instance highlight how a technology is defined by the relations it has with other actants, and how when moved from one context to another these relations are fully renegotiated. In these renegotiations, 'scripts' do play a role: developers of a technology inevitably 'in-scribe' it with specific imaginations and values on who the users are and how they are expected to implement the technology, whereas the users themselves in turn ‘de-scribe’ following their imaginations and needed (a more in-depth look at such scripts can be found in Oudshoorn and Pinch’s review of semiotic approaches to users (Oudshoorn & Pinch, 2003)). Her work highlights the inappropriateness of the technical-social dualism in understanding technological change, pointing out how - in the case of the gazogene, for instance - this dualism can be used as a way to interpret the difficulties of a technology-transfer, and in so doing obscure the true reasons for its failure.

In the same vein, Shepherd and Gibbs tell what they call ‘a story about the transportation and reconstitution of a heterogeneous socio-technical assemblage from a temperate climate to a tropical milieu’ (Shepherd & Gibbs, 2006). This heterogeneous socio-technical assemblage is a ‘model’ dairy farm, based on best practices as applied in Australia and brought to East Timor in an attempt to contribute to its development. In their description of the difficulties of this transfer, they use ANT to illustrate how an endeavour that was described as apolitical - the technical support of a society in need - had in fact a political agenda - the access to East Timor’s gas and oil reserves - embodied in its discourses, epistemology and human and non-human actors.

The case of a successful technology transfer is described by de Laet and Mol in their work on the Zimbabwe Bush Pump (de Laet & Mol, 2000). In it they describe how a pump was successfully introduced in the Zimbabwean rural context. Key to this success has been what the authors call the ‘fluidity’ of the technology, i.e. its ability to be adapted to the prevailing circumstances, rather than its ‘introducers’ trying to adapt the circumstances to their vision of the pump.

A more specific look at the power-dimension of technologies-as-heterogeneous actor-networks can be found in the work of Holloway et. al. on the knowledge shifts in livestock breeding in the UK through the introduction of genetic markers (Holloway, Morris, Gilna, & Gibbs, 2009, 2010; Holloway & Morris, 2008). A key concept in their work - drawn from Foucault - is the concept of ‘biopower’. It refers to the power that can be exerted on populations - in this case livestock - through systems of knowledge and strategies of intervention that are associated with specific truth claims and authorities. These are maintained by ‘biosocial collectivities’, heterogeneous networks binding breeders, livestock, tools and techniques together to enact and maintain control over a specific livestock breed. With these as starting point, they describe how the introduction of a technology like genetic markers brings about shifts in the sites of knowledge and power, in this case leading away from ‘livestock breeds’ as repositories of particular characteristics and traits towards a focus on specific genes.

Finally, moving beyond specific technologies to a field of technological practice, Noe and Alroe take a specific look at the practice and characterisation of farming (Noe & Alrøe, 2003a, 2003b). They propose an approach that combines ANT and Luhmann’s work on autopoietic systems in order to describe farms as heterogeneous actor-networks whose enactment is guided by self-referential systems of meaning. In so doing the authors are able to describe technological change on farms as a process of enrolment of external actor-networks guided by these systems of meaning. This exposes the arbitrariness of any distinction between ’traditional’ and ‘modern’ farming systems and - again - between ‘social’ and ‘technical’ issues, arguing instead that farms may operate according to a multitude of different 'logics' that should be the starting point for any attempt at supporting their development.

From Single Technologies to Global Processes

ANT has not only been used to describe technologies and their corresponding networks, however. It has proven to be equally suited to describe wider - even global processes of technological change and/or control. One example is Law's analysis of how the 16th century Portuguese were able to control its colonies on the other side of the globe through the combination of ships, maps, astrolabes and trained mariners (Law, 1986). Arguably the most well-known work on this issue is Latour's description of the work of Pasteur on the anthrax bacillus. By what he describes as an inversion of the micro and the macro in his lab he was able to position himself as the spokesperson of the bacillus - and as obligatory passage point for French farmers and veterinarians to access the means to combat it - and thus became able to reshape and revolutionise the whole of French agriculture (Latour, 1983).

In a subject closer to issues of contemporary agricultural development, Busch and Juska use this ability of ANT to overcome the dichotomy between micro and macro as a 'way out of the modernist box' in which Political Economy finds itself trapped (Busch & Juska, 1997). To make their case, they apply ANT in a description of aspects of agricultural globalisation in the Canadian rapeseed sector. By 'opening up' the actor-network that is a corporation and looking at the intermediaries (most notably hybrid seeds) through which it is able to act on farmers at a distance, they are able to take a closer look and better understand the 'specifics' of agricultural globalisation. While the findings of such a research may be less generalisable, the authors argue that such 'modesty' in Political Economy might nevertheless be required, and that this might make such findings both more accurate and more useful.

The literature mentioned above illustrates how ANT as a theory offers ample opportunities to address issues of (agricultural) development. This might be especially relevant in Development Studies, where according to Heeks the work has been caught up between the polar opposites of positivism and economic thinking based on rational choice on the one hand, and a post-modernist focus on culture and discourse on the other (Heeks & Stanforth, 2013). According to him the theory moves the analysis closer to the 'complex and non-linear dynamics of day-to-day development work', and thus going against the trend in much of development policy and research of seeing the world as 'stable, linear and predictable' (Leach, Sumner, & Waldman, 2008, p. 731, 734-5; in Heeks & Stanforth, 2013). It also acknowledges the multiplicity of actors that are involved at different scales, and in so doing also includes non-human ones, making it uniquely suited to address issues of technological change.

2.4. Positioning this Dissertation in the Wider Literature

The literature reviewed so far covered several aspects: the travel of technoscience, the differences and similarities of indigenous and scientific knowledge as well as the attempt of integrating them in Farmer Participatory Research, the ethnographies of aid and finally Actor-Network Theory. The following dissertation will draw on this literature in a number of ways. It follows in the footsteps of Postcolonial Technoscience in that it describes the process of the travel of Western technoscience to African contexts. This description will however not consist in structural explanations with an exclusive focus on Western technoscience as such. Rather, by drawing inspiration from the ethnographies of aid and by using Actor-Network Theory as a framework, it will describe this travel as a meeting of the 'ways of knowing' of farmers and scientists, and analyse the ‘messiness’ and struggles that such a meeting entails. Furthermore, rather than viewing the farmers’ and the scientists’ knowledge as two distinct epistemological entities, it will follow Turnbull’s example by looking at the underlying heterogenous assemblages of which they are constituted that make it difficult to draw a clear line between the two. By looking at one case-study in which Farmer Participatory Research was applied, it will also show the power dynamics that underlie such attempts at integrating ‘indigenous’ and ‘scientific’ ways of knowing.

Overall, the reflections and analysis found in this dissertation can be understood as taking up the call of Powell (Powell, 2006). He argues that while development is generally viewed as a ‘giant service industry’, its work cannot be simply boiled down to, say, the introduction of new agricultural production technologies or the delivery of clean water. Rather, it is as much - if not more - a matter of creating socio-economic conditions in which these technologies or the water delivery can be integrated. This however requires a thorough understanding of the current context and of the knowledge and perceptions of the people that ‘development’ is supposed to benefit. However, ‘*[m]ost development organisations (...) have failed to recognise the fundamental significance of conceptions of knowledge, and use of knowledge, to development; they have failed also to recognise how contested are the choices involved (...).’* (p.530). In addition, *‘the [development organisations’] tools (...) are based on the linear processes of a service industry, rather than the complex interactions of a knowledge industry.’* (p.526). This dissertation will show the extent of which this also applies to the field of agricultural research. In so doing, it will strive to help overcome this ‘blind spot’ by providing avenues for a better understanding of the knowledge dynamics that underlie development initiatives.

The backbone of this better understanding is the theoretical framework, to which we will turn next.

Chapter 3 - Theoretical Framework

The focus of this dissertation is on what can arguably be described as the ‘front-lines’ of the global spread of science and technology in animal breeding, and the attempts of scientists to have smallholder farmers be part of it. As these farmers and scientists meet, there is a ‘clash’ of their respective ways of perceiving and acting upon the world, and of the role that livestock plays in it. For the scientists, these ways refer to how they mobilise and adapt a range of new tools - from the simple weighing scale to complex analytical software packages - in order to assess smallholder realities and suggest avenues for change. In doing so they bring along new practices, ways of managing animals and directions in which to develop them. This in turn is based on a vision of moving farmers away from subsistence farming towards integration into wider value chains and urban markets and having them meet the perceived challenges of the ‘Livestock Revolution’. Farmers on the other hand have knowledge and practices that they have developed and adapted to their social and environmental context, using local means at their disposal to maintain their livelihood. They too have their own agenda, focused on the maintenance and perhaps even improvement of their livelihood.

These ways of knowing however cannot be boiled down to merely an individual’s perception of and interaction with the world. Rather, as Jasanoff states, ‘the ways in which we know and represent the world (both nature and society) are inseparable from the ways in which we choose to live in it.’ (Jasanoff, 2004, p.2). In other words, ways of knowing are closely interlinked with and thus cannot be viewed loose from the way in which the knower’s society is structured. Jasanoff coins the term ‘Co-production’ to describe this phenomenon, in the sense that both the farmers’ and the scientists’ ways of knowing and the social orders of their respective societies co-produce each other. These social orders can be (co-)produced in a number of ways, including through identities such as the authority of ‘experts’, institutions as repertoires of problem-solving, discourses and the use of language as well as the ways in which knowledge is represented and shared (p.40). The following sections will describe the theories and concepts through which the ways of knowing of farmers and scientists will subsequently be analysed. Jasanoff’s ‘idiom’ (p.3.) of Co-production can be understood as underlying them all, in that the focus of the analysis is not on individuals, but on the social orders that are enacted and maintained through specific ways of knowing.

3.1. Actor-Network Theory

The main theory used in this dissertation is Actor-Network Theory, or ANT in short (Callon, 1986; Latour, 1992, 2005; Law, 1992). Using ANT has a couple of distinct advantages for addressing the questions covered in this dissertation. First, as the spread of technoscience is not limited to people’s minds, but also involves objects and - in the case of livestock - animals, ANT provides conceptual tools to address the role and impact that such non-human elements have in shaping interactions.

In addition, its use circumvents one of the often used ‘shortcuts’ in describing technological change in developing countries, namely the referral to the ‘social context’ as backdrop to science-based, ‘objective’ technological change (see e.g. Rege et al., 2011). ANT challenges this commonly held dichotomy between ‘society’ and ‘technology’, seeing them instead as arbitrary distinctions that cannot be differentiated empirically from within the complex web of associations that characterise a given situation. In practice, a ‘technical’ object like a weighing scale for instance cannot be understood loose from its 'social' implications, such as the nature of its ownership or the potential power that it may confer to its user. ANT thus dissolves this dichotomy by treating 'social' and 'technical' aspects as part of the same, heterogeneous 'whole'.

3.1.1. The Actor-Network

Key in doing so is the concept of actor-network. Underpinning this concept is the view that the meaning of any entity is only established in relation with other entities. A 'farmer' for instance can only be fully 'understood' when seen in relation to land, animals, markets, farm buildings etc. Similarly, a 'scientist' only 'works' within the context of, say, university laboratory facilities, computers, scientific journals etc. These entities in turn are not homogeneous by being limited to humans alone. Instead they are heterogeneous, meaning that understanding a 'scientist' involves not only understanding the human being, but also, say, the software she uses and the papers she publishes. The key element in all these are not so much the entities as such, but rather the associations between them (Latour, 2005). The analyst's task is to 'trace' these, and in so doing unravel the web of associations in which a given actor makes sense. It is this 'web' that is captured with the term 'actor-network'.

It should be highlighted however that such an actor-network cannot be described in an 'objective' manner. Expanding on the example of the scientist, the actor-network that constitutes her is of an almost infinite complexity, being not only limited to the software she uses, but potentially also encompassing her office-space, her research material, her associations with colleagues both within her university and worldwide, her coffee supply, her family and friends… For practical purposes an actor-network should therefore be understood as an analytical construction aiming to describe a certain situation or in order to answer a specific question, thus limiting the scope to the associations required for the purpose at hand (Law, 1999). In the same vein, specific actor-networks can be 'collapsed' to facilitate the analysis. The scientists' research may be funded by a specific agency, which is a complex actor-network in its own right. Rather than disentangling the agency's web, one may consider it as a 'black box' whose networked nature is implied but not further expanded upon.

3.1.2. Introducing Non-Humans

While other theories are limited to human actors, ANT is novel in that it explicitly draws attention to the influence that non-humans (e.g. animals, localities, tools…) have on the actor-networks of which they are a part. This is captured by the understanding that actor-networks are seen as being *heterogeneous*, i.e. consisting of both human and non-human elements, none of which is to be seen as subordinate to the other. In fact, ANT requires the analyst to deal with human and non-human actors *symmetrically*, i.e. ascribing agency to both of them. As an illustration, one may consider a farmer buying a herd of high-yielding dairy cows. These cows' 'agency' of the farmer will consist in them 'forcing' the farmer to modernise his stable, upgrade his milking equipment and establish closer ties with a veterinarian. Similarly, a weighing scale will guide a scientist's conceptualisation of a sheep, 'encouraging' him to understand the animal in terms of numbers rather than based on, say, tactile and visual cues. Such agency may be inherent in the non-human under consideration, or - as is more often than not the case of technological objects - the result of an explicit 'delegation' of such agency by a human actor. A typical example provided by Latour (1992) is that of the speed-bump, to which government authorities have 'delegated' the task of slowing down drivers on given stretches of road.

This example of the speed-bump furthermore nicely illustrates the role that technologies play in stabilising societies. As mentioned above, the introduction of high-yielding dairy cows will 'force' the farmer to re-organise his farm and maintain ties with specific actors such as dairy co-operatives, veterinarians and breeder societies. Put differently, the cows stabilise a specific technological regime in which specific actors play key roles, resulting in a specific societal order and distribution of power. To use a seminal title by Latour, '*technology is society made durable*' (Latour, 1991).

3.1.3. Network Enactment and Translation

This durability is however not permanent. While technologies do provide a certain degree of stability and permanence, it can nevertheless dissolve. The farmer having obtained a herd of high-yielding dairy cows will have 'stabilised' his actor-network through associations with a given set of actors, be they human (veterinarians, dairy co-operative representatives…) or non-human (stables, milking-robots…). It will however always be dependent on him regularly feeding his animals, fulfilling requirements of contracts and credit payments etc. In other words, the actor-network has to be *enacted* on an ongoing basis. Actor-networks are therefore not to be understood as structures that exist in and of themselves, but as ongoing *processes* that build on the active maintenance of associations with other actors (Law, 1999). Any perceived stability over time (which is captured by the notions of 'punctuation' and/or 'black-boxing' mentioned above), is just that: a perception, which may overlook the net*working* or ongoing translation that goes into keeping those networks in place. If circumstances change and associations get changed or dissolve or even new ones come in, the actor-network as is might change as well.

This leads to a last concept from ANT to be addressed here. Actor-networks consist of a large number of different actors held together through associations. The aim of any given 'entity' (e.g. a 'farmer') is to maintain the associations of the actor-network through which he is enacted. This attempt at maintaining associations is captured with the concept of 'translation', to be understood in the sense that one actor has to 'translate' his interests into those of the other actor with whom he wants to establish or maintain an association (Callon, 1986; Law, 1999). And it is in these attempts at translating the interests of others that issues of power can be examined.

3.1.4. ANT and Subjectivity

A final consideration regarding actor-networks is that given their inherent complexity, there is not one 'objective' way of describing them. Each description is always guided by the purpose of the analysis to which the description is to contribute. This subjectivity also means that there is no universally valid 'story' that can be extracted out of such an analysis. To quote Law (1999), ANT 'cannot be told as a single narrative'. Instead, the concept encourages one to look for 'little stories' and the ways in which these are held together, making ANT into an 'an art of describing the patterns and textures that form [an ontological] patchwork'. The following analyses are therefore to be understood not as a description of 'things as they really are', but are indeed a collection of subjective 'little stories' that aim to analyse farmer-scientist interactions in the field, and 'tracing' the actor-networks that underpin them.

As the aim is to understand the ways of knowing that come to the fore in these processes, the next step will be to build further on ANT in order to conceptualise these.

3.2. Conceptualising Ways of Knowing

Taking ANT as a starting point, this dissertation describes the spread of technoscience to rural communities in Ethiopia and Uganda. While this 'spreading process' has many aspects and can be observed at various levels, the starting point of my analysis will be on the *ways of knowing* underpinning them, i.e. on the ways in which farmers, scientists and the societies and networks of which they are a part perceive and act upon the world surrounding them. Care will be taken not to fall into the classic dichotomy of differentiating between 'indigenous' and 'scientific' knowledge. Doing so may be difficult for practical reasons alone: most farmers in developing countries - including those covered in the case studies of this dissertation - have already been exposed to and are using modern, 'science-based' technologies, and have accordingly adapted their way of managing their animals. Similarly, scientists too do not live in a scientific vacuum. Several of those interviewed in the course of my research have a farming background - or may even originate from the communities to which they return later as researchers. So, while in theory one might be able to identify specific characteristics of 'scientific' and 'indigenous' ways of knowing, in practice one is more likely to encounter hybrids.

Therefore, just like the distinction between 'social' and 'technical' aspects, the dichotomy of 'indigenous' and 'scientific' knowledge will be viewed as arbitrary and dismissed. Instead, following the ANT premise of a 'level field' (Latour, 1992), I will 'trace' ways of knowing as I could observe them empirically, i.e. based on my observations of how people acted, the tools they used and on what they said about what they did and why they did it. This however requires a more specific conceptualisation of what I mean with 'ways of knowing'. To do so, I will combine a number of additional theories with ANT's basic premises as outlined above, which taken together will provide me with the conceptual tools to analyse the ways of knowing of farmers and scientists as I observed them in the field.

3.2.1. Practice Theory and Communities of Practice

The first theory to be used is Practice Theory, of which Reckwitz provides a handy overview (Reckwitz, 2002). It has its origins in what Reckwitz describes as 'cultural theories'. These theories approach human action and social order by looking at collective cognitive and symbolic structures that generate 'shared knowledge' through which meaning is ascribed to the world and which guide action. Or put more bluntly, these theories view 'the social' as consisting of 'cultures' that bind individual people together in their understandings and actions. In Practice Theory the focus is on 'practices', which are defined as a 'routinized type of behaviour which consists of several elements, interconnected to one other' (p.249).

In other words, a practice entails the combined actuation of a set of elements. These include:

Bodies, in that a practice is exerted *through* the bodies of individuals by physically performing an activity, including speech.
Mind, as each 'external' activity also entails a corresponding mental activity which guides the action. This includes ways of thinking about and ascribing meaning to it, but also.emotions as well as tacit forms of knowledge which may not be perceived consciously by the person performing the activity.
The use of things, as most (if not all) practices will involve the use of certain objects in specific ways, such as a ploughing farmer's plough, a lecturer's pulpit and drawing board, a scientist's lab equipment etc.

and finally *knowledge*, in that each activity also implies certain forms of routinised know-how, modes of intentionality and practice-specific emotionality. Note here that while 'mind' refers to the mental activities of the person as s/he is performing a practice in a given moment - say, a football-player kicking a ball aiming at the goal - 'knowledge' refers to the shared body of understandings, intentions and emotions underpinning it - in the footballer example the rules of the game, shared tactical understandings, emotionalities tied to club loyalties etc.

By drawing attention to the diverse elements of which a practice consists, an analyst's attention is moved from the individual as 'seat' of understanding and action to the practice as such. The individual thus becomes the 'carrier' of the practice and the means through which it is actuated at a given place and time. The 'social world' then is seen as being populated by numerous different practices, with one individual 'carrying' several and co-ordinating them within him/herself (think. e.g. of a farmer combining the practices of farming, of being a part-time politician, cattle trader etc. within himself). 'Structures' in turn are then understood as a set of routinised practices. Here the 'scientific community' is a case in point, as it combines a set of established practices - such as laboratory work, publication procedures, networking - in its production of scientific output.

The added value of Practice Theory for the theoretical framework of this study is that it moves the analysis away from an understanding of knowledge as something 'in the head' towards this 'mental knowledge' being embedded in a complex of bodily activities and routines, emotions, tools, making farmers' and scientists' ways of knowing both observable and describable. It also combines well with Actor-Network Theory, given that both take a heterogeneous approach to 'the social', seeing it as a combination of human and non-human elements. For the purpose of this dissertation, practices can therefore be understood as manifestations of the enactments that keep actor-networks stable.

Communities of Practice

With ways of knowing being understood as being observable through practices, the difficulty remains of how to draw a distinction between the ways of knowing of farmers and those of the scientists. Discerning farmers from scientists as such is relatively easy on a superficial level - one group has a livelihood based on agricultural production, while the other is tied to research institutions. It becomes more difficult however when addressing the different groups' ways of knowing. In practice one is more likely to encounter 'hybrid' practices combining scientific elements and farming know-how. So how to differentiate between them?

To do this, we will draw on an additional concept, that of *Communities of Practice* (Wenger, 1998). Communities of Practice have their origins in Learning Theory, but later found their way in a range of other fields, including management (e.g. Wenger, McDermott, & Snyder, 2002). According to Cox (2005), this wide use is probably due to the variability of the term 'community', and due to there not being a unified definition of what a 'Community of Practice' is supposed to mean. It is this flexibility of the term that we will draw upon in order to differentiate the farmers' ways of knowing from those of the scientists. The definition to be used will be based on Lave and Wengers' (1991) definition of 'Community of Practice' as being ' [a group] *of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly."* Wenger further detailed this definition in another writing, identifying three elements that characterise a Community of Practice (CoP) (Wenger, 1998):

A *domain* - members of a CoP have a shared domain of interest to which they are committed. This 'domain' can be but does not necessarily have to be formally defined or organised. Scientists for instance do engage in the advancement of research in a specific discipline, but the borders of that discipline might be contested or even porous (as might be the case with interdisciplinary research).
A *community* - CoP do require that there is regular interaction between members and the engagement in a shared activity. Farmers in a specific locality for instance do interact regularly, and will often gossip about farming-related issues or even actively engage in the exchange of knowledge and experience.
A *practice* - members do have a shared repertoire of physical, informational and symbolic resources that they draw upon when engaging in their (shared) activities. While Wenger did not refer to Practice Theory regarding this element, we will do so here.
Using this definition of a Community of Practice with its corresponding elements helps in differentiating the farmers' ways of knowing from that of the scientists in several ways.
- First, it draws attention to the domain in which the practice is embedded - the farmers' livelihood and the scientists' context of working and living respectively - and the influence this domain has on the respective ways of knowing.
- It furthermore points to the importance of regular interaction to differentiate the two CoP from each other. At the same time, this opens up an avenue of investigation to see - in combination with the ANT concept of translation - in how far the interactions between farmers and scientists do or fail to generate a new, fledgling CoP between them.

- The term 'practice' (in Practice Theory terms) finally is flexible enough to allow for 'knowledge hybrids' to exist within any CoP, such as farmers combining their 'traditional' know-how in animal husbandry with more 'modern' practices originating from industrialised countries.

It should be pointed out however that CoP as a concept may paint a rather homogeneous picture of a 'community', thus ignoring any power differentials within it which may be of importance for the questions covered by this research. Analytically CoP is therefore to be understood as a starting point, with the actor-networks underpinning the respective practices being an avenue for the further exploration of power issues.

3.2.2. New Perspectives on Expertise

While Practice Theory and the concept of Communities of Practices provide a means to differentiate between the Ways of Knowing of farmers and scientists, this in itself is not enough. Chapter 2 described how there is an ongoing debate on the inherent qualities of 'indigenous' and 'scientific' knowledge, on their delineation, similarities and differences. One aspect that hasn't been looked at in this debate so far but that is of relevance to the argument of this dissertation is the concept of 'expertise'. Implicit in the concepts of 'indigenous' and 'scientific' knowledge is that farmers and scientists are the 'experts' in their respective fields, the farmers in the actual practice of farming on their farm, and the scientists in the analytic approaches and technologies that make up their academic discipline. 'Expertise' as such is however too blunt a concept to be of any analytical use. I'll therefore draw on the work of Collins and Evans on the subject, applying the conceptual tools they provide in order to take a closer look at the elements of which this expertise actually consists (H. Collins & Evans, 2007).

The basis of their work is what they call the 'Periodic Table of Expertises'. Without going too much into detail, what follows is a description of the elements of this table that are relevant to this dissertation. First comes the notion to differentiate between what the authors call ‘Ubiquitous Expertise’ and ’Specialist Expertise’. The former refer to practices that are common fare within a given society, such as walking, the do’s and don’ts of social interaction and generally all the other skills and performances that one has to master in order to function effectively as a member of a given society. Here already one should note however that some of these ubiquitous expertises are indeed ubiquitous in the global sense (e.g. walking), others are culture-specific; think here e.g. of the different approaches to criticism between German and Japanese societies. ‘Specialist Expertise’ on the other hand refer to an individual’s mastery of a given practice that is not shared by the rest of society, such as farming or the practice of Sociology.

It is in its differentiation of the different levels of Specialist Expertise that the work of Collins and Evans is at its most useful. Underlying this differentiation is the concept of tacit knowledge: becoming an expert in a given field is not merely a matter of acquiring formal knowledge. At least as important is the acquisition of its corresponding tacit knowledge, i.e. that knowledge that cannot be expressed in words, and that is only gained through observation and imitation during a prolonged and active immersion in a given practice. Such tacit knowledge is even a key element of the natural sciences, as Collin’s example of the replication of experiments on the resonance of sapphire nicely illustrates (H. M. Collins, 2001).

This concept of tacit knowledge forms the backbone of their differentiation of Specialist Expertise. This differentiation consists of five levels, the first three of which are available to the lay public. These include ‘beer-mat knowledge’[5], such as the simple knowledge that a cow can be artificially inseminated through frozen semen. A higher level is ‘popular understanding’ as obtained through the reading of magazines and newspapers. Here knowledge on artificial insemination will go somewhat deeper, also including topics such as the existence of breeder societies and breeding catalogues. The third level is ‘primary source knowledge’, referring to a lay person also having read scientific publications on the topic. For all three levels, so-called ubiquitous tacit knowledge is enough, i.e. the kind of knowledge that can be obtained by being part of and interacting with a given society. The person in question, while knowing aspects of artificial insemination, is not able to *do* anything with it beyond, say, using his/her knowledge in a quiz or an online debate on the topic.

For the two higher levels of specialist expertise one needs what Collins and Evans call ‘specialist tacit knowledge’ that can only be acquired by being involved with the ‘culture’ of experts of the targeted specialty. In our example, this would mean taking an active part in the activities of animal breeders and animal breeding scientists, and getting a ‘feel’ of the work, topics, preferences and perspectives that the people involved in it have. Doing so enables one to acquire the two additional levels of specialist expertise that Collins and Evans introduce. The highest level is ‘contributory expertise’, in which one is an active contributor to a given field, which for science means being a practising scientist who is able to ‘walk the talk’ by doing research, performing calculations and publishing in peer-reviewed scientific journals. It is the second-to-highest level that is the truly innovative finding of Collins and Evans, however: ‘Interactional expertise’ refers to the ability to ‘talk the walk’, i.e. being able to have deep and meaningful conversations with other experts within a specialist field without necessarily being able to do the calculations that actual scientific practice within that field would involve. The importance of such specialist knowledge for scientific practice as a whole cannot be underestimated. Taking the example of a deep-space telescope, its construction

[5] Based on the notion that it is knowledge that can be written as a factoid on the back of a beer-mat.

requires the coordination of a number of highly specialised, separate fields of expertise, ranging from electronics via optics and orbital physics to software design. Since no individual is able to master them all, it is only through their shared interactional expertise that the different experts can have in-depth discussions about the intricacies of telescope-design, enabling their to co-ordinate their efforts and eventually create such a telescope.

While it was initially designed with Western technoscience in mind, Collins and Evans' Periodic Table of Expertise can easily also be applied to non-scientific ways of knowing such as those of smallholder farmers. These, too, require a combination of formal and tacit knowledge for them both to practice their craft and have meaningful conversations about it. The concepts contained in the Periodic Table thus provide a valuable avenue to analyse the farmers' and scientists' respective knowledge of each others' fields of expertise, as well as the level at which the interaction between them takes place.

3.2.3. Embodiment of Knowledge

While so far the concepts to describe and analyse ways of knowing have still had people as the main focus, one of the strengths of ANT is that it draws attention to the importance of 'things' - or non-humans, to use ANT terminology in social analysis. In animal husbandry, non-humans play a key role, be it the animals themselves, the environment in which they and their owners live (…be it man-made such as a stable or 'natural' such as a region's given climate), or the wide range of tools and structures used in their management. Hence there is a need to explicitly address how these shape and influence the knowledge and practices of which they are a part.

A first aspect to consider is the non-humans' agency. One of the main tenets of ANT is that non-humans can exert influence on others. They do so either by virtue of themselves - as with rain driving hikers to seek for shelter - or - in the case of technologies - as a result of a task being explicitly 'delegated' to them. When applied to ways of knowing, the latter implies that 'knowledge' too can be delegated to a non-human. Two examples will illustrate this:

The first relates to the building of the Chartres Cathedral. In his analysis of the way in which it was built, Turnbull (Turnbull, 2000; Watson-Verran & Turnbull, 1995) points out how this was done without any central plan guiding the work or lead architect co-ordinating the whole effort. For an outsider it might rather have looked like an 'ad hoc mess' of a large number of artisans, masons and workers building simultaneously at the site, with the cathedral somehow emerging organically out of this effort. The one thing that did make sure that the building effort eventually resulted in a coherent structure were wooden templates used in the cutting of stones. These templates '[helped] to make possible the unified organization of large numbers of men with varied training and skill over considerable periods of time.' (Watson-Verran & Turnbull, 1995). Any building decision was 'inscribed' so to speak into these templates, ensuring that the cathedral would adhere to the structural mechanics to keep it standing.

The second example is the 'carreira', the vessel that the Portuguese used during the heyday of their rule over the seas (Law, 1986). In their attempt to reach the Indies and stabilise their trade with them, the Portuguese revolutionised maritime navigation. A first step was through new discoveries in astronomy facilitating the determination of a ship's position. As it was not possible to send a trained astronomer on each ship, however, they constructed a tool - the astrolabe - and wrote instruction books that would enable mariners to perform this task even with no astronomical training whatsoever. Astronomical knowledge was thus delegated to the 'trinity' of an astrolabe, an instruction book and a mariner drilled in their use.

What these two examples illustrate is that objects may indeed be 'inscribed' with their designers' knowledge and intentions. Or put differently, knowledge can be *embodied*. Furthermore, building on the quote by Latour 'technology is society made durable', such knowledge embodied in non-humans may contribute to the stabilisation of specific practices, and hence of ways of knowing. The wooden templates 'stabilised' the masons' craft, enabling the construction of a cathedral. The trinity astrolabe-book-mariner 'stabilised' navigation, enabling vessels to sail beyond coastal waters and thus project Portuguese power over long distances. Similarly, academic publications may be understood as the means through which scientific knowledge in a given discipline is 'stabilised', and even animals - adapted over time to a given environment and management regime - may be understood as contributing to the stabilisation of a given farming system. This implies that anyone becoming enrolled into the actor-network underpinning a certain practice will be affected by the agency of its non-human elements, an agency that may be the result of the knowledge that they embody.

3.2.4. Quantification, Classification and Standardisation

The notion of an embodiment of knowledge is especially useful when considering the role of quantification, classification and standardisation in science. These play a central role in any endeavour in the (mostly natural) sciences, including animal breeding. Some additional concepts and understandings will therefore be introduced to address these.

We'll begin with quantification. While numbers have been used for several millennia, the high reliance we find on them in 'modern' societies is still relatively recent (Porter, 1995), and is continuously growing as the Digital Revolution progresses. Within science, numbers exemplify the scientific ideal of escaping the bounds of locality and culture, thus contributing to a more public form of knowledge (Porter, 1996). However, in order to understand how this ideal is translated into practice, two aspects of quantification need to be considered.

First, it is important to highlight that in this 'escape' from locality, some locally specific aspects might be lost. According to Porter, quantification can be understood as '[abstracting] from a rich complex of meanings (…) to lift up and preserve what can most easily be controlled and communicated to other specialists in other places'. Or - quoting Nietzsche as Porter does - it is the 'Art of Forgetting'. Thus whenever in this study knowledge about an entity is embodied through numbers written on a paper and/or stored in a USB-stick, this is not to be seen as a description of a measured entity 'as it really is'. Instead, it is to be understood as the enactment of a new 'thing', a way of translating the entity into a format that meets the needs and understandings of a specific actor-network.

A second aspect to bear in mind - and one where the embodiment of knowledge plays a role - is the process by which numbers are generated. Here Porter describes how this was the work of increasingly complex and bureaucratised nation states and economic institutions, which for their functioning and maintenance required accountability and control. To achieve this, procedures had to be developed and introduced, tools invented and people trained in their use, and once everything was in place it had to be continuously maintained and improved. In other words, generating numbers depends on the creation and disciplining of huge networks of people, instruments and processes. A number is therefore not an abstract or even transcendent entity. Rather, it is part of an ongoing enactment of a heterogeneous actor-network. Given the key role that numbers play in science-based ways of knowing, one focus of the analysis will be to trace these networks and the means through which they are stabilised.

The same applies to classification and standardisation. In conceptualising these however we will draw on the work of Bowker and Starr (1999). As with quantification, the aim is to understand the 'how' and 'why' of classification/standardisation, understanding and analysing them not as given absolutes, but as enacted means to meet specific needs. Following Bowker and Starr, classification can be defined as a spatio-temporal segmentation of the world. A standard in turn is seen as a set of agreed-upon rules to produce various 'objects' or perform specific practices. Both are tightly intertwined, or 'two sides of the same coin' (p.15).

In the framework of this dissertation, they will be viewed as 'a kind of work practice' (ibid. p.5), or - using ANT terms - the result of the enactment of heterogeneous actor-networks. The aim will then be to trace these networks, and in so doing understand how they are enacted and stabilised. As for Bowker and Starr, the 'story' this is expected to produce is one of a conflict between the 'ideal' of classification and standardisation, and the realities and difficulties and of the application thereof.

3.2.5. Performativity and Power in Knowledge

Another aspect of ways of knowing to be considered is their performativity, based on the work of Annemarie Mol (Mol, 1998, 2002). The basic premise of such an understanding is that reality is seen as '*done* and *enacted* rather than observed'. To illustrate this premise, Mol draws on the example of anaemia[6] in cancer research. In her research of practices surrounding the topic, she observed that there was not one single answer to the question 'what is anaemia?', the answer instead depending on who was asked and in what setting this blood disorder was being dealt with. A General Practitioner diagnosing a patient may answer the question by listing a set of specific, visible symptoms and feedback from the patient. Workers in a medical laboratory on the other hand will feed blood samples into a machine which will then generate a blood cell count. This result will then be compared with a standard count based on statistics from a larger population, with anaemia occurring if the sample's count is below a certain threshold in relation to the standard. A pathophysiologist finally will look at the body of a specific individual, and determine the occurrence of anaemia if the individual's blood cannot carry enough oxygen to satisfy his/her body's needs. In other words, the label 'anaemia' is the outcome of three different observations, or put differently, is 'performed' in three different ways.

It should be pointed out here that it is *the practice of defining* that the concept of 'performativity' is capturing. There may be a 'reality out there', i.e. a specific number of bloodcells and/or the oxygen-carrying proteins in an organism's bloodstream that may or may not meet that organism's requirements. Each of the definitions described above attempts at capturing this 'reality' as accurately as possible, but at the same time *tries to meet the needs of the setting in which it occurs*. A GP may have to consider issues of time and cost-efficiency, a cancer research lab may have to take into account the requirements of the scientific community… A compromise will therefore usually have to be found between accuracy and practical requirements. As a result, each performance of anaemia will look at different aspects, using different tools and coming up with (perhaps only slightly) different answers. This is also echoed by Latour (2004), who points out how the generation of specific

[6] i.e. a low level of hemoglobin or red blood cells in the blood

facts is always closely intertwined with specific concerns. This does not imply that facts are 'not real'. It however highlights that each fact is the result of a specific way of seeing some things - and of overlooking others - that is the result of the background and objective of the entity generating that fact.

In addition, each definition requires the *enrolment of a wide range of human and non-human actors into an actor-network* - e.g. a GP, her office space, a patient, his health insurance company, a diagnosis handbook; or a blood sample, a spectrometer, a large population of people, their corresponding blood samples and the infrastructure required to compile these and generate a standard etc. In other words, each definition is *embodied*, it has a *physical presence in space and time*. Becoming aware of the materiality of such definitions then raises specific questions regarding the performance of anaemia. One might wonder for instance where in space and time the choice for one definition over the other is to be located. Should a GP be enough to diagnose anaemia, or should a lab and its statistics-based diagnosis be required? Who should decide on this, and on what basis? Similarly, each definition is always limited, and while it may capture some key aspects, it will always also overlook others. Statistically speaking an individual may for instance have low levels of haemoglobin, but not be bothered by it as this is how her body is set up. In other words, her needs will not have been 'translated' into the actor-network that came up with the haemoglobin level standard. This opens up questions of representation and representativity.

All these questions relate to issues of *power*, i.e. of who is to exert control on a certain definition, how, and what the consequences of this will be. These issues of power and the performativity of knowledge that underpins them will be a key element to bear in mind throughout the present study. As the subsequent chapters will show, farmers' and scientists' ways of knowing use a range of 'definitions' and display a number of ways of 'performing' specific aspects of animal husbandry. None of these will be understood as absolute. Instead, they will be seen as multiple performances that are embodied in space and time, that meet specific needs and have specific implications regarding power and control.

3.2.6. The Locality of Knowledge

As was mentioned above, ways of knowing have a locality in space and time. Livingstone (Livingstone, 2003) explicitly addresses this with regards to science. He writes:

'Taking seriously the geography of science positions the local at the center of scientific ways of knowing. It confirms that the authorized apportionment between "the natural order," "social context," and "scientific inquiry" is a rhetorical device that imposes clarity on ambiguity. It renders suspect the idea that there is some unified thing called "science." That imagined singularity is the product of a historical project to present "science" as floating transcendent and disembodied above the messiness of human affairs.' (p. 179)

This is echoed by Latour (1993), for whom the dissociation of nature and society through science is a key characteristic of 'modernity' that obscures the close linkages that tie nature and culture together. Acknowledging the locality of science and its close intertwinedness with location-specific issues and concerns however makes it possible to compare 'scientific' and 'local' ways of knowing on an equal footing.

Such a move is characteristic of Postcolonial Technoscience (Anderson, 2002; McNeil, 2005), whose aim is to shift Science and Technology Studies away from what is seen as its initial Western bias and open it up to the new geography brought about by Postcolonialism. In this way it becomes possible to show the influence of technoscience in shaping the development of former colonies. Some studies in Postcolonial Technoscience have explicitly addressed the locality of knowledge, introducing concepts that highlight how it is often tied to specific spaces and places (D. W. Chambers & Gillespie, 2000; Livingstone, 2003; Turnbull, 1997; Watson-Verran & Turnbull, 1995). Turnbull (2000) for instance introduced the notion of 'knowledge spaces', which he describes as '[having] *a variety of components: people, skills, local knowledge and equipment that are linked by social strategies and technical devices or 'heterogeneous engineering*.' (p.20).

This study will follow this 'localist' perspective introduced through Postcolonial Technoscience and pay explicit attention to the social and geographical sites in which knowledge is performed. Its conceptualisation of ways of knowing as embodied practices stabilised through an actor-network and shared within a community of practice is somewhat similar to (and certainly inspired by) Turnbull's 'knowledge spaces'. However, for reasons of simplicity Turnbull's term will not be used. Instead, locality is to be understood as being made manifest through the embodiment of actor-networks underpinning specific ways of knowing.

Considering the locality of ways of knowing will draw attention to a range of issues. First, it will require us to pay attention to the settings and places where knowledge is generated, and the role these have in substantiating knowledge-claims. Livingstone (2003) provides a historical description of how within science knowledge-'making' was organised in space, and where and under which conditions valid knowledge-claims could be made, for which he coins the term 'context of justification'. He especially examines the differences in value and validity attributed to claims made in the 'laboratory' and in the 'field', a distinction that is echoed by the distinction between on-station and on-farm research in the agricultural sciences. Attention will therefore have to be paid to how ways of knowing are tied to different settings, and how these are valued (see also Henke, 2000; Latour, 1983).

'Space' is however not limited to physical locations. As Livingstone points out (ibid.), metaphorical spaces are just as important. In the early stages of modern science, for instance, it was only the gentry that was deemed trustworthy enough to be able to validate scientific claims (see also Shapin & Schaffer, 1985). While today's scientific procedures have become less discriminatory, this does draw attention to the importance of what Turnbull (1997) calls the 'social organisation of trust'. Knowledge-claims are not only to the places where they are made, but also to the people making them and the material and rhetorical resources used in their making.

The Travel of Knowledge

Addressing 'scientific' ways of knowing meeting their 'local' equivalents draws attention to another geographical aspect. It implies some kind of movement in space, as the carriers of scientific practice have to 'go' to the places where local ways of knowing are embodied in order to meet them. This then triggers the question how ways of knowing do 'travel', how they are maintained at a distance, and how this can best be conceptualised. This is especially important given that science is usually described as being universal, with e.g. Newton's Law of Gravity applying as much to a falling apple in Cambridge as it does to a mango in Kampala. How can something that is universal 'travel'?

Key here are again actor-networks. While it is true that the force of gravity can be felt equally in Europe as in Africa, for people to work with Newton's law and its gravitational constant takes more than that. To begin with, working with its equation requires familiarity with the decimal counting system, study books, tools to measure key elements in its application, people to perform whatever practice is supposed to be performed with it etc. In other words, applying Newton's Law of Gravitation requires the association of a number of heterogeneous actors into an actor-network. Moving on to the 'universality' of science, then, Latour points out that '*If science is indeed perceived as universal, it is because of the [actor-]networks underpinning it.*' (Latour, 1993, p.24). Networks are heterogeneous and embodied, and thus have a physical presence in space and time. As Livingstone (2003) puts it:

'The appearance of universality that science enjoys, and its capacity to travel with remarkable efficiency across the surface of the earth, do not dissolve its local character. To the contrary. These triumphs are at least in part a consequence of such spatial strategies as the replication of equipment, the training of observers, the circulating of routine practices, and the standardizing of methods and measures.' (p.14)

Science's 'universality' is then not a metaphysical trait. Instead, the 'travel of science' can best be understood as the enrolment of new actors into existing actor-networks, and its 'universality' is the result of these actor-networks having spread and stabilised themselves on a global scale. This implies a range of aspects to be considered in the analysis of the present study:

The first one is the conceptualisation of what it is that actually 'travels'. The most widely applied model in the industrialised world has been that of the 'Linear Model of Innovation', whereby basic science generates scientific knowledge, applied science turns it into a technology, which is then diffused to its various users (Godin, 2006). In agriculture, this model is epitomised by the Transfer of Technology Approach (Jarret, 1985; in Klerkx, van Mierlo, & Leeuwis, 2012). Implied in this model is the view that there is an unchangeable element the 'technology' or 'scientific knowledge' - which is passed on unchanged and adopted its final users. From an ANT-inspired perspective however such a 'neat' transfer is not possible. Instead, 'to adopt is to adapt' (Akrich, Callon, & Latour, 2002a, 2002b). Introducing ways of knowing or a technology into a new setting - a new actor-network - always implies its deconstruction and reconstruction - its translation - by the actors involved (Akrich, 1992). This is especially the case since part of these ways of knowing are tacit, and cannot be transferred as such (H. M. Collins, 2001; Polanyi, 1966). This is echoed by Livingstone, who writes:

"Scientific knowledge gleaned in laboratories is (…) less about the local instantiation of universally valid facts than about what one writer calls "the adaptation of one local knowledge to create another." (p.142)

As such, within the theoretical framework of this dissertation there is no 'thing' that travels from one setting to another. Rather, the 'travel' of specific ways of knowing is understood as enrolment into a specific heterogeneous network, and the inevitable process of adaptation and change to a new local setting that this entails. Even in the case where according to specific narratives it may be a 'technology' that travels, this technology is not understood as a monolithic whole introduced into a new setting. Instead, it is understood as a 'fluid' entity that can fulfil a number of roles and functions (de Laet & Mol, 2000). Attention will thus be drawn to the network underpinning it, the roles and values inscribed in it, and the way in which these are deconstructed and reconstructed - translated - in this new setting, sometimes resulting in functions that were not initially intended by its designers (Law, 1999).

Second, if the travel of knowledge is understood as an enrolment into heterogeneous actor-networks, this explicitly draws attention to the shifts in power that this entails. As an example to illustrate this, one can think of the historical impact of surveys, and the means they provided for colonial powers and nation-states to exert control over their territories (Livingstone, 2003). The botanical and cartographic surveys of Great Britain's colonies for instance were a primary means for colonial powers to translate knowledge about these colonies into a format that would form the basis for subsequent action and control. Similarly, as in the 19th century France was slowly transforming into a bureaucratic nation-state, national surveys were a primary means for this state to visualise its constituency and provide a basis for regulation and taxation, as well as for maintaining its own stability and justification. As Livingstone writes,

[w]hat gives a state its identity (…) is not just how it is visualized or constructed but also how it is regulated. Courtesy of the spirit of calculation and the impulse toward planning, the state has enlisted the methods of science not only in making, but also in maintaining national identity. So alongside its role in surveying the state's territorial scope and natural assets, scientific surveillance has been harnessed to manage cultural capital and demographic resources by applying quantitative procedures to public affairs. (Livingstone p. 128)

In other words, as the 'travel' of science entails the enrolment of actors into global networks, it brings along with it a potential shift in power and control, as knowledge about an actor enables one to act on him/her/it. Tracing the associations underpinning these global networks then makes it possible to identify the channels through which this power can be exerted. This consideration is tightly interwoven with Latour's concept of 'centres of calculation' (Latour, 1993), which can be understood as 'the nodal points in the flow of information and controlled widespread networks of communication' (Livingstone, 2003, p. 171) in which information is compiled and translated into comprehensive depictions of 'reality'. By their nature and activities, these centres hold power, as they shape the way the world is put together, perceived, and eventually also acted upon. Tracing the associations through which information is gathered and brought together to enact a new 'reality' therefore also entails identifying the centres where this compilation is made, and the means through which subsequent influence is exerted.

Here, quantification and standardisation again become important points of consideration. According to Livingstone,

Standardization (…) is the prerequisite for conquering space—the space between the field and the center of calculation, and the space between nature and language. (176) Standardization, then, was designed to overcome distance and distrust and to promote circulation. (p. 177)

This is also echoed by Porter's work on quantification (Porter, 1995, 1996). He points out how its emergence and refinement were the work of 19th and 20th century professional groups in bureaucratic organisations. The different means to quantify they introduced then can be understood as 'technologies of distance' enabling them to overcome the distance and distrust that characterised their working environment. Using the concepts introduced above, this dissertation will thus trace the associations through which control is established and power exerted, as well as identify and describe the nature and work of the centres of calculation were these associations come together.

Overall, through this theoretical framework ways of knowing are described as heterogeneous actor-networks (I.e. consisting of both human and non-human elements) that are enacted by communities of practices in order to meet the needs of their respective settings. Being heterogeneous implies that they are bound to specific geographical places. A phenomenon such as the ‘travel of science’ therefore requires the enrolment of new actors from a different geographical setting into a specific actor-network, including the re-ordering of these actors’ social orders.

Before applying this framework to the empirical material underlying this dissertation, the following chapter will describe the methodology through which this material was gathered, as well as the approach used for its analysis.

Chapter 4 - Methodology and Analysis

4.1. Basic Approach

The key topic of the dissertation are the ways of knowing of farmers and scientists as they meet and interact in agricultural research projects in Ethiopia and Uganda. Accordingly, the research approach of choice has been qualitative, ethnographic research (Bernard, 2006; Desai & Potter, 2006; Flick, 2009; Neuman, 1997; Wolcott, 2004), as it goes beyond the 'what, where and when' questions to address the how and why of knowledge generation and use. In addition, while the case studies are delineated to some extent, the Actor-network Theory-maxim of 'following the actor' and its inclusion of non-humans in the scope of analysis implies the need to be open to unexpected twists and turns in tracing the actor-networks underlying the technologies and practices covered here. An open, exploratory approach is therefore also required. The aim is to enter the field with a clean slate without too many preconceived notions, and tracing the associations, following them wherever they may lead (Latour, 2005).

Closely tied to the collection of data is the issue of how it will be analysed. Given the open-ended, exploratory character of the research, I did not enter the field with a ready-made theoretical framework. I did have a set of research questions and interests as well as a number of theories from Science and Technology Studies in mind, used as what Blumer (Blumer, 1969) calls 'sensitising concepts', i.e. guiding my investigations and sensitising me for specific areas of interest. As data collection progressed, I used Grounded Theory (Charmaz, 2006; Glaser & Strauss, 1999; Strauss & Corbin, 1990) in its analysis, and it was only after field research had been completed that Actor-network Theory emerged as the social theory of choice.

Since two case studies are included in the dissertation, it is worth repeating here that this was not done with the purpose of making a classical comparison between them. The case studies have both commonalities, including some of the institutions and individual scientists involved being involved in both, as well as the underlying scientific theories and approaches that they used. At the same time they differ both in the purpose of the research that the scientists were implementing, as well as in the farmers' background and context. This combination of similarities and differences made it possible already during data collection to for instance better trace and understand scientific practices such as animal recording by observing how they were being applied in very different settings. Furthermore, throughout the analysis the availability of two cases to compare and contrast with each other enabled me to differentiate elements and processes that could be viewed as general patterns from those that were more situation-specific. By using these two cases I was thus able to provide a more comprehensive picture of the ways of knowing of farmers and scientists as they interact with each other.

In the following sections a detailed description will be given of how data was collected and analysed. Staying in line with the open-ended, exploratory approach of this research, the chapter will provide a chronological description of the main stages of my field research. The corresponding methods for data-collection will be introduced in depth in separate boxes as they first were used. This will be followed by a description of Grounded Theory as it was used in the analysis of the data.

4.2. First Step - Exploratory Field Trips

The case studies were research projects funded by the Austrian Development Agency and managed and implemented by animal scientists from Boku and from CGIAR-centres. Contact with the Austrian scientists was already made upon initiating my research, in order to obtain permission to observe their work and discuss the logistics of my involvement. The first visit to 'the field'[7] however occurred during two so-called backstopping visits they organised, and which I was allowed to join.

Box 1: Non- participant observation/ethnography of scientists' activities:

Based on the premise of open-ended, exploratory research, and on the need to 'follow the actors' by tracing the actor-networks underlying technologies and practices, ethnography was the approach of choice. According to Bryman, 'ethnography' is a term that can be used interchangeably with participant observation (Bryman, 2008, p.402). The aim is to enter a 'different culture' with an open mind and try to understand it 'from inside'. My own approach differed in the sense that while I joined the scientists in their meetings and activities, I tried as much as possible to remain in the position of the passive observer. This in order to be viewed by the farmers as someone separate from the scientists' team, something which - as will be described later - I mostly failed to achieve.

While it is difficult to pinpoint specific methods - ethnography being more an attitude than a distinct method (Desai & Potter, 2006) - the most important data gathering tool is observation, in combination with an 'anthropological eye', i.e. a 'penetrating attitude towards looking at social practices'. Following this approach I joined the group of scientists, traveling with them during their field visits, staying in the same hotels, eating together and sitting with them as they held their meetings and their informal discussions. My position was one of a participant-as-observer (Bernard, 2006; Gold, 1958), in that the culture I was immersing myself in - the scientists' work and practice - was aware of me as a researcher. I observed them, took pictures, interacted with them and asked questions informally whenever it was suitable, or on occasion even performed informal, conversational interviews (Bernard, 2006; Mikkelsen, 1995). I scribbled down my notes and reflections throughout, transcribing them afterwards on my computer while combining them with additional reflections.

The main difficulty in observing the scientists and analysing my findings about them was due to the fact that I was raised and trained in the same culture that they were operating in. My academic background in agriculture and development co-operation meant that I shared many of the imaginations and practices that characterise their ways of knowing. This was partly counteracted by my initial lack of familiarity with animal (breeding) science, as well as my sociological training and perspective, enabling me at times to take a more neutral perspective. In addition, any fallbacks into routine development views and discourses in the dissertation were usually pointed out by my supervisor.

The first of these backstopping visits - to Uganda - took place during two weeks in March-April 2009. In the course of this visit the scientists met up, planned and implemented two feedback workshops - one in each research area. During these workshops they informed the project farmers about the progress of their work, followed by field-visits to some of the project farmers' farms. This was closely followed by the first visit to Ethiopia, which took

[7] The term 'field' is actually to be understood in a broad sense, as I was observing activities wherever the farmers and scientists went. Here however it is meant in the sense of activities taking place in Ethiopia and Uganda

place during three weeks in May 2009. Again, the scientists met up and planned and implemented eight workshops, two for each of the project's four research sites. The purpose of these workshops was to have the farmers select one among the four breeding scenarios that the scientists had developed. Here I was able to join them and observe the workshops in three of the four project regions.

During these visits I undertook non-participant observation of the activities the scientists undertook (Box 1), be it the workshops themselves, the planning and evaluation meetings they held and the numerous informal discussions they had during long drives in the car, lunch and dinner breaks and whenever the opportunity offered itself to exchange ideas. In-between I also had semi-structured interviews with some of the scientists to gain more in-depth insights and put my observations in context (Box 2). The people to be interviewed were chosen following a snowball-sampling approach. It began with the scientists actively involved in project implementation, who were each interviewed at least once.[8] Some were interviewed twice or even three times, as they played a key role in the project or provided information that was needed to elaborate on some of the concepts that were emerging in my analysis. Based on the data thus collected, additional people were then identified and interviewed based on their relevance for the research.

<u>Box 2: Semi-structured interviews:</u>

Semi-structured interviews as described here were done with scientists, extensionists, government representatives and any other informants other than farmers whose activity was deemed relevant for the research. In all cases, after asking the informant's permission a digital tape recorder was used to record the conversation for later transcription. A separate interview guide was set up individually for each interview (Mikkelsen, 1995), taking the shape of a mind-map outlining the different areas to be covered by my questions. While some questions were used in each interview (e.g. personal background, lessons learned), others were specific for each informant, allowing me to address issues that were specific to them, that had emerged as a result of my research until then, as well as to cross-check previous findings.

On one occasion during the first field visit to Ethiopia a group interview of the scientists from Boku, ILRI and ICARDA was held at the end of my visit, as for time-reasons it had not been possible to interview each of them individually.

The main outcome of these field visits was a general overview of the case studies and their potential for my research purposes. In addition I was able to limit the scope of my research, as I realised that for time-reasons I would not be able to cover both projects completely. In Uganda, where the research project was working with farmers in both Western and Central Uganda, I opted for the scientists' involvement with Bahima dairy farmers in the West. This region was the main focus of the scientists as well, and given the rapid processes of change in the Ugandan dairy sector promised to provide the more interesting findings. In Ethiopia my choice fell on Menz region in the highlands of Amhara region. This choice was initially informed by practical considerations: in Afar region the participating farmers were nomadic - thus difficult to follow - and uncooperative; the farmers of Bonga region spoke a local language for which it would be difficult to find a suitably competent translator who'd also be

[8] For logistical reasons I was not able to interview one of the scientists in Uganda, however.

fluent in English; and in Shambu region most farmers did speak Amharic, but it was not their main language, thus limiting the advantage I would get by learning its basics. In addition, co-operation between the scientists and the local research centre there was patchy. In addition, according to the scientists, the farmers in the Menz region were highly co-operative. My initial thoughts were that this could provide a useful contrast to the farmers in Uganda, where the co-operation with the scientists had been under a severe strain already during my initial field visit.

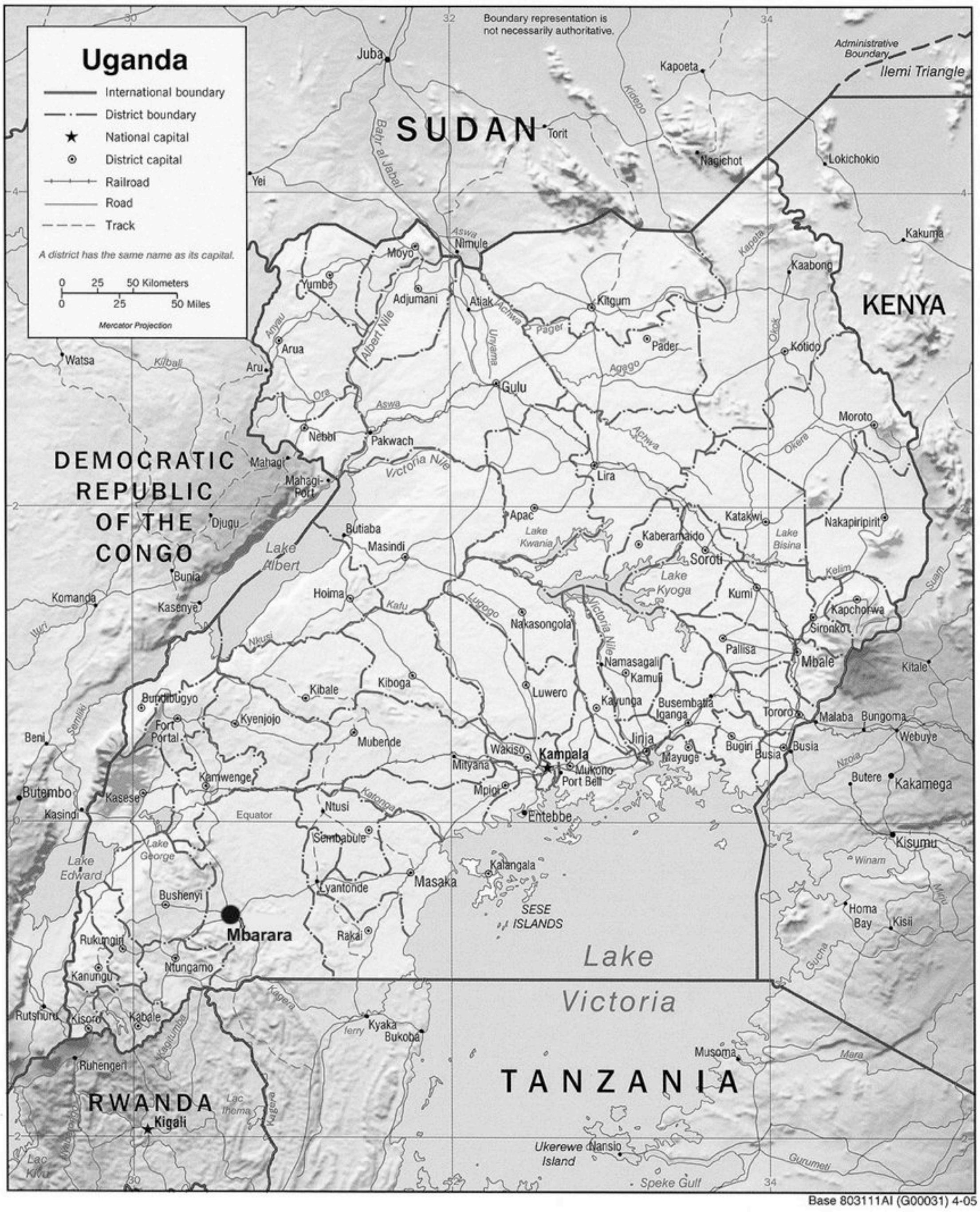

Figure 1 – Map of Uganda (Source: Perry-Castañeda Library Map Collection; University of Texas)

In addition to the activities mentioned thus far, I was also able to make logistic arrangements for my subsequent longer stays in Uganda and Ethiopia. This included establishing first contact with counterpart institutions,[9] initiating first steps to obtain a research permit,[10] as well as - in the case of Uganda - arranging for a prolonged initial stay with one of the project farmers.

Based on the findings obtained during these initial field visits I wrote a first research proposal which was presented and discussed at the Raach Summer School in June 2009, and which would form the basis for my subsequent field research activities.

4.3. Second Step - Field Research in Uganda

4.3.1. Location of the Field Sites

The bulk of the data was collected during prolonged stays in Uganda and Ethiopia respectively. In Uganda, such a stay took place from September to December 2009, for a total of 14 weeks. While my 'home base' in Uganda was located in Kampala, the field research site was located in Kiruhura District in Western Uganda, next to the town of Mbarara (Figure 1).

The project had two key sites in which its project farmers had their farms. One was in Kikatsi Sub-county, with farmers living up to 30-40km away from the town of Mbarara. The second site was around Rushere - allegedly Western Uganda's main dairy hub - with farmers living 5-20km away from the town centre. There were 18 project farmers in total, all of whom were Bahima, i.e. former cattle herders who had settled down sometime during the 20th century. They all now owned land - some up to two square miles - and had the production and sale of milk as the main income-generating activity on their farm. The one exception was a state-run farm which also provided a number of animals for the scientists' measurements. The scientists themselves had hired one private veterinarian based in Mbarara as enumerator, whose task it was to visit each project farmer once per month and do routine measurements on a sample population of cattle. When the scientists were in the country, they would join this veterinarian on a number of farm visits, and organise a total of four feedback workshops (two of which I attended) and to which all project farmers were invited. In-between they would have a number of formal meetings on-site and in Kampala, and informal discussions during lunch/dinner and on road-trips, almost all of which I was able to attend and observe. Finally, the project was to a large extent managed from the Nairobi campus of the International Livestock Research Institute (ILRI), with one of the PhD-students getting additional training there.

All of the locations mentioned above, i.e. the farmers' livelihoods as I could observe them on their farms, the scientists' formal and informal activities and discussions both on-farm and in their home institutions as well as the ILRI-campus formed 'the field' in which I would collect my empirical data. In the sections below I will describe more in detail the activities this entailed and the methods that were used in the process.

[9] In Uganda this was the Department of Forestry of Makerere University, who were involved through our partner project 'Natural Resource Management Revisited (NAREM); in Ethiopia I got a position as graduate fellow at the International Livestock Research Institute (ILRI).
[10] Such a permit was only required in Uganda, where my research was formally independent. Obtaining the permit did not have any influence on the content or direction of the research, however, and was merely a (relatively expensive) formal procedure.

4.3.2. Empirical Data Collection

Initial Stays on Farm and First Data Analysis

The first research activity to be performed during the prolonged stay in Uganda was a 10-day visit on the farm of a project farmer who had agreed to host me during my previous exploratory field trip to the country. He was a model farmer in his early eighties with friendly relations to the scientists, owning a 2 square-mile farm on which he kept his dairy and meat-production cattle herds.[11]

> ***Box 3: On-farm participant observation:***
>
> Contrary to the non-participant observation of the scientists - whose culture I shared and whose practices and perceptions I was familiar with - trying to understand the Bahimas' ways of knowing required my active immersion into their life and practices. In addition to several farm-walks I participated in the daily tasks of the herdsmen, asking questions and taking notes throughout (Spradley, 1979). This included gathering the herd in the mornings, milking, loading the milk onto the trader's truck, the treatment of sick animals, dipping and spraying, corralling some of them for inspection and sale, inspecting bush-clearing efforts etc. Whenever the opportunity arose I also participated in social activities such as church services, visiting relatives and attending one wedding. My main source of information was the farmer's grandson, whose command of English was at times limited. In addition, one additional farm staff member spoke English, having received training at an agricultural college and being tasked with keeping track of the animals' health. On one occasion I also interviewed the farm manager with the grandson as interpreter, with only limited success. As I had recorded this interview, I was able to correct some of my transcription errors with the help of my Muhima research assistant later on.
>
> I took pictures throughout my stay in order to document the activities, as well as as ice-breaker and means of giving something back to the people I had observed and interviewed (I would print out and give some of these pictures to the farmer and herdsmen before I left).

During the stay on the farm I did participant observation of the farming activities related to animal husbandry and milk production, actively joining the farm's herdsmen in their activities, and doing ethnographic interviews with the informants I encountered during my stay (Box 3). Since the farmer himself did not speak any English, he assigned me to the care of his 20 year-old grandson who was also working as herdsman on the farm. While the grandson's command of English was at times limited, I was nevertheless able to use him as key informant both during the different herding activities and during a number of independent walks through the farm. I was able to cross-check some of the data gathered in this way by talking to his older brother, who had also grown up on and worked on the farm as herdsman,[12] had pursued academic studies and had a perfect command of English.

Overall, this stay gave me a first-hand view of the Bahima livelihood in general and their dairy farming practices specifically. The findings of this stay were to form the basis for the farmer interview guideline I developed later on.

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[11] On a separate piece of land several miles away - which we visited - he also kept a herd of pure-breed Ankole cattle

[12] He would actually take over the leadership of the farm a few months after my visit.

Following the stay on the farm, I travelled back to Mbarara where I met up with the scientists as they were preparing the third feedback workshop. I again engaged in the participant observation of their planning discussions, and joined them in the workshop that took place the next day. Here I continued my observations, however this time focusing on transcribing in real-time the presentations and discussions that took place.[13] I then traveled back with the scientists to Kampala, observing their follow-up discussions about the workshop and informally interviewing them whenever the opportunity arose.

With the data I had collected thus far I took a four-day break, during which I coded most of it and wrote an interim case study (Miles & Huberman, 1994), summarising my main findings and outlining my first, emerging concepts. During this break I also began developing the interview guideline that would be used during the visits of the farmers later on. I furthermore took the opportunity to meet up with my research counterpart at Makerere University and arrange a number of practicalities (research permit, contract with research assistant).

After this break I went back to Mbarara, and from there to a state-run farm of the National Animal Genetic Resource Center (NAGRC), on which I would spend the next 7 days. The decision to do so was taken during my previous on-farm stay, based on the farmer's opinion of that state-farm's work and the (allegedly low) quality of its cattle. With this opinion as starting point it seemed promising to investigate NAGRC's approach to breeding.

During these 7 days I was a guest of the farm's veterinarian, and joined him on his daily tours of the farm, observing and participating in activities such as the artificial insemination of the farm's cattle, herding, treatment and dipping of the animals, management of herdsmen etc., while informally interviewing him throughout the day. These notes were complemented with a semi-structured interview of the farm-manager on the last day of my stay. Overall, these observations gave me a thorough and practical understanding of NAGRC's self-understanding, breeding activities and the challenges they faced in implementing those.

Interviewing (Non-) Project Farmers and Other Informants

Following this stay, I went back to Mbarara to meet up with my research assistant. With the help of the private veterinarian hired by the scientists I managed to rent a motorbike, and got the phone numbers of the farmers involved in the project.

The following two weeks were spent visiting project farmers living in Kikatsi Sub-county.[14] A first contact with these farmers was done by my assistant via mobile phone, arranging for a suitable date and time, usually around the morning milking, at on some occasions while the animals were being dipped. My assistant and me would then usually travel early in the morning to each farmer. The visit itself would consist of a farm-walk in combination with a semi-structured interview (Box 4). After an interruption including a trip back to Kampala and a visit to the ILRI campus in Nairobi (see below), we did a corresponding visit to farmers around the town of Rushere. A total of 18 farmers were interviewed in this way, including 14 involved in the project, and 4 who were unrelated to it.

[13] This workshop was the moment in which the farmers had jointly decided to stand up against the scientists, which is why they had refused that I record the proceedings on tape.
[14] Note that both the farmer on whose farm I stayed and the state-farm were part of the project. This brings the total of farms in Kikatsi covered by my interviews to 8.

Box 4: Farm-walks and farmer semi-structured interviews:

Most of the farms were visited during the morning, when the farmer would be supervising the herdsmen as they were milking the cows. On three occasions the farmer himself would not be there (two were absentee-farmers and one was strongly involved in local politics), and the interview would be held with the farm manager or - in one case - the farmer's wife. On two occasions my visit would coincide with that of the veterinarian/enumerator, enabling me to observe his work with data collection and at times even helping him doing so in order to get a feel for it.

After a personal introduction of myself and explanation of my work I would begin asking questions following my guideline and taking notes along the way. In most cases, if/when milking was over, we would walk to different parts of the farm, allowing me to take pictures, triangulate some of my findings through observation and intersperse the interview with additional questions triggered by what I saw. The conversation would either be in English or - whenever the farmer requested it - in Runyankore, with my research assistant serving as translator. In most cases we'd be invited into the house after the walk, where I'd complete my interview and have a longer informal conversation with the farmer on various issues related to my research. In addition to interviewing the farmer I took photographs throughout the farm-walk, some as courtesy (I would have them printed and given to the farmers later on in return for their hospitality) and others as a means of documentation.

The fact that my research assistant was himself a Muhima actively involved in dairy farming was a big boon in this respect, as he helped me in seeing and interpreting many of the subtleties of what the farmers were saying and doing to which I as an outsider was not attuned. Doing the farm-walks he was able to point out a range of details (e.g. quality and breed of the cattle, details on the organisation of the farm etc.) and provide contextual information to some of the farmers' answers. Furthermore, after each visit he would go through my notes and point out my misinterpretations or provide additional information. As a consequence I was able to gain a much deeper insight into the cultural understandings, performances and practices of the Bahima by having them explained to me by an insider and 'livestock-practising' member of the ethnic group.

Unfortunately the research project in Uganda was marred by tensions between the farmers and the scientists, with the former begrudging the latter that they were collecting data on their farms and troubling their animals without giving anything meaningful in return. This also affected my research, as most farmers I interviewed had seen me for the first time as part of the scientists' team at the workshop held during my exploratory field trip. As a consequence, four of the project farmers openly or indirectly refused to have me visit them, and some were skeptic or in a few cases even showed open animosity to my coming. While with the help of my research assistant I was able to disarm any tensions, it is nevertheless possible that some of the responses given to my questions may have been affected by this situation.

As the topic of my research was the interaction between farmers and scientists, I intended to interview as many of the project farmers as possible. Those not included in my data collection either could not be reached by phone, or explicitly refused to have me visit them. The latter was due to the trouble they had had with the scientists' project, seeing me as part of the scientists' team (see Chapter 6 for more details). Four non-project farmers were also included using snowball-sampling or 'snowballing' (Desai & Potter, 2006), to control for any potential biases that may have resulted from the scientists' selection of the project farmers.

Last but not least, given the project farmers' poor response to recording, on the recommendation of one scientist from NAGRC I included one (non-Muhima) farmer who had enthusiastically embraced the practice.

The same interview guideline was used for all farmers, in order to identify common trends and personal idiosyncrasies (Bryman, 2008, p.377), as well as triangulate any key findings. Covering the same or similar topics with each farmer also enabled me to reach a saturation point at which no truly new findings were forthcoming and I could assume that I had fully covered a given subject or issue.

In-between my farm-visits, and following the principles of theoretical sampling I visited a number of other institutions that were potentially relevant for my research. These include a research farm of the National Agricultural Research Organisation (NARO), the building site of a farmer-owned milk processing factory, a shop of Cooper Uganda selling (amongst others) acaricide, a veterinary shop, a rural radio station, a milk-cooler, a cattle market and the head office of Land O' Lakes in Kampala. The approach to such visits would differ. Where possible I would arrange a meeting with a representative of the respective organisation and prepare and hold a semi-structured interview with them. Other opportunities were more ad hoc, and I would observe and ask questions on the go.

Finally, in-between my stays in Mbarara and in Rushere I went for a one-week visit to the campus of the International Livestock Research Institute (ILRI) in Nairobi, Kenya. This provided me with the opportunity to do additional semi-structured interviews with some of the key scientists of the project who were based on the campus, as well as gather data on dairy farming in the region in the ILRI library.

In addition, again following theoretical sampling principles, I also took the opportunity to gain an understanding of the Kenyan cattle-breeding system, which for both scientists and Ugandan farmers served as source of inspiration or even template for what they wanted to achieve in Uganda. To do so I attended and observed a state-sponsored cattle-day organised by the Central Artificial Insemination Service, and having a series of informal discussions as well as two semi-structured interviews with the Kenyan consultant who had designed that country's animal recording scheme.

4.4. Third Step - Field Research in Ethiopia

4.4.1. Location of the Field Sites

Most of the data for the Ethiopian case study was collected in 20 weeks from January to June 2010. My 'home base' in the country was the campus of the International Livestock Research Institute (ILRI) in Addis Abeba, where I became a graduate fellow. ILRI was also the home base of the research project itself, with the project manager being based there and the scientists using it as a place to plan and discuss the project and its activities.[15]

[15] By becoming an ILRI graduate fellow I was able to perform my research without the need for a separate research permit, since it was formally viewed as being part of the case study's research project. Since however my co-supervisor at ILRI worked in a different department and on different research topics and thus had no stakes in it, my position as graduate fellow did not influence my research findings.

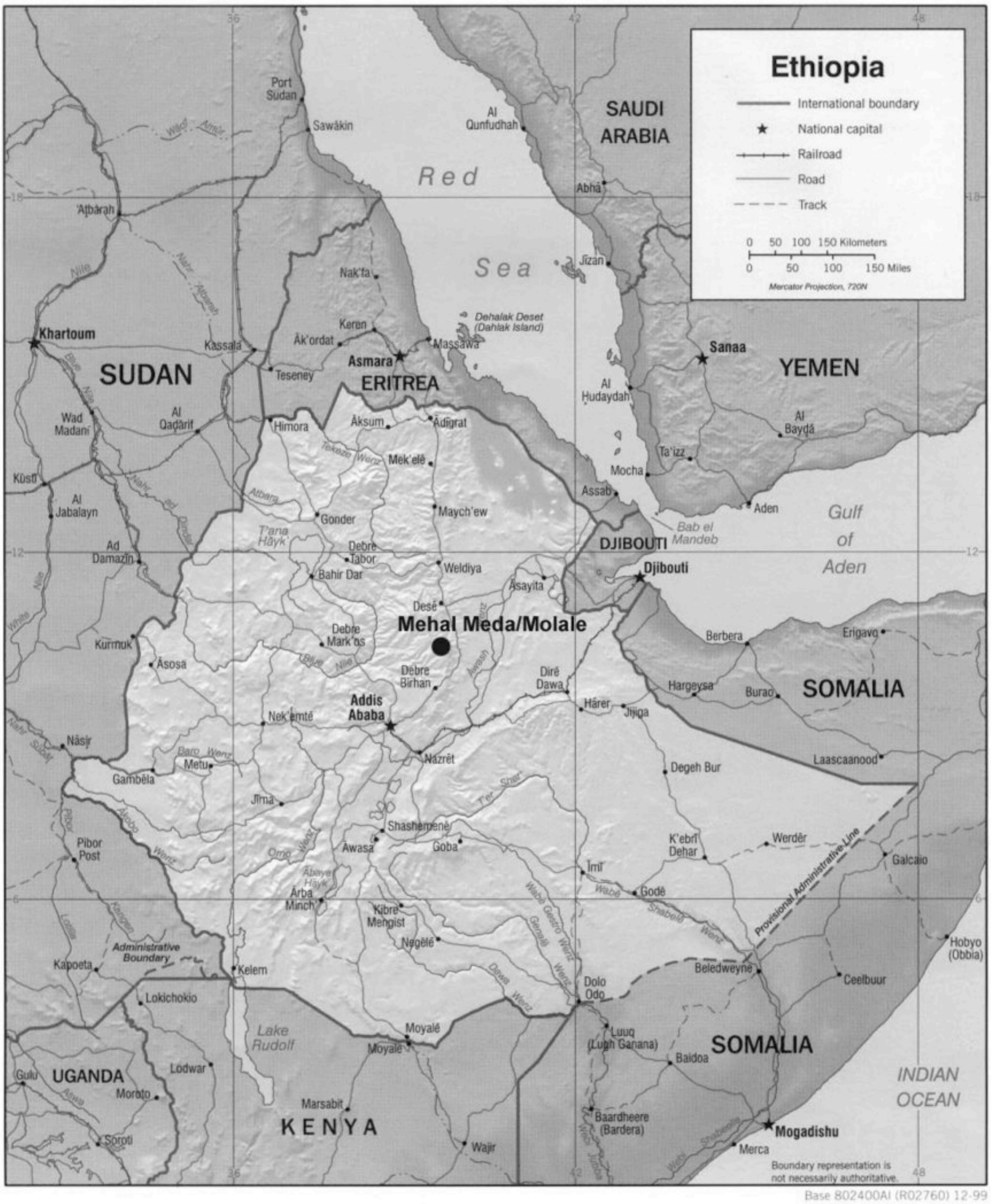

Figure 2 – Map of Ethiopia (Source: Perry-Castañeda Library Map Collection; University of Texas)

Out of the four regions in which the research project was taking place I decided to focus my attention on Menz in the highlands of Amhara Region some 200km northeast of the capital (Figure 2). There I would cover both communities involved, i.e. first the farmers living close to Mehal Meda, a town located some 250 km by road from Addis Abeba[16] at around 3000m asl, and the farmers around Molale, a town at 2600m asl and some 30 km by road south of Mehal Meda. The farmers in these communities practice a mixed crop-livestock farming system, growing cereals and vegetables as well as keeping flocks of sheep, chicken and some even cows. They live in small clusters of houses surrounded by their fields, and both communal and privately owned pastures. On four occasions during the research project (three of which I attended) the scientists would implement workshops with the farmers involved in

[16] Given the poor state of the roads - including parts of it being under construction at the time - it took 9 hours to travel by bus from Addis Abeba to Mehal Meda.

the project, one on breeding scenario selection, and three for the actual selection of rams (see Chapter 7). Given my traveling schedule I was able to attend the scenario selection workshop during my exploratory field trip, as well as two selection workshops in February 2010 and February 2011 respectively.

The main, larger urban centre in the area is Debre Birhan, some 150 km by road from Mehal Meda. It is also the home of Debre Birhan Research Centre (DBRC), an Ethiopian agricultural research institution that had been appointed by the Ethiopian government to be the local research counterpart of the research project. Through DBRC a few farmers in Mehal Meda and Molale were hired as enumerators on a part-time basis, being tasked to do daily measurements on the project farmers' sheep, while DBRC scientists would visit the sites at least every two weeks for monitoring and follow-up.

Empirical data for the Ethiopian case study was thus collected by observing farmers' livelihoods and project activities in Mehal Meda and Molale, as well as the scientists' activities and (in)formal meetings during their field-trips and in DBRC and ILRI. Below follows a chronological description of my research activities.

4.4.2. Empirical Data Collection

Upon my arrival in Ethiopia in January 2010 I spent the first two weeks establishing myself and making administrative preparations, including a presentation of my research at ILRI as part of my graduate fellowship. I then met up with the scientists as they prepared another field trip to the project farmers. This time they would implement selection workshops in which the best breeding animals were to be selected. I joined them in two of their project regions: Menz and Shambu. While the second was not part of my research, joining them nevertheless allowed me to observe the additional meetings and discussions they had there on the research project as a whole. During this trip I was also able to arrange my first translator, a manager from a nearby state ranch.

Box 5: Community walks:

As opposed to the field research Uganda it was not possible to do farm walks with the individual farmers in Menz. However, almost all travels to, from and between farmers were done on foot accompanied by one of the enumerators. These walks thus took on the character of extended community walks (Reijntjes, Haverkort, & Waters-Bayer, 1992) in which the enumerator served as key informant, answering ad hoc questions and commenting on any observation that I made. Especially in Mehal Meda this was accompanied with a closer acquaintance with the enumerator's family, in whose house the translator and myself would stop on numerous occasions (including one wedding and one birthing ceremony) and interact informally with his parents, asking further questions and cross-checking some of the data obtained thus far.

The next activity was a one-week stay in Mehal Meda with the support of said translator. The purpose was similar to the on-farm stay in Uganda, i.e. gaining a first in-depth overview of the farmers' livelihood as a basis for the development of an interview guideline for the farmers. As opposed to Uganda, the farmers in Menz were too poor for me to ask them to host me for some time, and it would probably also have been difficult to convince an interpreter to stay with me there. As a consequence I was not able to do the kind of participatory observation I had done in Uganda. Instead I chose for community walks in the company of a key informant (Box 5). As my 'home base' was in Mehal Meda, some 4 km away from the closest project farmer, I hired the governmental AI-technician to bring us to the farmers on his motorbike. Overall this stay proved to be relatively problematic in terms of data collection due to the poor English skills of the interpreter (Box 6).

The first stay in Mehal Meda was followed by a four-week intensive Amharic language course - allowing me to reach the level of basic small-talk - additional reviewing of literature, transcribing the data thus far as well as preliminary analyses.

I then went back to both Mehal Meda and Molale for three and two weeks respectively, during which I did the bulk of the data collection with the farmers. In each site the visit began with interviews of state officials at the woreda offices in order to introduce myself and get a general overview of the area. The remaining time was spent visiting the farmers. Since the initial visit to Mehal Meda had not yielded enough usable data in order to develop an adequate interview guideline, I began with two separate Focus Group Discussions of

Box 6: Lost in translation:

Since proficiency in English is not as widespread in Ethiopia as it is in Uganda, even among people with an academic degree, it was more difficult to find a suitable interpreter. An additional challenge was finding someone willing to stay for longer periods in Mehal Meda and Molale. My first interpreter - whom I hired for the first week spent in the field - was a manager from a state-run ranch some 20 km from Mehal Meda. His good intentions notwithstanding his English was limited, making it at times challenging to ask questions and understand the answers that were given.

The second interpreter was a human resources manager from Debre Birhan Research Centre (DBRC), and thus a colleague of the local scientists involved in the project (albeit not having any role in it himself). While not perfect, his English was good enough to allow for a fluid communication with the farmers. To further limit mistranslation, most taped interviews were reviewed together in the evening. He would be my ‘main’ interpreter during the prolonged stays in the communities, and also helped me in arranging my visit to DBRC and the interviews with its scientists.

Despite his better English, my second interpreter had no agricultural background or training, meaning that it was not possible for him to give me the same insider information as my research assistant in Uganda. His affiliation with DBRC furthermore meant that for many farmers - and despite my claims to the contrary - both he and myself were most likely perceived by the farmers as being part of the scientists’ team. This became especially apparent when interviewing non-project farmers, who - without exception - all wanted me to ensure that they would also be allowed to join the project. Their responses were thus most likely coloured by they views and expectations of the scientists’ research project. As a consequence I was not able to obtain as detailed in-depth findings on the Menzei’s ways of knowing in farming as I had for the Bahima. My assumption of homogeneity in their ways of knowing is thus not as empirically founded as with the Bahima. This is the reason why a small story specifically describing the farmers’ ways of knowing is only found in the Ugandan case study.

In order to overcome some of the translation difficulties I also did a four-week intensive one-on-one Amharic course, reaching the level of basic small-talk. While I was not able to have any conversation, this did enable me to break the ice vis-à-vis the farmers as well as roughly follow the direction the translations were taking.

respectively a number of male and of female farmers (Box 7). Based on the outcomes I obtained during these I developed the interview guideline.

Box 7: Focus Group Discussions:

Since - as opposed to the Ugandan case study - the farmers were living on walking distances from each other, focus group discussions were used as an additional tool to gather empirical data (Desai & Potter, 2006, p. 153). The hope was that through discussions and interactions between the farmers additional information could be obtained (Mikkelsen, 1995). However, since any questions I asked and responses that were given had to be translated first, the dynamic of the interaction took on more that of a group interview.

The subsequent approach was similar to the Ugandan one in that I interviewed a combination of project and non-project farmers. As it was not feasible to cover all of the more than 60 farmers involved in the project a selection was made. Using resource maps of the community developed by the research project I asked the enumerator in each site to identify ‘weak’, ‘average’ and ‘strong’ project- and non-project farmers. Based on this information, a selection of farmers from each category was made whom I would ask to be interviewed. On some occasions the farmers were not available, in which case I would revert to the maps and ask the enumerator to identify an alternative farmer. Overall 31 farmers were interviewed individually (26 male, 5 female), and 17 through the focus group discussions (8 male, 9 female).

The farm-visits themselves were not farm-walks as in Uganda, since the fields of most households were spread over different localities. Instead, farmers were usually interviewed in their houses (Box 8). Additional ad hoc information and insights were instead obtained through village walks, i.e. by walking from farm to farm and asking the enumerators who accompanied us on most of the visits (Box 5).

Box 8 - Interviewing farmers in Menz:

As opposed to the case study in Uganda, the farmers’ fields were usually not close to their homes. Therefore, interviewing them while walking around on their farm, including asking ad hoc questions on observations I made was not an option. Instead the interviews usually took place in their homes. All farmers were again interviewed using the same interviewing guideline. Interviews were taped, transcribed in the evening and checked with the translator in order to make sure that the transcription was accurate.

As in Uganda, the relation to the farmers was influenced by my association to the scientists. Most farmers had seen me as being part of the scientists’ team both during the exploratory field trip and during the first selection workshop. Given their approach to the scientists’ research project as a source of support (see Chapter 7), this perception of me is likely to have coloured some of their responses. This was especially visible whenever I interviewed non-project farmers, who almost all asked me to make sure that they, too, would be allowed to join the project soon.

Again following the principle of Theoretical Sampling, the data collection was complemented with ad hoc visits to and semi-structured interviews in veterinary centres, extension services, a tree nursery, livestock markets, formal and informal farmer meetings as well as informal interaction with the farmers during their social gatherings (wedding, birth ceremony, religious meetings, coffee ceremonies). By coincidence I also happened to be present when scientists from DBRC were in Mehal Meda and signed a contract for the use of a selected ram with one farmer (see Chapter 7). In most instances except for the ad hoc ones I was able to prepare question guidelines before these visits.

After having completed my main data collection in Mehal Meda and Molale I went for a 2-day visit of Debre Birhan Research Centre. This included a guided visit of the premises and being introduced to its main areas of research. I also had semi-structured interviews with scientists from those disciplines related to the research project, which included animal breeding, animal nutrition, veterinary science and socio-economics (Box 2).

The final opportunity for data collection in the field was during a four-week follow-up visit in February 2011, during which I had the opportunity to perform non-participant observation of the final selection workshops held by the scientists within the scope of the research project covered by this dissertation.[17] I attended the selection workshops in Menz, Shambu and Bonga, observing the proceedings and following the scientists' discussions about the results and their planning of a follow-up project. The biggest advantage here was to be able to observe the impact of these workshops as covered in Chapter 7.

4.5. Fourth Step - Analysis

4.5.1. Grounded Theory in a Nutshell

The topic of this research is part of a 'messy' social reality that is characterised by a high degree of unpredictability and complexity, made even more complex by the fact that different people have at times very different perceptions of and perspectives on it. My focus was on 'visible' actions in scientific and farming practice, as well as on how the people involved understood these actions and the wider setting in which they took place. While a lot of this 'reality' that I was looking at was unfamiliar to me - most notably animal (breeding) science and the farming contexts in Ethiopia and Uganda - I was nevertheless myself also one of the 'people involved'. I had studied agronomy and development studies and had previously worked in development consultancy, which meant that my own perspectives and practices often coloured my view on the situation. As a consequence my own biases had to be explicitly addressed as part of my analysis. Grounded Theory was therefore chosen as the main analytical approach (Charmaz, 2006; Strauss & Corbin, 1990). This would allow me to start my research with data-gathering and a 'theoretical blank slate', providing me with the necessary room to take into account both the unfamiliarity of the field of my research and the need for self-reflexivity inherent in my own background and position.

The starting question for Grounded Theory is 'What is happening here?' (Charmaz, 2006, p.21). From this starting point it aims to create 'abstract, conceptual understandings of the studied phenomena' (p.6), i.e. theoretical constructions and interpretations that help to better grasp and understand the situation and its dynamics. The basis of the approach is therefore the collection of data. Regarding data itself Grounded Theory is not very prescriptive, as in Glaser's words 'All is data' (Glaser, 2002; in Charmaz, 2006, p. 16; see also Latour, 2005, p. 133). The aim is to engage with the research topic (in my case already starting with my first meetings with the Austrian scientists at Boku) and collect and take note of whatever is

[17] The scientists would stay involved with the farmers in Menz through subsequent research projects.

available. As data is thus collected it is increasingly conceptualised; say, from observing the meetings of the scientists to subdividing them into 'international' and 'local' teams. The leads that one follows further and the additional data that one gathers are then defined through the data obtained and conceptualised thus far, and not beforehand. It is hence not the usual approach of data collection followed by analysis, but the two going hand in hand and contributing to an increasingly directed and focused gaze. This also shows itself in the approach to sampling, which is geared towards theory construction and thus partly entails the selection of informants as research progresses, rather than a randomised selection aiming for 'objective' representativeness.

4.5.2. From Ongoing Analysis to Final Dissertation

Given this use of Grounded Theory, ongoing analysis was a key element of the research process already during empirical data collection in the field. When the research began my research questions were as yet very general and tentative. They were based on theories and concepts from Science and Technology Studies that were meant not as a predefined theoretical framework, but as 'sensitising concepts' (Charmaz, 2006) used to provide inspiration and starting points for my analysis. As I collected empirical data I simultaneously began coding and memo-writing using Atlas.ti (Lewins & Silver, 2007), where possible having short breaks between data collection to catch up with coding and making first attempts at theory construction (see sections 4.3.2. and 4.4.2. above). Actor-network Theory was thus not my theory of choice right from the start, but showed its usefulness in describing the phenomena I observed only halfway through my research, when most of my empirical data collection had already been completed.

Once I had come back from my field research in Ethiopia and Uganda the research proposal was rewritten and presented for approval.[18] It was based on this newer proposal that I then began with actual dissertation writing. By then I had chosen Actor-network Theory as basis for my theoretical framework. However, the choice of theoretical framework and writing of the dissertation does not imply that analysis was over, quite to the contrary. Rather, the writing was an integral part of the analysis, as it was only through writing that the theories and concepts used to describe and interpret the case studies were solidified. Latour writes:

The text, in our discipline, is not a story, not a nice story. Rather, it's the functional equivalent of a laboratory. It's a place for trials, experiments, and simulations. (Latour, 2005*, p. 149).*

Writing the dissertation thus involved further memo-writing, refining my thoughts and helping new ideas emerge. This came hand-in-hand with the reading of additional literature, following of specialised STS-courses (whose course-work was always used to further refine my theories and concepts), the presentation of my texts during doctoral seminars and the writing of scientific papers that all fed into my on-going writing and reflection. Where possible further data-gathering also took place, following the principles of theoretical sampling. Since most of the writing took place in Vienna I was always able to contact the Austrian scientists and the Ugandan and Ethiopian PhD-students involved in my case studies for further questions. Through personal contacts I was also able to visit and informally interview Austrian and German dairy farmers, as well as help them in milking and other farming chores. While not directly related to my research topic, it did help me better understand the industrial breeding- and farming background from which many of the

[18] While a first proposal had already been presented and discussed after my exploratory field trips, this re-writing was required due to my change from an older 'Doktorat'- to a newer 'PhD-programme'.

scientists came and through which they interpreted the benefits of selective breeding and animal recording practices. While I was able to do a follow-up visit in Ethiopia (see section 4.4.2.), for reasons of time and logistics it was not possible to have individual interviews with any of the farmers again.

While dissertation-writing was in itself a ‘theoretical playground’ and a space for in-depth reflection and analysis, it was also the place where the findings eventually took shape and turned into the linear narrative that you are reading right now. Given the open-ended and exploratory approach to data-collection and analysis this narrative - while grounded in the data that I gathered - cannot be understood as an ‘objective’ description of the case studies, nor are the theories and concepts that I came up with the only accurate way of looking at them. Rather, it is an ‘interpretive portrayal of the studied world’ (Charmaz, 2006, p.10). According to Charmaz,

‘[a] finished grounded theory explains the studied process in new theoretical terms, explicates the properties of the theoretical categories, and often demonstrates the causes and conditions under which the process emerges and varies, and delineates its consequences (p.7-8).

In other words, it provides avenues for reflection and action about a given situation, which in turn can be used ‘generalisable insights’ (Morgan, 1997) that guide reflection and action in similar situations and contexts elsewhere.

Chapter 5 - Introducing the Case Studies

The dissertation is based on ethnographic field research of two Austrian Development Agency(ADA)-funded research projects led and implemented by Boku and CGIAR Research Centres, selected based on the criteria set up by the project proposal with which this dissertation was funded. According to these criteria they had to take place in Ethiopia and Uganda, and had to involve an Austrian research institution as one of the parties involved. They were eventually identified through personal contacts with Austrian scientists at Boku who were willing to have their research projects become the subject of research of its own.

The first case study is situated in Western Uganda. Its setting is the dairy farming practices of the Bahima, a formerly pastoralist tribe who settled down throughout the 20th century and are now increasingly getting enrolled into the emerging Ugandan dairy industry as milk producers. In the research project, two Ugandan PhD-students under supervision from Boku and from the International Livestock Research Institute (ILRI) in Nairobi did basic on-farm research on the Bahima's cross-breeding practices, trying to understand the process and its potential. While it was on-farm research, it was nevertheless 'fundamental' research in that its aim was to generate findings *about* the farmers rather than *with* them.

The second case study took place in the Ethiopian Highlands, in the home of the Menzei, a strongly traditionally-minded tribe of farmers with a mixed crop-livestock system. Climatic changes in the past 30 years combined with population growth have led to shortages in food and the increasing dependency of farmers on food aid programmes. While sheep were more of an additional side-activity in the past, farmers are increasingly using them as their main source of income. Here scientists from Boku, ILRI and the International Centre for Agricultural Research in Dry Areas (ICARDA) saw this as an opportunity to test community-based breeding, an breeding system in which farmers are organised into networks in order to breed and improve their sheep breed in a co-ordinated manner, thus increasing the speed of the breed's genetic improvement. Here the research was applied in that the aim was to 'test' this system together with the farmers through an approach based on farmer participatory research .

While the choice of the case studies was arguably mainly based on the geographical distribution of Austrian development research funding - the same funding that financed this dissertation - they do provide snapshots of what is happening at the front-lines of what some of the authors introduced in Chapter 2 called the travel of Western technoscience. In both case studies the scientific backbone of the research projects was selective breeding, an approach to livestock breeding that originated in 18th century Britain and that would eventually spread throughout the world. It is this global spread of selective breeding that is the subject of the first section of this chapter. The illustration of this spread is meant to achieve two things. First, it locates the research projects covered in the case studies within the process of global development and the spread of science-based agriculture. They are both part of the attempt of research institutions and policy-makers to have smallholder farmers partake in and benefit from scientific advances in agriculture in general and livestock breeding specifically, and in this way benefit from the potential that the Livestock Revolution offers for them to escape from poverty and achieve 'development'. Secondly, it shows how even science-based selective breeding has local origins and is the result of the co-production of a specific society and its corresponding understanding of nature in general and livestock specifically; or put differently, it is a 'local' way of knowing despite the 'universality' that it has achieved by being spread throughout the world.

The second section then describes how the Bahima moved from a pastoral livelihood to one based on market-oriented dairy farming Bahima, whereas the third illustrates the ups and downs of the Menzei farmers' interaction with urban centres throughout the centuries. Here the purpose is to show the historical background out of which their respective ways of knowing emerged in response to - or through co-production by - specific social and environmental settings and needs.

Some notes of caution are in order, however. Throughout this dissertation the Bahima and Menzei will be referred to as if they were homogeneous ethnic entities sharing the same respective ways of knowing. Obviously, any closer look would show that this is not necessarily the case. The people that are part of the Bahima tribe for instance range from the President of the Republic of Uganda via city-based businessmen and practising dairy farmers to a relatively small minority still living a pastoral way of life. The ways of knowing found among the Bahima may thus show a large diversity, including both pastoral know-how and knowledge acquired through formal schooling and even university. Since the focus of the dissertation is on established dairy farmers, the scope is already much more limited, however. Furthermore, based on both the data gathered from the farmer interviews and its corroboration by my Muhima translator I can claim that there are indeed understandings and practices that they themselves see as being widely shared among Bahima dairy farmers. It is these that are meant when referring to the Bahima's ways of knowing. The situation is a bit more complicated with the Menzei. While I could not observe as wide a range of livelihoods among them as among the Bahima, here too any closer look would likely reveal differences in livelihoods and probably also their corresponding ways of knowing. In addition, my limited ability to gain inside-information from the farmers during my field research in Ethiopia - as opposed to Uganda - means that any statements I make about shared ways of understanding and practising farming are on a somewhat more shaky ground. Nevertheless, the farmers I visited, too, shared many understandings and practices with regards to their farming and general livelihood strategy, and it is these that are meant when referring to their ways of knowing.

It should also be pointed out that these historical accounts should not be viewed as 'the' history of the origins of the farming systems of the Bahima and the Menzei, since the sources of information and scientific literature are too limited to do so. The aim is therefore not so much to offer an accurate and comprehensive historical analysis. Instead, the chapter aims to provide a backdrop to the case studies, enabling the reader to view them not as separate historical events but rather as snapshots from a much broader and continuously ongoing process of interaction and change.

With these notes of caution in mind, we begin with a description of the historical origins and spread of what can be described as science's contribution to the practice of livestock breeding.

5.1. The Origins and Spread of Selective Breeding

While animal breeding has a history that is probably as old as animal domestication by man, it seems to have been predominantly based on the empirical principle of choosing only the 'best' animals (in terms of traits one was looking for) to mate. This 'unconscious selection' as Darwin coined it was probably transmitted orally for the most part (Ollivier, 1999). Thus, '*[a]nimal breeding has for a long time been a collection of recipes, before progressively evolving into an art and then becoming a science.*' (Ollivier, 2008). It is this shift from art to science that will be examined here.

5.1.1. Bakewell's Brilliant Idea

The concepts and technologies of science-based animal breeding trace their origin from the socio-economic context of the Industrial Revolution in Europe and the US. During these times, the food requirements of the growing urban populations put pressure on livestock producers to meet the increasing demand for animal products. Robert Bakewell (1725-1795) in Britain was the first to use systematic methods in animal production and breeding to meet this demand (Wood & Orel, 2001). Working initially with what would become known as his New Leicester Sheep, he realised that keeping his breeding efforts within his own herd limited the improvements he could achieve. Instead he created what Rabinow (1999; in Holloway et al., 2009) describes as a 'biosocial collectivity' that joined farmers, livestock, tools and techniques into a network aimed at exerting control over animals' (re)production and development. The farmers involved formed the 'Dishley Society', jointly deciding on their breeding objectives, adopting uniform management practices, systematically recording the animals' performance and selecting and sharing their best breeding rams (Wood & Orel, 2001).

Controlling the animals to achieve increased output and productivity required a shift in enacting animal production. First, farmers enrolled in Bakewell's network had to move from focusing on their individual flocks to seeing all flocks involved as one 'population' to be managed and improved upon. Second, from judging an animal's qualities based on eye and experience, emphasis was now put on measurement and quantification. In addition, this quantification was not only applied to the animal itself, but also on the performance of its offspring, the so-called concept of 'progeny testing'. Porter (1996) highlights how 'adequate measurement means disciplining people as well as instruments and processes'. The farmers involved through the promise of better animals had to adhere to a uniform management regime, and uniform tools and methods had to be used to measure and record performance in order to enable comparison between farmers. This 'trust in numbers' (Porter, 1995) also entailed a degree of selectivity in what was deemed important to be measured and what should be ignored. Bakewell for instance saw sheep as 'machines for turning herbage...into money' (Wood & Orel, 2001), aiming for high muscular growth and sale for slaughter. To the dismay of fellow sheep farmers, he saw wool production as not profitable enough and hence not worth any further consideration. While superficially 'objective', the quantitative measurements performed on the population were a reflection of Bakewell's priorities and values.

Bakewell's approach proved extremely successful and was widely adopted throughout the industrialising world. His Dushley farm hosted visitors coming from all over Europe to see the famed performance of his sheep, learn his principles of breeding and apply it in their home countries. Even George Washington is reputed to have imported sheep directly from Bakewell. Ultimately this spread of Bakewell's breeding practices - and corresponding networks of farmers - would result in the formation of a large number of extensive, institutionalised biosocial collectivities known as 'breeder societies', centred on the enactment of the population of a given livestock phenotype. Thus 'breed' became a widely used concept, describing a population of animals tied to the breeding efforts of a specific breeder society, and thus reflecting the decisions and values of its members.[19]

5.1.2. Breeding - From Art to Science

With time Bakewell's teachings also began to be taught at university level, with e.g. the State Agricultural Institute in Berlin founded in 1804 providing a two-year course to students from all over Europe, and its head Albrecht Daniel Thaer (1752-1826) later being appointed to the University of Berlin the first professor in agriculture on the European continent. However, while breeding efforts were thus increasingly systematised, it would take until the 20th century before animal breeding would become a science of its own. The monk Gregor Mendel was the first to try and understand the mechanisms underlying heredity. He coined the concept of 'gene' in his studies on peas. The result of this discovery is that '[s]uddenly the biological phenomena acquire the rigour of mathematics' (Jacob, 1970; in Ollivier, 2008). It would take time however until these insights would find their way into animal breeding, a fact that - for France at least - is partly blamed on the lack of interaction that was found between academic biologists and animal breeders (Gayon & Burian, 2000; in Ollivier, 2008).

Jay Laurence Lush (1896-1982), and American geneticist, was the first to build a bridge between genetics and practical breeding. As a consequence he is 'universally recognised as the father of scientific animal breeding' (Ollivier, 2008). He translated the findings of genetics into a range of complex, statistical methods through which one could evaluate the performance of animal populations and thus guide breeding efforts. To Lush, genetics was a means to 'dispel confusion and bring clarity' in breeding, as '*one was struggling only to utilize natural laws, rather than against capricious, unknown and possibly hostile forces*' (Lush, 1951; in Ollivier, 2008). Through his statistical methods it became possible to determine the probable breeding results under a given time-frame, and compare them with expected costs. His work was thus also a way to closely tie economic considerations and animal breeding together.

Through Jay Lush animal breeding became even more closely tied to universities and research. What began as biosocial collectivities of breeders, their pastures, animals and farms grew into a network that also included universities generating new methods and techniques, research facilities in which they were being tested and extension services providing these findings to the farmers. A seminal role in this development was played by his book 'Animal Breeding Plans', published in 1937 and translated into several languages, as well as by his 279 students from 33 countries which spread his ideas worldwide. After Lush, research in animal breeding began to grow exponentially as evidenced by the number of publications on the subject (Ollivier, 2008), and it became possible for breeders to be increasingly effective and targeted in their breeding efforts.

The next step in turning animal breeding into a science was taken by Charles Roy Henderson (1911-1989), an American statistician and a pupil of Lush. Even with Lush's statistical methods, breeding was still a relatively messy endeavour, with a large number of interrelated traits and difficult measurements that didn't always generate complete and comprehensive data. To address these difficulties he developed what is known as the Best Linear Unbiased Prediction (BLUP), which 'show[s] how to draw linear meanings from masses of

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[19] Note that the definition of 'breed' is contested within the scientific community FAO. 2007. *The State of the World's Animal Genetic Resources for Food and Agriculture*. Rome: Food and Agriculture Organisation of the United Nations.

performance data, missing information and genetic relationships' (Gilbert, 2008b). Even without knowing the specifics of heredity, it thus became possible to make accurate predictions out of large quantities of data and thus disentangle nature (i.e. genetics) from nurture (the environment). However, the calculations required by BLUP are highly complex, and could not be applied in practice before the advent of relatively cheap computers made their computation possible. It was only starting with the early 80s that such computers became available and entered the scene as new actants in the growing network of animal breeding in industrialised countries. With their help and using BLUP, breeders could now compare animals from different farms, management settings and even born in different years.

However, the advent of computers also meant a shift in decision-making regarding breeding. From previously being based predominantly on the eye and brain of the breeder(s), decision-making gradually shifted towards also encompassing a wider network involving measurement tools that generate numbers and computers and software that process these. The results of this shift became clearly visible in the speed in which breeding objectives were realised on the farmers' animals, to the extent that some cattle were suitable only for keeping in stables, and not able to live on pastures any more (Gilbert, 2008a).

This speed in breeding was not only due to improved breeding calculations. It was also the result of increased control over the reproduction processes of livestock. Starting with Leeuwenhoek's first discovery of sperm in 1678 (called 'animalcules'), via Spallanzani's first successful insemination of a dog in 1784, the first pioneering efforts to artificially inseminate livestock were done in 1899 with horses by the Russian biologist Ilya Ivanovich Ivanow (Foote, 2002). From then on, artificial insemination (AI) grew to become an inherent part of the industrialised breeding network. The first dairy co-operative using AI in its breeding efforts was founded in Denmark in 1936, and it was also in Denmark that the straw to store semen was invented (in 1940). The late 1940s and early 50s also saw a steady improvement of technologies to preserve frozen semen and to store it using liquid nitrogen. Global co-operation in breeding was strengthened starting 1948 with the first International Congress on AI and Animal Reproduction, which would be held every 4 years from then on (Foote, 2002). This combination of calculation methods, reproduction technologies and global co-operation further contributed to the speed in which breeding proceeded, as it became for instance easily feasible to package semen, transport it and preserve it long enough for e.g. having an already deceased bull having lived in the United States to inseminate hundreds of cows in Europe. These possibilities triggered an international trade of semen and 'breeds' within a global network involving catalogues, mail orders, royalty payment systems etc.

Efforts at further improving reproductive control is still ongoing. Synchronisation is for instance a widespread technique to time the ovulation (and hence possible pregnancy and consequent period of milk-production) of a large number of cows. Similarly, efforts are underway to also conserve, transport and multiply the gametes of promising cows through embryo transfer, a technique that is however as yet still too complex to have found any wide adoption on farms. Other technologies under development include sexed sperm, enabling breeders to specifically obtain male or female calves, and even cloning is considered as a means to preserve high-performing animals. Gene markers finally are being developed as a way to not any more select for specific traits, but for the genes underpinning them. All these developments arguably lead to a tendency of breeding decisions escaping breeder organisations and becoming increasingly laboratory-based (Ollivier, 1999), and for farmers to 'buy genes' rather than a specific breed (Holloway et al., 2010). And while aesthetics still do play a role to some extent, as the numerous cattle competitions being held prove, the bulk of breeding in industrialised countries still adheres to the same values it got from its origins in the Industrial Revolution, namely the increase of production output and efficiency.

Reproduction is only one area in which humans bring an animal's biological process under increased control. Through improved nutrition - e.g. using concentrated feedstuffs - production and growth is increased, stables and other farming structures are used e.g. to enable year-round intensive milk production while a myriad of drugs and health management practices reduce the risk of diseases and death. Livestock production in industrialised countries has thus increasingly become entangled with universities, veterinary services, input suppliers, farmer co-operatives, political institutions etc. It has become a growing and highly complex agro-industrial complex, a large network involving a wide range of structures, systems, institutions, control mechanisms and policies, using increasingly advanced tools and usually requiring specialised knowledge.

As this network spread throughout the industrialised world, efforts were made to standardise its practices in order to facilitate co-operation and exchange. The International Congress on AI and Animal Reproduction had already been mentioned previously. In addition, during the early 20th century the practice of recording milk production spread throughout Europe, with each country introducing its own standard practices. During the International Congress on Agriculture in Paris in 1923 a motion was passed supporting a standardisation of milk recording practices. By 1935 34 countries adhered to standardised recording methods. It was only after the war that this effort would gain global proportions. In 1947, the Food and Agriculture Organisation of the United Nations recognised the importance of recording, given strong exchange of animals within Europe. 1951 finally saw the foundation of the European Milk Recording Committee, later followed by the International Committee on Animal Recording, an international NGO with its seat in Rome, whose task it is to develop and maintain global standards of recording practices for traits of economic importance.

As this global technoscientific animal breeding network emerged with its myriad of actors and standardised practices, it created what one could call a global 'knowledge space', i.e. a social space in which a specific form of knowledge is made possible (Turnbull, 2000; Watson-Verran & Turnbull, 1995). In the case of animal breeding, it is a space in which animals are perceived predominantly on economic terms and as part of a wider agro-industrial complex, a perception that is shared by all human actors that are a part of it. It is also a knowledge space in which data and information about animals is stored in various forms and on diverse media, as well as shared globally. This allows for new and extensive forms of control of farming practices and policies by governments and international actors.

5.1.3. The Global Spread of Science

While this global, technoscientific network of animal breeding and its corresponding knowledge space originated in industrialised countries, it would eventually spread to what was first known as the Colonies, and later as the 'Third World'. In Africa, the starting point was the colonisation of the continent, during which European powers felt it as their moral obligation to 'civilise the African savages' (Preston, 1996), while at the same time enrolling them as cheap sources of raw material for their industries. Agriculture was one area for this enrolment. Allegedly 'primitive' native farming systems were to be replaced by European farming practices, using African labour and a European 'logic' of international market integration and economies of scale. Ethiopia - the country of the second case study in this dissertation - was a special case in this respect. The Italians' attempt at colonising it failed as they were decisively defeated by the Ethiopians during the Battle of Adwa in 1896. Nevertheless, this did not preclude early attempts at modernisation, as Emperor Haile Selassie introduced a range of European innovations during the pre-war years, including cabinet ministries based on European models, electrical grids, printing presses, cars, bicycles and trucks etc. Ethiopian agriculture however was mostly left untouched, up to the Italians' short-lived colonisation of the country from 1936 to 1941.

The Europeans' involvement in the development of African countries continued even after the wave of post WWII-decolonisation and independence. This time it was in the form of aid, inspired by Modernisation Theory and moved by a combination of Cold War Politics and market expansion that industrialised countries expected developing countries to follow a linear development path through all stages that they themselves had undergone (Preston, 1996). Technoscience from industrialised countries played a seminal role in this process. It was seen as an inherent part and vehicle of modernisation, and thus had to permeate the industrialised countries' efforts in developing Africa. This also included agriculture, in which African farmers were to be trained in modern agricultural methods, which were seen as the best guarantee to increase production and productivity, and thus contribute to the development of African countries into fully-fledged industrial societies.

One vehicle to do so were institutions and people. Partly already during Colonisation, and later also through Development Co-operation developing countries were offered support in setting up institutions for formal training and even higher education. Makerere University in Uganda for instance - for a long time viewed as the 'Cambridge of Africa' - was set up by Britain with the purpose to generate African scientists and thus bring the benefits of technoscience to its colonies. While Ethiopia would have to wait until after World War II, 1950 saw the foundation of the University of Addis Abeba following European models of higher learning. With time a large number of institutions for research and education would be set up in developing countries, aiming to train people and provide them with an institutional setting to find science-based solutions for the specific problems of their respective countries, including in the agricultural and livestock sector. The efforts to find such solutions were not limited to country-specific institutions, however. In agriculture the Green Revolution in South-east Asia in the 1950s epitomised the potential that science-based agriculture has to ensure developing countries' food security. Inspired by its success, the Consultative Group for International Agricultural Research (CGIAR) - a group of research institutes dealing each with a specific production branch or climatic area - was set up in 1971 as a way for industrialised countries (most predominantly Europe and the United States) to pool their resources in funding agricultural research for development to deal with the problems agriculture is faced with in developing countries. Even universities and research institutions in industrialised countries trained and still train people and implement research targeting agricultural issues in developing countries, providing staff for development programmes, institutions and research.

Technologies, too, increasingly spread and established themselves in developing countries, including in Africa. For livestock, during colonial times white settlers established ranches to implement beef- and later also dairy-production. After some initial trials, local breeds were discarded for being 'inferior' for the colonisers' economic objectives. Instead 'exotic' breeds from Europe, the United States and India were imported and put to use. In Kenya, the white settlers even set up breeder societies following European models. After World War II this spread continued, with development aid's continued efforts at transferring modern, science based agricultural technologies and practices into African setting including e.g. improved livestock breeds, synthetic drugs, artificial insemination etc. This transfer process was ‘carried’ and further stabilised by a range of development projects and programmes that helped to set up institutions for research, education and training in Africa as well as train the institutions’ staff in modern livestock management and breeding practices.

Currently this process of a spread of science-based livestock management and -breeding technologies and practices is carried by the discourse of an ongoing Livestock Revolution (Delgado et al., 1999). Growing urban populations and the emergence of a middle-class bring with them an increased demand for livestock products such as milk and meat, and require that livestock production also increases in order to meet this demand. This discourse has led to research institutions in both developing and industrialised countries as well as the ‘international’ research institutions of the CGIAR to team up in order to provide science-based knowledge and technologies that meet both the growing demand and address issues of poverty alleviation and environmental sustainability. This is a difficult endeavour. While most African farmers have to a greater or lesser degree already been in contact with and been using ‘modern’ technologies and inputs, doing so has nevertheless involved overcoming many obstacles and pitfalls. These range from weak infrastructure limiting timely delivery via a large diversity of farming systems and styles adapted to specific context that limit the impact of any ’one-size-fits-all’ approaches to still relatively high levels of illiteracy among many farmers.

It is in this difficult and complex process of the travel of technoscience that the case studies insert themselves. Both were initiatives by scientists from the Austrian agricultural university Boku and from institutes of the CGIAR, and were meant to contribute to the overall objective of promoting agricultural development in Africa through the use of science-based approaches and technologies. The first case study was research of a more ‘fundamental’ nature, whose aim was to scientifically assess and analyse a dynamic situation of change in order to identify future avenues for development. The second research project was more applied, in that it involved having farmers take part in a simplified selective breeding programme. Both were ultimately attempts at having African farmers become engaged with the wider networks and processes that the scientists and their institutions stood for, in order to benefit from the advances that science-based livestock breeding practices represent in the scientists’ eyes.

These attempts at engaging farmers however took place in settings that have undergone their own, respective historical evolution and have resulted in the emergence of specific ways of knowing of the farmers living there. It is this historical background of the farmers from the two case studies that will be described next, starting with Uganda and the Bahima’s move from a pastoralist livelihood to one based on commercial dairy farming.

5.2. The Bahima - From Herders to Dairy Farmers

The Bahima are a Nilotic tribe of pastoralists which may have come to Western Uganda from the Sudan and Ethiopia around the 1300s.[20] They conquered the land – which was particularly suitable for cattle – from the crop growing Bairu already living there, subjugating them and forming the Kingdom of Ankole. They maintained a pastoralist way of life within its borders. It was ruled by the Mugabe, and autocratic ruler supported in his position by local chiefs. Cattle – their indigenous Ankole Longhorn Breed (Figure 3) – were a central element for the stabilisation of the kingdom. Through them they maintained a caste system, in which

[20] http://orvillejenkins.com/peoples/hima.html

the Bahima (comprising an estimated 10% of the total population) were the cattle-owning ruling class, whereas the Bairu were their land-tilling serfs (James, 2006; Roscoe, 1923).

Their network was geographically limited to the borders of the Ankole Kingdom, with the exception of occasional bouts of warfare with neighbouring tribes. The Bahima maintained a pastoralist way of life within it. Land was enrolled flexibly: it was not regarded as property or wealth, all animals were free to graze and herds would be moved once pastures were exhausted or to avoid disease-infested areas (Roscoe, 1923). Their cattle were perfectly adapted to this environment, being able to live on limited water supply during the dry season and relatively resistant to local diseases. They moved along in small, family-based units, following their herds and settling down in small kraals for periods ranging from a few days to a few months, based on the availability of water and pastures for their cattle. In addition to their families, many Bahima would also employ herdsmen (around 4-5 per 100 animals). These were also Bahima, but were too poor to own cattle of their own, and would instead guard the herds of their masters in return for the produce of some of his animals (Roscoe, 1923).

5.2.1. The Central Role of Cattle

Cattle played a central role in their livelihood, culture, and ethnic identity. The Bahima's food consisted predominantly of produce obtained from their cattle: mostly milk, in some cases also blood tapped from their animals as well as meat. Additional food (such as millet and beer) and tools (e.g. spears, milk-pots) were obtained through barter with the Bairu, in return for meat, skins and butter. Milk itself however was never sold, and was only consumed by the pastoralists themselves.

Figure 3 – Ankole bull

The management of the cattle was divided according to the sexes. Women were responsible for the household and for taking care of milk distribution and processing, whereas it was the mens' role to milk and look after the animals. Training for those tasks was done within the families, starting with the children up to 6-7 years of age being tasked to care for the calves. From 7 years on the boys were expected to help in managing the cattle, and in so doing learned milking, herding and the treatment of diseases through the use of herbs. The girls on the other hand stayed with their mothers and learned the tasks of managing the household (Roscoe, 1923).

In addition to food supply, cattle also played a central role in Bahima rituals and relations. The number of cattle one owned defined one's standing in society, with for instance men only being allowed to speak in public if they had 100 heads of cattle or more (Wurzinger, Okeyo, Semambo, & Sölkner, 2009). Ownership of cattle also helped maintain ethnic cohesion: the giving and trading of cattle was only allowed among the Bahima, and Bairu were forbidden to own any[21] (Roscoe, 1923). Within the ethnic group they were used as a means to establish and maintain social ties. They held a predominant role in the payment of dowries for marriages, and 'empaano', the borrowing or giving of cattle to friends and relatives was a key means of ensuring support. In addition to their bonding function, cattle that were given away in this way partly functioned as a kind of 'insurance', since the giver could at any time come and claim back some of the offspring that his gift had produced.

The cattle the Bahima kept in the past were exclusively of the Ankole Longhorn breed.[22] These animals gave only small quantities of milk every day, but since most of it was consumed within the family and surplus only produced and traded to cover basic needs, breeding animals for high milk yields was not a priority. Instead, the aim for a pastoralist was to obtain large numbers of them, and to breed for aesthetic beauty (Roscoe, 1923; Wurzinger et al., 2009). Since the pastoralists spent their whole life around their animals, they all knew their respective ancestry from memory and experience. While Roscoe does not cover breeding explicitly, he does highlight that herdsmen used to keep track of matings in order to allow cows to stay near the kraal when they were about to calve. These observations were not foolproof however, and many calvings took place out in the field. He also mentions the swapping of bulls between herds to avoid inbreeding, and the breeding taboo on bulls that were the result of a parent mating with its offspring. In other words, targeted breeding efforts most likely took place, albeit under the relatively uncontrolled conditions that pastoral life implied.

Roscoe and Infield also describe a wide range of herb-based practices that the Bahima used to cure their animals from the many ailments they could suffer (Infield, Rubagyema, & Muchunguzi, 2003; Roscoe, 1923). All male Bahima were trained in their use since their early childhood. For more complex cases they had access to the 'omutsikiri', a medicine-man who against payment (usually sheep or goats, in more difficult cases a cow) would treat the animal with the help of herbs or auguries. Other means of disease control included the moving of cattle to less disease-infested areas, as well as a wide range of taboos. Targeted nutrition on the other hand was not practiced. The animals would receive salt (obtained through trade with the Bairu), but beyond that their food was limited to what the pastures would offer (Roscoe, 1923).

All in all, the Bahima maintained a relatively closed system both regarding their ethnic identity, the knowledge and experience they generated and the cattle breed they kept. Knowledge and experience were generated and reproduced on an oral basis within the ethnic group, and the main driving force for development was the acquisition of large numbers of beautiful Ankole cattle in order to raise one's standing in society. The values reflected in their social structures and their keeping and breeding of animals probably remained relatively unchanged over a long period of time, excluding outside influences. This would change dramatically both during and after colonisation.

5.2.2. Colonisation - Enrolment into Modern Networks

With the coming of the British, the Ankole Kingdom was incorporated into the British Protectorate of Uganda (it would eventually be abolished in 1967 by the first post-

[21] According to James (2006) exceptions may however have existed.
[22] 'Breed' being used here in the sense of a population of animals with a homogeneous appearance, behavior, and other characteristics that distinguish it from other animals of the same species.


Figure 4 – Herd drinking at a water-dam

independence government). The British came with a paradigm of modernisation, seeing the development of their own country as a model to which Uganda had to aspire (Ebner, 2010). The indigenous, traditional livelihoods were not compatible with such a vision for the country. This was especially valid for pastoralists, whose nomadic lifestyle had no place in a country aiming for economic growth. The colonial government therefore initiated a process of sedentarisation through a range of activities that directly and indirectly encouraged the Bahima to settle down. This same process continued after Independence, the new Ugandan government having taken over the modernisation paradigm of the British (Ebner, 2010). Formal education was promoted as a way forward by the government and missionaries, meaning that the increasing number of pastoralists sending their children to school were limited in their movements to the proximity to the schools. Water dams were built, making access to water easier, and further encouraging Bahima to settle close by (Figure 4). Most importantly, land was eventually turned into a commodity. As more and more of it got privatised and distributed, fewer areas were available on which the remaining pastoralists could let their cattle graze, further pushing them towards sedentarisation. As more and more families acquired private land, and with the establishment of Mburo National Park within the Kingdom's borders, less and less land was left available on which the remaining pastoralists could let their cattle graze, further pushing them towards sedentarisation. Sedentarisation went on throughout the 20th century. While there are still some pastoralists left, they are now only a marginal group. Most Bahima have acquired land and settled down, and are apparently happy with this development as it meant acquiring some of the benefits of modernisation and not facing any more many difficulties that pastoral life implied[23] (Wurzinger et al., 2009). Colonisation had also brought with it the abolishment of the caste system. Some Bairu farmers started keeping cattle, and many Bahima, now that they had fixed plots of land were they lived, also began growing crops.

5.2.3. Emergence of Dairy Farming

Parallel to the process of sedentarisation, the emergence and growth of the Ugandan dairy industry further tied the Bahima to newly emerging processes, networks and structures. First efforts in increasing milk production were initiated by the British, who up to the 1940s bred indigenous breeds for higher milk yields. The underlying assumption was that these breeds were better adapted to local conditions, and through targeted breeding could reach economically viable levels of milk production. As these attempts failed to generate satisfying results, the discourse shifted. Now crossing with 'exotic' breeds from Europe and the US was

[23] During my visit in Uganda I met a group of Maasai from Tanzania's NgoroNgoro Crater who were on a study tour in order to learn from the Bahima's experiences in settling down, indicating that it seems to be a wider trend in Africa.

Figure 5 – Artificial insemination of a cow

seen as the only way forward to have cows produce enough milk to reach marketable levels. Artificial insemination (AI) was introduced and promoted among farmers as a way to obtain such high-yielding animals (Figure 5).

After Independence, the Obote I regime continued in this modernisation vein, and was the first to do a big push towards the establishment of an actual milk industry in the country (Ebner, 2010). Dr. Bahiba, then Minister of Animal Industries and Fisheries played a seminal role in this development. Having seen 'modern' milking breeds and dairy industries during a trip to Europe, he networked among donors and the Ugandan government in order to replicate a similar industry structure in Uganda (Mbabazi, 2005).

One part of these replication efforts were the animals themselves. Continuing the breeding work of the British, he intended to further modernise the national herd by further introducing high-yielding genotypes. In order to obtain a certain degree of independence from abroad in terms of semen supply, a national ranching scheme was established where animals would be bred and sold to farmers at subsidised prices (Ebner, 2010; Mbabazi, 2005). Second, marketing channels were established by setting up the Uganda Dairy Corporation (UDC), a parastatal that held the monopoly for the purchase and processing of milk as well as its sale to retailers. Farms and farming were also to be modernised, with the government offering subsidies for the building of fences[24] and dip-tanks.[25] Veterinary services were also provided, and synthetic drugs introduced and sold to farmers at subsidised prices through government supply shops. Last but not least, efforts were made to train farmers in modern dairy production methods. These measures ultimately mostly profited wealthier farmers, who were the main recipients of the new, cross-bred animals. Nevertheless, it also represented a qualitative shift in society since for the first time there were farmers in Uganda whose only source of income was the sale of milk (Mbabazi 2005).

This network was vulnerable in that it was dependent on foreign imports of key inputs, most notably drugs. This became apparent with the toppling of the Obote I regime by Idi Amin in 1971 and the subsequent civil unrest, which engendered a long period of decline for the burgeoning milk industry. Services were disrupted, the UDC failed to reach most farmers and milk could only be sold locally, and as drugs could no longer reach the farmers most of the animals obtained through AI died from local diseases (Mbabazi, 2005).
During the subsequent Obote II regime the country was still plagued by wars and instability, and the industry limped along (Mbabazi, 2005). In a few places like Bushenyi District farmers joined forces in obtaining and using acaricides and drugs. For most farmers however

[24] Fences enable herds to be kept separate, and thus provide a more suitable infrastructure for targeted breeding, as opposed to having herds walk freely and intermingle with each other.
[25] Dip-tanks are used to dip cattle in a pool of acaricide in order to remove ticks and thus reduce the risk for disease infection.

the unavailability of inputs meant the loss of their cross-breed animals, which could not survive the disease pressure without them. Nevertheless, this period also brought with it a sharp increase in the price of milk, a development that motivated even more farmers to take up milk production as their main source of income (Mbabazi, 2005).

The biggest push towards setting up a full-fledged dairy industry in the country took place after the NRM took power in 1987. One of its key policies was the liberalisation of markets and the privatisation of milk marketing. This brought in its wake a mushrooming of milk coolers in Western Uganda, which in combination with the improvement of road networks made it much easier to collect, store and transport milk from a large number of farmers and have it reach markets as far away as Kampala and beyond. In parallel, a number of international organisations and NGO's made efforts to support this development. DANIDA (Danish International Development Agency), through a seminal project promoted milk consumption among the wider population of the country, and established a policy framework for the industry that also included the privatisation of AI services. NGOs like Land O' Lakes and Heifer International, as well as the church-based Send-a-Cow distributed animals, provided AI services and organised trainings for farmers in key aspects of modern dairy farming. Similarly, both Ugandan and international scientific institutions began doing research on adapting modern livestock production technologies to the Ugandan context. (Ebner, 2010; Mbabazi, 2005).

5.2.4. A Livelihood in Constant Change

Overall, these processes of sedentarisation and the establishment of a dairy industry implied a move from an endogenous to an exogenous form of development (Ploeg & Long, 1994). If previously inputs were obtained from and innovations occurred within a more or less strictly delimited geographic area and ethnic group, now outside actors – the Ugandan government and its services, private milk coolers, NGOs and international organisations – became strong and powerful driving forces of change, providing new inputs and knowledge to farmers and coming with a range of new technologies and understandings that were changing the way Bahima were living and keeping their cattle.


Figure 6 – Farmer house in Western Uganda

The biggest change can be found in the Bahima livelihood as such. From roaming the land and living in kraals made out of branches, they have become sedentary and live in mud or concrete houses (Figure 6). The advent of education meant that nowadays Bahima children spend most of their time at school rather than with their parents' herds. They obtain knowledge and skills that streamlines them for urban lifestyles and jobs, and precluding them from much of the knowledge that previous generations obtained through on-farm training and took for granted.

Increasing cash income has also become a new driving force, being both a means to function within contemporary Ugandan society as well as a new means to establish one's social standing. Through the earning of cash they can afford the school fees to send their children to schools and institutions of higher learning, and are able to buy factory-made clothing and electronic appliances, the richer ones even equipping their houses with solar power and buying cars.

Partly driven by the wish or even need to earn cash, their 'farming style' (Ploeg & Long, 1994) also differs significantly from the past. Cash-based 'farming as business' is slowly replacing traditional perceptions and values regarding cattle-keeping. From having more or less self-sustaining family units for whom cattle provided both food and identity, the Bahima dairy farmers have become part of an extensive value chain reaching all the way to the milk markets in Kampala and even beyond. They have thus become inextricably linked to a range of actors for whom cattle are a cogwheel in the system, valued mainly for their ability to produce large amounts of milk. Many Bahima – generally known throughout Uganda to be an industrious and business-minded tribe – have even partially left cattle behind and have become engaged in a wide range of city-based enterprises that are not related to keeping cattle, having delegated the day-to-day running of their farm to a farm manager.

At the core of this shift is the introduction of cross-breed cattle, most notably crosses between the traditional Ankole-breed and European/US Holstein Friesians (Figure 7). Starting with the few farmers who 'tried them out' in the late 80s, now the large majority of farmers in Western Uganda own from a few animals to whole herds of cross-breed cattle. Once included in a farmer's herd, they bring about significant changes in a farmer's network. Being developed for industrialised farming contexts, the Bahima cattle-keeping knowledge developed and passed on through generations is in itself is not sufficient any more to manage contemporary herds with large numbers of cross-bred, high-yielding animals. Drugs have to be used to keep them alive in the Ugandan climate and pastures have to be managed in order to supply them with food, the knowledge on how to do this being provided by a range of new, external actors such as NGOs, veterinary services, governmental extension services and private companies. In combination with the dairy value chains they have become part of, the Bahima have had to restructure their whole actor-network and enrol new actors to stabilise their new farming system.

Figure 7 – Herd of cross-breed cattle

These difficulties notwithstanding, cross-breeds are seen by most actors in the dairy industry as the way forward towards higher milk yields, and a prerequisite for further growth of the sector. Most interviewed farmers described this breed as the 'way forward' for them, as they epitomise modern farming and high milk yields. Their popularity has reached levels whereby one representative of the National Animal Genetic Resource Center described how the hills of Western Uganda were 'turning black and white', the new cross-breeds displacing the pure-breed Ankole that were previously grazing these lands. However, by replacing Ankole with cross-breeds the country is basically exchanging the one breed that is adapted to its environment for animals that increase its dependency on inputs it as yet cannot manufacture itself. As a consequence some government representatives have raised critical voices against this trend, mentioning the risk of losing a genetic asset, and heavily criticising those institutions and private companies that actively promote a further spreading of Holstein Friesian crosses.

This situation of dynamic and rapid change is the context in which the Ugandan case study inserts itself. Before it will be described in detail, the origins and background of the Menzei - the farmers of the Ethiopian case study - will be described.

5.3. The Menzei - Adapting to Change

While Ethiopia has a history that is rich in literature and historical records, these predominantly cover matters of church and government. Expressed interest in agricultural production by the ruling governments only arose after World War II. However, even then the interest has mostly been on production as such, viewing agriculture as an engine for industrial growth, with little consideration of the livelihoods and situation of smallholder farmers. Thus, given the scarcity of literature on the latter subject, and since the purpose of this chapter is to provide a general backdrop to the case studies and not an accurate historical analysis, the following section is predominantly based on two sources: its main source is James McCann's agricultural history of Ethiopia (McCann, 1995), complemented by the ethnographic studies of farmers in Menz in the 1950s by Donald Levine (Levine, 1964, 1965, 1968).


Figure 8 – Ploughing with two oxen

In his work, McCann notes the difference in observations about the highlands of Amhara region by Portuguese travellers in the 16th century with the narratives by 20th century scientists. While the former noted that it was an area of agricultural abundance, the latter described the region as one characterised by droughts and famine. To him, such changes are not the result of a mere change in agricultural production as such. Rather, he argues that to understand such dynamics one has to broaden the scope of historical analysis to also include social and material/technical aspects. He writes:

Farmers individually and in the aggregate continually renegotiate the connections among the physical environment, customary practice, experience, and new contexts in agriculture (…) agricultural history must combine the long-term effects of environmental changes (e.g., climate or soil fertility) with specific and cumulative seasonal adjustments by farmers in crop choices, agronomic practice, and storage strategies, as well as with broader changes in the political domain. (…) The central idea of this study is to explore agriculture as environmental history, human manipulation of the natural world as conditioned by a rich variety of social practices. (p.6-7).

While his approach is not explicitly inspired by Actor-network Theory, it provides a good basis on which to describe the evolution of the Menzei's livelihood and of its wider context.

5.3.1. The Menzei as Backbone of the Shewan Kingdom

A key element in McCann's description of Ethiopian agricultural history is what he calls the ox-plough complex, i.e. a mixed crop-livestock farming system centred on a plough drawn - ideally - by two oxen (Figure 8). While the origins of this farming system are likely to have been outside of the country (Smith, 1998), cave paintings in Eritrea indicate that due to its introduction probably already during the first millennium B.C. In this sense McCann argues that it can basically be considered as an endemic technology. Even more so since it is a technology that played a crucial role in the expansion and stabilisation of of the kingdoms and empires in which it was used. As these maintained a large bureaucratic state and armies, an annual agricultural production that can be divided, stored and transported was a crucial element in keeping these functional. McCann writes:

Incorporation of new areas particularly along the frontier between agricultural and pastoral highlands, involved military conquest and also the expansion of Christianity, language, social institutions, and plow agriculture. In the long run, it was the successful expansion of these latter factors rather than military conquest which resulted in incorporation into the highland political economy. Being an Arnhara or Tigray-Habasha-was not a tribal identity dependent on lineage but a social category which implied adherence to religion, knowledge of language, and, more subtly, being part of a system of cultivation. (46)

Figure 9 – Farmer houses and barley fields in Menz

In other words, farmers were a crucial part of the economy of larger kingdoms, mainly linked to these through the payment of taxes and tribute. This also applied to the farmers in Menz, who were part of the Shewan kingdom. Little is known about the area until the 19th century, when a British and French explorer visited the area for day-trips in 1842 and 1882 respectively (Levine, 1964). It did however play a seminal role in Shewan history, as it was from there that the reconquest of the region by the Amhara against the Galla (Oromo) began, and since it is said to be the birthplace of the Solomonic dynasty which ruled Ethiopia, ending with Haile Selassie in 1974. Due to its high altitude - it is said to be coldest inhabited region of the country - it is not suitable for the cultivation of teff, and farmers usually cultivate barley instead (Figure 9). The climate and the influence it exerts on farming have made the Menzei into a distinct people. They are characterised as much by themselves as by outsiders by being strongly attached to their ancestral land, by their combative (even quarrelsome) spirit and their strict religiosity, which is expressed amongst others by their scrupulous adherence to Christian fasting laws. According to one of my informant farmers around 160 days of the year are celebrations of various saints, during which most kinds of physical labour were not allowed. Less flatteringly, they are also known for their illiteracy, having the overall reputation to be 'brave, daring and ignorant' (Levine, 1965 p.45). During Levine's fieldwork in the late 50s he observed how they would have a strong scepticism vis-à-vis formal schooling, expressed in their unwillingness to send their children to government schools[26].

Despite their alleged ignorance, the Menzei farmers were thus an element of what can arguably be described as the backbone of the kingdoms and empires of which they formed a part, providing their cities and bureaucracies with the food - and on occasion the soldiers - needed to sustain (and defend) themselves. Fulfilling these functions however demanded from the farmers the ability to balance and manage a number of elements.

5.3.2. 'Juggling' Elements to Stabilise a Livelihood

According to McCann, the lack of historical records about the livelihoods in the region - beyond the reports of Portuguese travellers in the 16th century as well as the 19th century explorers mentioned above - may indicate that there was very little interest in it by the ruling kingdoms at the time. As such, the influence these exerted on farming was probably limited to tribute and taxation (McCann, 1995). This lack of interest notwithstanding, it must have played a crucial role in the stabilisation of these kingdoms. The highlands - i.e. the area above 1500 metres a.s.l. - comprises 42 per cent of Ethiopia's land mass, is home to 80 per cent of its human population and livestock and contains 90 per cent of its arable land (Figure 10). They were therefore a key resource for the production of food, and thus evolved in interaction with urban centres, whom they supported with their agricultural produce. The farmers living there were thus living in a context combining specific local environmental conditions and external influences, within which they had to establish and stabilise their livelihood. To do so they had to 'juggle' a number of elements, a number of which will be described here.

Figure 10 – Landscape in Menz

The main element the farmers had to contend with was the climate. Menz being at a generally high altitude, the low temperatures exert a determining influence on what can and what can't be grown there, and when growing can take place. The region is subject to a bimodal seasonality with two main rainy seasons: Belg from March to May, and Mehal from June to October. Given the altitude, Belg was the only season where grains could reliably grow, with Mehal being subject to a risk of frost in October-November that is usually fatal for the harvest. In addition to a certain variability in the occurrence of rains within the year, farmers also had to contend with inter-annual variation. Chapter 7 will address the unpredictability of rains that the Menzei are faced with today. However, according to McCann such unpredictability may also

[26] In 1960 he counted less than 400 pupils for a total population of 50-60.000 families.

have occurred in the past, as the highlands are historically prone to droughts. Thus, while farmers were to some extent able to predict the seasonality of their rains, these annual variations were more difficult to cope with. As a consequence risk-aversion was a crucial element and guiding principle of the farmers' livelihood.

Whereas the climate determined the wider scope of the Menzei's farming, they had a number of elements under more or less direct control, and their ability to manage these had a direct impact on their ability to successfully maintain a livelihood. Regarding social standing, McCann writes:

At the level of the farm (…) [c]lass was less a function of ascribed, hereditary background than success in the manipulation of political and economic networks to control productive farm capital resources (oxen, seed, and local forms of credit) and land. (McCann, 1995*, p.77f.)*

Land can be viewed as the most essential resource in this respect. According to McCann, since land was usually distributed among a farmer's children, there was no long-term consolidation as such. Instead, each farm had to be re-established through marriage and the subsequent accumulation of resources. With the advent of political stability and the growth of urban markets starting 1916 however the population in the highlands started to grow,[27] meaning that households had to be maintained with increasingly small land resources. The result was that additional occupations outside of agriculture or even out-migration became established survival strategies.

Regarding crop production, McCann observes how it evolved in adaptation to the region's climate and conditions. Given the high variability in soils, in altitude and corresponding micro-climates as well as different local traditions, there was an according variation in cultivars and crop regimes being applied (McCann, 1995). He writes:

Beyond subtly adjusting crops to local landscapes and attempting to minimize crop loss, farmers have used the tools, and agronomic strategies accumulated over time as customary knowledge to manage fertility and soil moisture and to minimize effects of climatic intrusions: frost, waterlogging, and drought. (…) the techniques have drawn upon a known, if not fixed, repertoire of solutions to potential problems. *The historical sources thus reveal a sometimes surprising historical stability in agronomic practice, revealing not so much conservatism as the depth of experience and risk aversion built into local agriculture.* (p.56, emphasis added)

In other words, openness to innovation and the willingness to change - or the lack thereof - may not so much have been a matter of the farmer's mind-set in itself, as it may have been a response to a given environmental context, something that McCann calls 'rational conservatism' (McCann, 1995, p.80).

Another essential resource were a farmer's livestock, fulfilling a number of functions within the Menzei's livelihood. Oxen were a key element, being needed for ploughing, thus determining the amount of land that a farmer could cultivate and ultimately that household's overall wealth. According to McCann, '*[t]he issue of oxen ownership versus rental, sharing, or borrowing appears to be a major determinant of economic class within the ox-plow system'* (McCann, 1995, p.80). Other animals however also played important roles, with cows being used for milk, donkeys for transport and marketing and chicken for food and

[27] While McCann covers in-depth the debate about the (complex) causes of this population growth in Chapter 3 of his book, this discussion will not be covered here.

savings. Last but certainly not least sheep and goats were an important element of the Menzei. About them, Levine writes:

> The average farm has a herd of 100 to 150 sheep, which provide a heavy wool as well as the Manze's favorite meat. This wool is used to make the *banna,* a warm blanket which is wrapped around the body and constitutes the standard dress of the Manze. (Levine, 1965 p.29)

In addition they served as an important means for savings, in order to cover any expenses for e.g. religious or family-related festivities or to cover against emergencies and drought.


Figure 11 – A school in Menz, with only 2/3 of the pupils present on that day

Given the importance of livestock, pastures were an important asset for the farmers, as their access determined the amount of livestock that one could keep. While they probably were not as much a limiting factor in the past as they became with increasing population growth, the Portuguese nevertheless already observed the practice of *ribi*, a system of sharing pastures and livestock in order to ensure higher livestock numbers despite limited pastures (McCann, 1995), a practice that is still commonplace today.

The last resource to be addressed here is labour. On this McCann observes how a gendered division of tasks evolved within the ox-plough system. Given ploughing's high demand on physical strength, crop production became the domain of men, whereas household tasks and the keeping of livestock - in pastures close to the homestead - was the responsibility of women. Children were actively involved at an early age, gradually being taught and involved in the different farming tasks as they grew older (see also Levine, 1965, p.96ff.). In addition to the distrust of formal schooling mentioned above, their crucial importance as source of labour was as much a reason for parents keeping their children away from schools, a fact that is still applicable today (Figure 11).

While these are some of the elements that a farmer in Menz had to contend with and manage in order to maintain a livelihood in the highlands, a more in-depth analysis would probably include many more. The interviewed farmers for instance reported a rich tradition of social networks as well as forms of mutual support - some linked to religious groups and festivities - that played and still play an important role in ensuring access to resources and labour. Rural areas in Menz were thus characterised by more or less closely-knit networks of farmers practising subsistence farming, whose main link to urban areas was through taxation and the payment of tribute. Up to the beginning of the 20th century there was not much technical change, and any growth or decrease in population and/or production was due to the interplay of demographics and limited resources. According to McCann the available evidence indicates a certain stability in the farmers' crop repertoire and cultivation practice, with the population being in balance with the resources that were available (McCann, 1995).

5.3.3. Growing External Influences and the Arrival of 'Modern' Agriculture

From the 16th to the 19th century the history of northern Ethiopia - of which Menz was a part - was characterised by a number of invasions, conquests and power changes too complex to describe here. From the point of view of the individual Menzei farmer these may primarily have manifested themselves through the payment of tribute and taxes as mentioned earlier, and through the very occasional open conflict - as with the invasion by Ahmad Ibn Ghazi in the 16th century - or through service in one or the other ruler's armies. According to McCann a significant shift occurred when Addis Abeba was founded and established itself as the political and economical capital of Ethiopia as a whole. As the economical centre was now relocated further to the south, there was not much interest any more by the state in the low potential northern farming areas. In combination with the now more difficult access to markets this meant that agriculture in the region gradually moved towards subsistence-based farming.

At the onset of the 19th century Ethiopia slowly ended its relative isolation and established first, tentative contacts with the British Empire. Later it was able to maintain its independence despite Italy's attempts at colonising it, which ended with the defeat of an invading Italian army at the Battle of Adwa in 1896 under the leadership of Emperor Menelik II. It was also Menelik II who recognised the role that the state could have in managing the country's economy. He introduced state structures inspired by European models, including a ministry of agriculture with the task to '*...improve the land, produce much grain and change agricultural work ... in the European method.*' (McCann, 1995, p.242).

This increased urban interest in agriculture became even more pronounced as urban populations grew post-World War II. A similar slow but steady population growth also took place in rural areas, an observation based on - arguably scarce - evidence such as Italian censuses in Eritrea from 1905 to 1939, aerial photography of the Simien Mountains from 1955 to 1975 as well as observations regarding the decreasing availability of land and of oxen (McCann, 1995, p.92f). While there is debate about the exact reasons for this, McCann argues that this must have been due to a combination of political stability, improved health care and migration into the highlands. For the individual farming household, this meant that it would have to be able to produce more with less. It also meant that there was now a conflict between using land for crop production and using it as pastures, making it difficult for many to maintain the two oxen that are ideally needed for optimum ploughing performance. Instead, less well-off households would have to use cows or horses instead. Also, a dramatic increase in the age of first marriage could be observed, as there was a scarcity of land to be given to new households.

By then Addis Abeba was established as the permanent political and economic centre of the country. The expansion of the cash economy and the availability of modern appliances in small shops all over the country meant that farmers now needed cash to pay taxes and purchase agricultural inputs or modern amenities such as clothing, soap, sugar etc. As trade between rural areas and cities grew, the government saw the need for a more direct intervention into agricultural production.

One way in which this manifested itself was through the attempted introduction of 'modern' production technologies into the country. The first sustained attempts to scientifically assess the country's farming systems were done by the Italians, initially already in the late 19th century through a small agricultural research station authorised by Menelik II and abandoned after the Italians' defeat, and later in the course of the occupation during World War II. After the War the then emperor of Ethiopia Haile Selassie initiated a technical co-operation with the USA through the Technical Aid Agreement signed in 1952. McCann writes:

[Technical aid] provided the foundation, training, and philosophical directions of Ethiopia's tiny agricultural development infrastructure for the next three decades. It called for Ethiopia and the U.S. to share the cost of developing an agricultural secondary school and college, as well as establishing agricultural research stations, demonstration centers, and an agricultural extension service. The Jimrna Agricultural School opened in late 1952 and the Bishoftu Agricultural Research Station opened two years later (see chapter 6). The agricultural university at Alarnaya, near Harar, accepted its first students in October 1956 as the Imperial Ethiopian College of Agricultural and Mechanical Arts. (McCann, 1995*, p.243)*

However, all these efforts were still very much city-based. The specialists that were trained under the Agreement - and some even trained abroad - had urban backgrounds and affinities. This led Sylvia Pankhurst[28] to observe:

Many visitors to the College of Agriculture who admire the electric equipment of kitchen and cafeteria, the light well ventilated spacious buildings, the efficient workshop and all the modem furnishings and paraphernalia ask doubtfully how it will be possible for young Ethiopians educated under these conditions to bury themselves in some primitive village? (McCann, 1995*, p.243f)*

In addition, the government itself invested 'next to nothing' in agriculture, and with a focus on commercial farming for import substitution. Its lack of interest in smallholder farming manifested itself amongst others in the almost insignificant staffing of its extension services, which in the mid 60s had only 120 extension workers for the whole country. In itself this did however not negatively impact smallholder farmers, as stability both in politics and in rainfall patterns meant that in the 50s a growth in per-capita income of 43 per cent could be observed (McCann, 1995, p.245).

The first expressed interest in developing smallholder farming in the country came through Swedish foreign aid, in a project using an 'integrated' approach that included the distribution of chemical inputs to farmers. While the impact of this project was mixed, it led to a change in the government's approach to smallholder farming. A number of similar projects were later implemented in its wake, funded by foreign donors and using foreign expertise, promoting the use of external inputs and focussed on high potential areas in the south of the country. Their overall impact was relatively limited, however, and by 1975 on 10 percent of farmers in the country had been reached in this way (McCann, 1995).

5.3.4. From Political Unrest to the Situation Today

These efforts at development notwithstanding, the government of Haile Selassie was unable to significantly improve the situation of the country's farmers. Combined with an unpopular war in Eritrea, a high level of inflation, a number of famines and high levels of corruption this led to the emperor's overthrow and assassination by the Derg ('Committee') in 1974. After having cut ties with the USA, and with the support of the Soviet Union this new government - initially led by the Derg and later by Mengistu Haile Mariam - went about to reorganise the country following the tenets of Socialism. However, despite its rural rhetoric their interest were mostly urban in nature. McCann writes:

[28] Sylvia Pankhurst was a British activist who dedicated the last 40 years of her life to campaigning for Ethiopian unity and independence from external (including British) influence.

The military regime and the urban bureaucracy which replaced Haile Selassie's government learned quickly that urbanites' sense of well-being derived from stable food prices more than from perceptions of social justice. Consequently the new rulers placed agricultural price control high on their list of priorities. (McCann, 1995*, p.248)*

In the course of the Derg rule agricultural production remained stagnant and even decreased in some regions. This was partly due to the growing rural populations and an increasingly erratic climate. However, the state's major intrusions in the production process also contributed to this trend. The logic of the urban bureaucracy of the ruling socialist regime was that a change in agriculture had to be initiated through the external management of production and the control of the farmers. The available extension services were re-structured and farmer organisations were set up in order to control farmers through the conditional distribution of agricultural inputs. Most importantly, marketing was als put under full control of the state through the setting of fixed market prices and sale quotas. While the more distant regions in the country weren't as much affected by these policies, those regions closer to Addis Abeba that ensured its food supply - which included Menz - were under tight control. Some farmers adapted some of their livelihood accordingly:

In one case, a farmer in southern Wallo who in the 1960s had 10-15 granaries outdoors in his compound, had by the mid-1980s shifted his grain storage to a hidden room inside his house, reflecting the value of secrecy over visible wealth in a socialist political climate. (McCann, 1995*, p.68f)*

The most drastic control measure of the Socialist regime was its 'Villagisation' programme during the second half of the 1980s, in which farmers were forcibly resettled into newly and uniformly built 'villages'. These were meant to allow better service provision, state control and the enforcement of co-operative farming. In Menz, interviewed farmers told how following the famine of 1984-85 - that deeply affected the region - everyone was relocated to villages in Oromia. As these villages were planned by urban technocrats, however with no consideration of the farmers' livelihood strategies and needs, their effect on agricultural production was highly detrimental and contributed to unrest and resistance against the ruling regime.

This unrest culminated in the overthrow of Mengistu by a number of regional resistance movements which would eventually join forces to become the Ethiopian People's Revolutionary Democratic Front (EPRDF). McCann writes:

[T]he 1991 revolution was a final and resounding rejection by farmers of the domination of their lives by urban imperatives in the prices paid for their crops, the allocation of their labor, and, finally, where they could live and work. (McCann, 1995*, p.255).*

After Mengistu's overthrow the villages built under the Villagisation programme were abandoned and the Menzei were able to return to their ancestral lands. In the following decades the EPRDF - while it would not implement as radical policies of reorganisation and control as with Villagisation - continued the attempts at guiding and even controlling agricultural production and development through a number of - to a large extent foreign donor-funded - policies and strategies. In terms of direct linkages with the targeted farmers, this manifested itself in that by 2011 public extension services were staffed with more than 45.000 technicians, veterinary services were available in most smaller towns and more than 8000 so-called Farmer Training Centres were built at kebele-level (Davis et al., 2010). However, as in many other African countries these extension services are as yet too underfunded to provide farmers with training and advice. As interviews with extension staff

Figure 12 – Terraces built through food-for-work programmes

and farmers revealed, the services' main role is that of channel for the distribution of agricultural inputs as well as the communication and co-ordination the state's agricultural policies such as its food-for-work programmes (Figure 12). Any actual training and development work that takes place does so usually within the scope of (the many) donor-funded agricultural development projects and programmes.

5.3.5. Risk-reduction as Livelihood Strategy

Figure 13 – Farmers returning home with food-aid packages

This short historical overview was meant as an illustration of how the livelihood of the Menzei evolved in a context of relative instability and a growing external influence. While at first linkages with urban centres were limited to taxation and tribute, there had always been a certain climatic uncertainty to contend with. More recently larger changes such as an increasing population growth as well as an at times radical interference by the state further contributed to this general unpredictability. Today their farming system is closely intertwined with external actors not only through the marketing of their livestock and crops, but also through their dependency on the state for the provision of inputs and - in those cases where land is not sufficient to feed the family - even food aid (Figure 13). Accordingly, agriculture in the region has evolved into what McCann describes as a '*subsistence-oriented risk-aversion rural economy*' (McCann, 1995, p.140). While new actors have emerged with whom farmers have to interact and to whom they have to relate, the farmers' main aim - stabilising their livelihood in a volatile context - has stayed the same.

5.4. A Meeting of (Actor-)Networks

While the three 'histories' described above differ in their context and direction of development, they can all be viewed as being three separate stories about how heterogeneous actor-networks spread, changed or stabilised over time. The spread of selective breeding throughout the world is a process involving institutions, people and projects that originated in industrialised societies and gradually spread to and became involved in African settings. The Bahima’s move from a pastoralist to a dairy-based livelihood is a process of shifting from mobile - pastoralist - networks involving people, pastures and cattle held together through heterogeneous bonds of family and ethnicity to static ones that are closely intertwined with the infrastructure, tools, people and processes of Uganda’s emerging dairy market. The story about the Menzei finally is a story of smallholder farmers striving to maintain a livelihood in a context characterised by political and climatic uncertainty in which they ‘juggle’ elements - i.e. actants - such as rainfall, the access to land and pastures and the ever-shifting and changing linkages and associations with external actors who have shown a growing interest in influencing and guiding their (agricultural) development through political coercion, support programmes involving food and/or artificial fertiliser etc. All three networks are thus heterogeneous in nature, involving not only people, their practices and their contacts, but also tools, animals, roads, pastures etc.

The following two chapters will describe and analyse the moment in which these separate stories come together within the scope of livestock breeding research projects.

Chapter 6 - Uganda: Translating Livelihoods

The first case study describes the interactions between farmers and scientists in a livestock research project in Western Uganda. The farmers in this case belong to the Bahima tribe, former pastoralists who have settled down and become dairy farmers. In doing so they are integrating their traditional livestock management practices with technologies and requirements of modern dairy farming. It is this new farming practice that an international team of scientists wanted to study in the Ankole II research project, using the tools and understandings - the ways of knowing - of science-based breeding.

This chapter will examine this interaction between Bahima dairy farmers and academically trained animal breeding scientists in three different small stories, with each small story drawing attention to a specific aspect of the case. In the first small story the ways of knowing of the Bahima dairy farmers and of the scientists will be described, highlighting how they are part of wider, heterogeneous networks that shape and influence how they view and/or practice dairy farming. The second small story then analyses the research project as part of the process of the 'travel' of Western technoscience, and as an attempt to enrol the Bahima dairy farmers into its underlying global, technoscientific network through publications and software-models. Here the emphasis will be on showing how this enrolment is predominantly shaped by the scientists' ways of knowing, with all the consequences this has. In the third small story finally describes the farmers' reaction to the scientists involvement in their farms, showing how the resulting conflict was due to the farmers' resistance was caused by the social orders that are inherent to the scientists' ways of knowing. The chapter closes with reflections on the implications of these small stories for the scientists' work.

6.1. First Small Story - Contrasting Ways of Knowing

The starting point of the case study is the ways of knowing of the Bahima dairy farmers and the scientists respectively. While overlaps may be found e.g. by some Bahima and the scientists having participated in formal schooling or through a shared Ugandan background, differences in tribal origins, (understandings of) farming practice and general livelihood - being farmers vs. working in academia - nevertheless warrant a description of them as separate communities of practice with their own interests and domains. In addition, while there also exist differences within these two communities - as with some Bahima having received formal schooling while others haven't, or scientists having different cultural backgrounds (Kenyan, Ugandan, Austrian…) - the empirical data have shown enough similarities and shared practices to allow such a 'homogeneous' approach in describing their respective ways of knowing.

6.1.1. The Bahima's Ways of Knowing

We begin with the Bahima, who had moved from a predominantly pastoral, geographically mobile livelihood to one of being sedentary dairy farmers.[29] This section will go through different aspects of the Bahima's ways of knowing related to (dairy) cattle farming, illustrating how these can best be understood as a hybrid of pastoral and 'modern' practices

[29] Bahima households are usually headed by the husband, who is also the one taking all main decisions related to cattle management. Female-headed households do exist (e.g. when a woman is widowed or divorced), in which case the woman has the same rights and responsibilities as a man. Since such households are only a small minority and for simplicity's sake I will however stick to the pronoun 'he' while referring to the farmers.

shaped by the respective requirements of a pastoral lifestyle and of Uganda's fledgling dairy industry.

Using Cattle to Stabilise Social Orders

Given their pastoral past, the first element to look at are obviously their cattle as such, which play a predominant role in stabilising their tribal order and livelihood, and through their shift to dairy farming become the main productive assets of their farming businesses.


Figure 14 – Farmer with bull

Through their integration into the Ugandan dairy market in recent decades, Bahima society itself has seen some significant changes. Almost all Bahima have abandoned their pastoral lifestyles and settled down. Children are sent to school and in some cases even university. True to the entrepreneurial spirit for which they are known throughout Uganda, many of them have moved to cities and started businesses there. The shift to higher education and urban lifestyles notwithstanding, their link to cattle is still strong. As their identity is so closely tied to cattle, many urban Bahima will still own some (or even many) animals, either as part of a rural relative's herd, or on their own farm that in their absence will be administered by a close relative or a farm manager. Among the interviewed farmers, too, a few such absentee farmers could be found, working either in politics or running businesses in town while leaving the management of the farm to one of their employees. Furthermore, cattle are still seen as much more than mere productive assets, being also objects of self-identity and pride. This could for instance be observed during my field research, where farmers would frequently ask to have a picture taken of them next to their favourite animal, in most cases a bull (Figure 14), or when the herdsmen of one farmer avidly studied the pictures and discussed the beauty of the cattle found in my copy of Infield's 'The Names of Ankole Cows' (Infield et al., 2003), which reminded me of young Westerners fondly looking at the pictures of sports cars in a magazine. And in the words of another farmer, if by accident or malice a neighbour's cow would be served by his bull, it would feel as if that neighbour had slept with his wife.

Self-identity and pride is also reflected in the tendency of Bahima to want large numbers of cattle, echoing their pastoral past in which land was freely available and there was prestige in numbers. According to the observations of several scientists and the representative of one NGO working in the area, this could be seen in the region's pastures, most of which were overgrazed. Several farmers who were interviewed partly echoed this, telling how they felt the need to reduce their herd size as their land was not able to feed their animals. The state farm on which I stayed furthermore had ongoing problems with encroachers, who rather than reducing the size of their herd would let them graze on its land during the night as their own land was not sufficient to meet their needs. In other words, by settling down and being constrained to limited areas of land was in direct opposition to their tribal values, which were the result of a livelihood in which pastures were freely available.

Similarly, prestige is also obtained through one's animals' aesthetic beauty (see also Infield et al., 2003). Especially pure-breed Ankole are highly valued in this respect. Those farmers who did own them expressed their appreciation of the animals' beauty in their colour, size and the shape and whiteness of their horns, and I saw such animals being nurtured and cleaned with care. In the words of another farmer 'They are like flowers, beautiful to look at'. Things were somewhat different for cross-bred cattle to which many farmers expressed a more functional attitude. As we were walking through his farm, one (older) farmer for instance was very eager to get pictures of him and his Ankole, carefully grooming them before the shot. As we later passed his cross-bred herd he waved dismissively at them and said 'You can also take pictures of them, if you want.' In several cases the aesthetic approach to cattle had been translated into cross-breeds, however. Several farmers mentioned how the colour of an animal was a key criterion when buying or selecting animals, with one of them going so far as to say 'For us, we buy colour!'. This focus on colour is further strengthened through most clan-specific taboos.[30] A large size is also seen as a key criterion for the selection of animals. As a consequence, Jersey cattle - which are smaller, but require less fodder while having milk-yields comparable to Friesians - have never really reached the degree of popularity of the larger Friesians.[31] Last but not least, a range of practices to enhance the aesthetics of an animal - e.g. by making cuts into its ears, sharpening the horns and branding animals - are also still practiced, as I could observe on many animals on the farms that I visited (Infield et al., 2003).

In addition to the enactment of self-identification and prestige through cattle, animals are also used as an embodiment of mutual ties. Called 'empaano', this practice consists in giving cattle to friends and relatives in order to establish reciprocal relations ('irembo') which may last for generations (Infield et al., 2003). This may take the shape of dowry payments during marriages - as I could observe when one day the farmer who was hosting me had a bull brought to a family whose daughter would get married the following weekend - but also spontaneous gifts to establish or strengthen friendships.[32] According to one Bahima saying, one is not a friend to someone else if one hasn't gifted him with a bull. As a result most farmers will have some or even many animals in their herd that have been given to them on various occasions, embodying and stabilising the linkages they have with the respective givers. As Infield et. al. describe, these will even be given names integrating the name of the giver in them. The value embodied in these animals is also nicely illustrated through the anecdote told about one farmer who had sold a bull to another farmer who was not a friend of his, having been told by the latter that it would be used for fattening and slaughter. When the farmer however heard that the animal was actually to be used for breeding purposes - thus being kept, used and becoming part of that farmer's tribal identity - he went and claimed it back. The Bahima's herds, thus, are much more than mere productive assets to be managed for their commercial use. Through the cattle he gives and the care for those he has been given a Muhima shows respect to his friends and relatives, stabilising and expanding his relations and securing mutual support in times of need.

This mutual support through cattle shows itself most visibly in that most of these gifts also represent what was described to me by the farmers as a kind of insurance scheme. If a farmer has for instance given an animal to another, he may at any stage claim back any offspring

[30] Some clans are for instance not allowed to let neighbours touch animals of a certain colour, let alone give them away.
[31] Note however that according to one Austrian animal scientist this preference for large animals is a global phenomenon, and also found among most Austrian farmers
[32] One farmer mentioned how among the Bahima one is not considered a friend if one hasn't given a bull to each other.

from that animal. Similarly, if a farmer has lost one or more animals, he will always be given animals as compensation by his friends and relatives, at times even getting back more than he has initially lost. In this way the maintenance of social ties through cattle goes hand-in-hand with risk-reduction, making sure that in case of accident or disease of his cattle the farmer always has other animals to fall back upon.

Last but not least they are also kept as savings, being sold whenever there is a need for cash. One young farmer for instance reported how he had kept his own herd ever since he was a youngster on his grandfather's land, 'with the calves as interest'. By the time I met him he was about to sell them in order to finance his business venture. Similarly, many farmers would sell cattle before the start of school in order to pay for school fees, resulting in a regular, region-wide drop in the price of cattle.

In other words, cattle form the backbone of the Bahima's community of practice, serving both as embodiment of a farmer's identity and his prestige within the wider farmer community, and stabilising his livelihood by providing both insurance, maintaining social ties and serving as a savings account of sorts. In so doing they become much more than the mere productive assets that dairy cattle in industrialised countries represent. They are as much a part of Bahima society as its people, holding it together through the ties and safety net that they embody. Commercial dairy farming however operates on a somewhat different logic, and the Bahima's shift to dairy farming has accordingly led to changes in their understanding and practice of managing cattle.

Changing Cattle, Changing Society

To understand these changes, one has to look at the most visible function of cattle which is their role as milk-producers. During pastoral times milk was predominantly used for subsistence-consumption, and only rarely traded. With the advent of roads, electrification and the establishment of milk-coolers there was and still is an ongoing shift among many farmers in Western Uganda towards dairy farming as their main source of income. As this shift progresses, there is a tension to be felt between keeping pure-breed Ankole - which are easy to maintain and represent their pastoral past, but produce only small quantities of milk - and keeping cross-breed cattle - which require more care but produce enough to sustain an increasingly cash-based dairy farming livelihood. Those interviewed farmers who still kept pure-breed Ankole on their farm told that they did so mostly for traditional reasons. In the words of one farmer 'Selling my Ankole would be like selling my grandmother'. For two interviewed farmers, their Ankole-herd also represented a kind of insurance against environmental adversities, as contrarily to cross-breeds Ankole are more resistant to the diseases in the region and would be more likely to survive prolonged droughts. One of these farmers based this decision on his experience with cross-breeds during the Ugandan-Tanzanian war, when due to the unavailability of drugs all his cross-breeds died, whereas his Ankole survived. Some would furthermore try to earn some money from their Ankole herd by using them for beef production.[33] Most farmers however felt the tension, with some arguing that on the long run they will have to remove the Ankole and focus on high-yielding animals instead. Even though Ankole milk has a higher fat content and according to the Bahima is tastier than the milk of cross-breeds, there is no demand for it in the Ugandan dairy

[33] Sudanese cattle-traders were said to prefer the meat of Ankole to that of the cross-breeds

market. Milk-coolers therefore pay for quantity, not quality[34] or origin, and introducing cross-breeds is the shortest way to get there.

Put differently, the enrolment of milk-coolers and the sale of milk as a mainstay of the Bahima's livelihood has created a conflict between cattle as an embodiment of prestige and their pastoral past - represented by pure-breed Ankole, and the new ontology of cattle as dairy production units - represented by cross-breeds. This conflict has at times also inter-generational front-lines, in that several anecdotes were mentioned to me of young men having to struggle with their 'conservative' Old Man[35] who was unwilling to introduce cross-breeds into the herd. In one (probably not unique) case the young man in question even had to wait until the death of his father before he could introduce exotic blood into his herd. Other farmers tend to the other side, maintaining their Ankole out of necessity, but envisioning a future where they will own only cross-breeds as their land resources are limited and cross-breeds generate more income. This preference for cross-breeds and shift towards an identity as dairy farmers was further exemplified by several farmers mentioning how in 'empaano' their friends and relatives were only asking for cross-bred animals, and no-one showed any interest in their Ankole. In another interesting shift of values, one farmer was reported to keep a picture of his highest-yielding cow as background picture on his mobile phone, rather than the long-horned Ankole bull that is usually associated with tribal prestige. Similarly, one could observe how the old animals brought to a slaughterhouse - i.e. those animals that were discarded from the herd - consisted only of Ankole, whereas the young bulls - i.e. the males removed from the producing herd - were all crossbreeds. The starkest example for this trend towards crossbreeds was a young university-graduate expected to take over his grandfather's farm. As soon as he took over he wanted to get rid of the Ankole, seeing them as 'only good to look at', instead turning his farm into a modern, stable-based enterprise following an industrialised model and aiming for animals yielding 30 litres per day or more.

This changing perception of the value of certain breeds of cattle further illustrates how Bahima identities are 'made' through cattle, i.e. how their representation of animals is co-produced with their society. While pure-breed Ankole embody the Bahima pastoral past, they are increasingly being displaced by cross-breeds which represent a shift to dairy farming, market integration and a cash-based economy. Nevertheless, in this move towards farming as business the Bahima translate some of their key values related to cattle onto their new cross-breeds. In their practice of cattle-farming the Bahima are not guided by productivity-considerations alone, and still maintain their Community of Practice enacting the traditional values of numbers, aesthetics and the maintenance of social relations through cattle. Cross-breeds are now used in 'empaano', size and colour are still criteria of choice, and herds are still relatively large - or even too large given the available land.

Farmers Embodying Knowledge

All farmers that were interviewed grew up living among cattle, taking care of them throughout their life, learning the different practices associated with herding, and getting to know and follow the evolution of the generations of animals of their herd(s). Their learning is not the result of reading books or being formally schooled, but is instead acquired through daily work on their farm. Similarly, information about their animals is not written down, but is obtained through the daily observation of, interaction with and care for their animals. This

[34] The coolers do perform some tests on the milk they receive, however only in order to identify contaminated milk. Fat-content is not reflected in the price they pay to the farmers.
[35] A (non-pejorative) term designating their father.

results in a wealth of experience ‘ of cattle in general and his herd specifically that is ‘contained’ in their person. This familiarity with the animals goes beyond the functional, as was nicely exemplified when we visited the farm of my translator’s uncle, where he had been herding animals as a young boy. As we walked through the herd he eagerly looked around to find out what the calves he had helped raise had become. The consequence of such lifelong familiarity with and attachment to cattle is that when it comes to their management, the farmer is still the main ‘centre of calculation’ (Latour, 1988), containing all the ‘data’ required on how to manage each of his animals. It is a specialist expertise (H. Collins & Evans, 2007) that goes beyond what could be transferred through mere writing, containing instead a specialist tacit knowledge that can only be acquired through such an extended exposure to cattle.

Several elements assist in the farmers’ ‘mind-based’ management. First of them is what could arguably be described as a basic way of ‘making discourses’ (Jasanoff, 2004) through the Bahima’s language, Runyankole. As for the Inuit’s many terms for ‘snow’, a Muhima has a wide range of terms to describe the various elements related to managing cattle, thus reflecting - co-producing - his pastoral lifestyle through his way of speaking about and conceptualising the world. There is for example a classification-system for heifers based on age. There are 6 stages in it, with each having its own noun,[36] and a similar variety of names exist for bulls.[37] Additional examples include adjectives such as ‘ebishamba’ for a cow that has just given birth and refuses to have its legs tied during milking, or nouns like ‘eshwaraga’ to designate the sound of grazing cattle (Infield et al., 2003).

Most notorious however is their system for naming cattle, which is still in active use today. Their animals are given specific names based on physical characteristics (mostly colour and colour-patterns, but also the shape of their horns and their bodies), followed by the name of its dam. When the animal is a gift, the name of the giver may be included as well, as may events that may have happened during the animal’s lifetime. This naming system has evolved with time and covers a wide range of names, some of which have come and gone as ‘breeding fashions’ evolved (an example for this is the rather recent name ‘kasocks’, for a cow whose leg colouring make it look as if it were wearing socks), and not all names are in use everywhere (Infield et al., 2003). The introduction of exotic breeds into the herds has not changed their naming system that much, and it is just as much put in use to designate their cross-bred animals. However, if the exotic origins of an animal are talked about, a farmer may use the term ‘crosses’ or ‘Friesian’ (in English) to designate this. This term is not in compliance with international naming standards, however, since a ‘pure Friesian’ in a Muhima’s understanding is an animal with at least 75-85% of Friesian ‘blood’ (i.e. second crossing and beyond) based on the farmer’s visual assessment or personal knowledge of it.

Having such a specific naming-system enables the Bahima to identify animals, remember their life and ancestry and co-ordinate their cattle-keeping and breeding work. It even further strengthens their ethnic identity, having evolved to an art form through ‘Okugambente’ - a kind of spoken poetry/performance which I had the chance to observe during one wedding that I attended. During this performance an old man named cattle in a very quick succession

[36] Suckling; weaned off; weaned off and the mother has produced again, i.e. heifer with a sibling; heifer trying to get its position among the cows; about to be mounted; in-calf heifer (further differentiated into 1-2 months and late pregnancy).
[37] Bull-calves; weaned off; 'smears mud with the cows', i.e. wants to mate but can't mate yet; can mate, but not enough for a cow to conceive since it may not be tall enough to service a mature cow; can mate but is young; mature bull (further specified according to the number of generations it has produced; after three generations it is considered very mature)

for as long as he could manage, to the delight of the audience. It was an act that was not unlike Western rap-performances, a comparison that was further confirmed when a woman joined him in order to 'battle it out' by pitching her Okugambente-skills against his. This performance - called 'Okuharikanisa' - seemed like the Bahima-equivalent of a battle-rap (Figure 15).

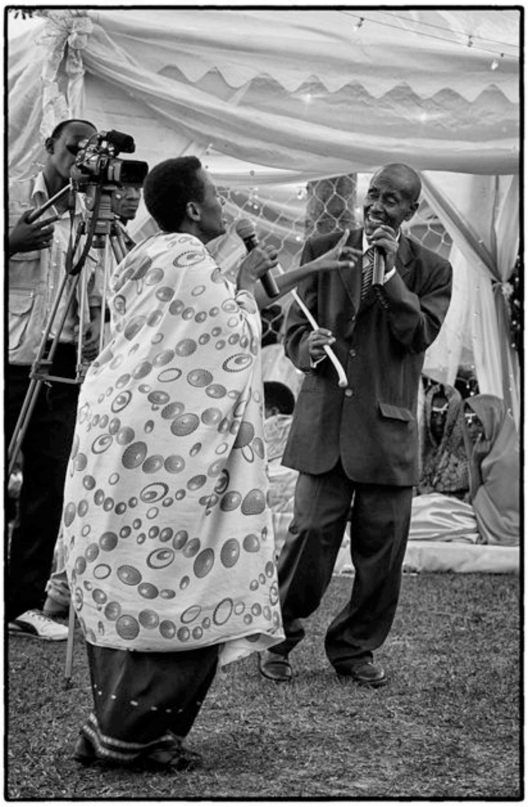

Figure 15 - Okuharikanisa

Combined with their language and a farmer's memories of his animals' upbringing, the animals themselves become 'living records', enabling him to recall a number of details about each of them. All farmers interviewed were for instance able to give an estimate of the average daily milk yield of each cow, sometimes combined with an additional (rough) indication about the evolution of that yield throughout the duration of the lactation or the duration of the calving interval. Some also claimed that they only needed a minute or so among their herd in order to know whether an animal was missing. Last but not least, many said they were able to trace the ancestry of their animals back to 4-5 generations. This of course applied only if the animal's ancestors had lived on the farm. Animals that had been given or bought were obviously less familiar to them. Furthermore, as some farmers had gained a decade or more of experience with crossing Ankole with exotic breeds, many had also acquired the ability to relatively accurately estimate the degree of crossing - or 'level of Friesian blood' in their terms - of an animals, basing themselves on its phenotypical characteristics alone[38]. Here too, however, the estimate was not very precise,[39] and - again - rendered even more difficult if the animal had been bought or given. The farmers even take a certain degree of pride in this personal knowledge of their animals. Many of the farmers refusing to join the Ankole II project did so for instance because the scientists wanted to tag their animals, which according to them might have given the impression to others that they didn't know their animals well enough. Similarly, there is a range of 'Mwiru-[40]jokes' circulating among the Bahima, several of which are based on contrasting the Bahima's ability to identify their animals on sight with the Bairu's inability to do so.

All this knowledge is based on memory alone - none of it is written down - and thus physically contained in the farmer himself. In practice this constrains knowledge-exchange about cattle to the direct interaction of people, as opposed to the written records and breeding catalogues of industrialised dairy farming that make such knowledge internationally mobile through publications and the Internet. Such circulation of knowledge through people does take place on an ongoing basis, however. Bahima are always on the lookout for new animals

[38] Note that while they claimed to be able to estimate the degree of crossing, they reportedly still found it more difficult to guess the age of crossbreeds, something they found much easier with Ankole cattle.
[39] My translator claimed that it could have a 10-15% margin of error.
[40] The Bairu (sing. Mwiru) were the land-tilling serfs in the Ankole kingdom, with the Bahima being the cattle owning nobility; see Chapter 5.

with which to breed and improve their herds. There is therefore a vivid and ongoing exchange of information about such animals, which I could observe whenever my translator - who was a Muhima farmer himself - would chat informally with the farmers we were visiting, asking them about the ancestry and performance of their animals. Even relatives living in urban centres as far as Central Uganda[41] or even Kenya would be on the lookout, as exemplified by one farmer hearing about a promising bull whose offspring she acquired in Entebbe, and about whom she had first heard about from her daughter living in Kampala. As my translator said, 'Information always comes to us', referring to how if a good bull is found somewhere, sooner or later Bahima farmers will find out about it.

Several NGOs have on occasion tried to encourage farmers to move away from their system based on memory alone and to start keeping written records, but have so far failed. Most farmers found the idea unnecessary, since they anyway knew their animals by heart. Some – especially older farmers – were illiterate and unable to use records, and all found that the actual implementation of the measurements would require an additional workload that they found impractical, especially since no milk-cooler required them to do so. Incidentally, the same applies to monitoring a farm's cash flow: most of the interviewed farmers did not maintain any kind of bookkeeping system, with one even saying that he didn't want to do so as he might find out that he is operating his farm at a loss. A few exceptions were found, including two young farm managers who had set up their own written system of keeping track of the farm's animals, and one farmer using a bookkeeping system to keep track of profits and expenses. All three had received formal education at agricultural colleges or university, which is where they said they had learned the use and value of such systems.

Overall, the identity of the farmer as repository of knowledge of his - and others' - animals is a core element in the Bahima's co-production of nature and society, serving both to guide their farming practice and maintain their ethnic identity as cattle-owning tribe. Adopting practices of writing down their knowledge would thus be more than a mere adoption of a new way of doing things. It would rather put into question their very self-understanding. Since none of the structures and processes of the Ugandan dairy market require any written records, and since the interviewed farmers felt that their current memory- and personal interaction-based system worked fine for them, they felt no need to change.

Changing Knowledge, Changing Society

This lifelong exposure to cattle is slowly disappearing among the Bahima, however. Ever since formal education has been introduced into Uganda, children will spend less time on the farm and more in classrooms following a curriculum that prepares them for urban jobs and lifestyles. Rather than familiarity with cattle and pastures they will acquire familiarity with numbers and books. They will thus not learn many of the practices and acquire the specialist expertise and specialist tacit knowledge about cattle management that their fathers have, nor will they acquire the same familiarity with the herds that they will eventually inherit. As my translator mentioned, 'My father will always know more about cattle than I ever will.' Similarly, some of the names of cattle are slowly falling out of use due to the children's lower familiarity with them (Infield et al., 2003). As a result of their schooling and the opportunities at hand, many farmers have furthermore set up businesses in cities. The grandson mentioned above who was to take over his grandfather's farm, aiming to get rid of its Ankole and fully modernise it instead, for instance also had a sports-betting business that he intended to manage in parallel. Like many other farmers before him he would thus become

[41] Central Uganda is known for having many cattle with high levels of Friesian blood.

an absentee farmer who leaves the day-to-day management of the animals to the responsibility of farm managers. These are usually either ‘high quality herdsmen’ with at least some degree of formal education, or - in the case of one wealthier farmer that I interviewed - even diploma graduates from agricultural colleges. These will however also never acquire the same familiarity or even - in the case of non-Bahima farm managers - affinity with cattle that characterised previous generations, thus moving one step closer to the more formal and functional enactment of dairy farming characteristic of industrialised nations.

These generational changes notwithstanding, as farming is practiced now knowledge about animals is still predominantly inscribed in the Muhima farmer, making him the ‘centre of calculation’ through which his herd is managed. With the introduction of cross-breeds new knowledge and skills are required, however, and farmers have gone at lengths to integrate their traditional experience with the requirements of these ‘exotic’ animals. It is to these attempts that we turn next.

Breeding Choices: Representing A World Through Cattle

As with their understanding and knowledge of cattle, the Bahima’s practice of breeding animals is shaped by the combination of enacting traditional networks and values and of meeting the needs of a growing dairy industry. In most cases the animals will be subdivided into separate herds ordered according to their purpose, e.g. into a pure-breed Ankole kept for traditional reasons, a milking-herd with cross-breeds, one herd with heifers[42] to prevent them being served by a bull before being ready for it, in some cases even one with beef-producing cattle. All herds have generally sizes that are manageable by the farmer or his herdsmen, and don’t lead to too much trampling of the pastures, since these have now become a limited resource.[43] From a breeding perspective, doing so allows first of all to have better control over mating behaviour (e.g. by not allowing the Ankole and cross-breeds to mix, and preventing young cows to be impregnated by their sire), and prevents fighting between bulls. These herds are often kept separate by subdividing the land into paddocks using tall hedges (in some cases also barbed wire) and having each herd monitored by a herdsman. Those herds that are expected to produce will have one or two bulls in them, which will serve (i.e. mate with…) the cows whenever they are on heat.[44] Here, too, knowledge about animals is still acquired through observation and interaction and stored through memory: since each herd is monitored by herdsmen at any time of the day or night, farmers claim that they can know which bull has mated with which cow, and in a last resort they may always find it out by looking at the colour of the calf. I however observed on one occasion - which as I was told does happen once in a while - that the bull from one farmer’s beef-herd had joined the cross-breed herd and chased away that herd’s bull. The farmer didn’t seem to mind too much that their system was a bit ‘messy’, as long as the offspring came from one of his own bulls.

With one exception, all interviewed farmers began cross-breeding after the NRM took power in the mid-eighties, with one even only starting as recently as 2006. Inspiration to do so had in most cases come from observing the cash that neighbours or relatives were earning by selling milk from cross-bred animals. Sources of cross-bred animals were varied, ranging from ‘empaano’ via cattle-distribution and/or artificial insemination(AI)-programmes from international NGOs promoting dairy development in the region (most notably Land O’ Lakes

[42] Young cows that have not calved yet.
[43] Separate herds will rarely be larger than 100 animals.
[44] In the case of two bulls - usually in larger herds - one will be younger, preventing fights while allowing the farmer to ‘test’ the younger bull by looking at his growth and the performance of his offspring.

and Heifer International), private AI-technicians and cattle traders to other farmers and cattle markets. The usual approach would be to get cross-bred or 'pure Friesian' bulls and have them impregnate the cows of a herd, thus gradually increasing its Friesian blood-level.[45] A 'shortcut' on the other hand would be to buy cross-bred cows, which was however only rarely done due to the cost involved.[46] While the most predominant exotic breed being introduced is the Holstein Friesian, I could occasionally also observe crosses with other breeds, including Boran, Angus, Brown Swiss, Ayrshire and Guernsey. My translator commented such occurrences by saying that 'the Bahima want variety in their herd'.

Despite its role in introducing cross-breeds into the country, artificial insemination (AI) is nevertheless not popular among most Bahima farmers. Almost all farmers I interviewed were skeptical of it, some based on bad experiences in the past, the others out of principle, preferring the traditionally-used natural approach of insemination through a bull. All farmers mentioned that it is difficult to get an AI technician to be on time when a cow is on heat, given the long distances and bad roads. In addition, as one farmer expressed it, with such a big herd as his (200 animals) he would have to call the 'doctor' every day. Furthermore, as one private inseminator mentioned farmers are reluctant to pay for the semen of an animal that they have not seen, highlighting their trust in personal experience over the claims of a private AI-technician. Since the cost for the insemination is borne by the farmer, no matter whether it resulted in an impregnation or not (the average success rate is around 70%), most prefer to abstain from it.[47]

When selecting which animals to keep and which to cull, the farmers' breeding priorities reflect his values and objectives, ultimately inscribing them in the herds he is managing. For the Ankole, the trait selection is predominantly based on aesthetics (see also Wurzinger et al., 2009). For the cross-breeds on the other hand the priorities vary, reflecting again the shift in values from a pastoral livelihood to one based on a dairy farming business. Most farmers mentioned milk yield as their main selection criterion,[48] combining it with 'functional' traits based on personal experience and traditional lore, such as size,[49] udder shape (for ease of milking) or the number of testicles.[50] Several farmers however emphasised the aesthetic value even of their cross-bred animals, with one even saying that when it came to selecting animals '[w]e only [select for] colour!'. Similarly, the personal relations embodied in cattle received through 'empaano' are at times at odds with the general trend towards higher milk yields, and on several occasions farmers reported being unwilling to part with less-than-optimal (in terms of milk-yield) animals since they were gifts from a relative or friend. Here industrial dairy farming's ontology of cattle as productive assets for the individual farmer clashes with their role in stabilising social relations between the Bahima.

When selecting within their own herd, farmers base themselves on their personal experience and their daily exposure to and observation of their animals. The farmer hosting me for instance would supervise milking in the early morning hours, sitting on a chair[51] and having the herdsmen bring the milking-bucket from each individual animal to him in oder to assess and remember its milk-yield. When buying from another farmer a different approach would

[45] To prevent inbreeding, most farmers will replace each bull after some years of service.
[46] A bull can impregnate a whole herd, whereas a cow will produce some 7 calves in her lifetime at best.
[47] Note that the same considerations are held by rangeland-farmers in the United States. See Foote (2002).
[48] For bulls this would correspond to the milk yield of its dam and/or its daughters.
[49] The predominant view among Bahima is that large animals produce more milk.
[50] Bulls with only one testicle are said to produce more female calves.
[51] Due to his old age. All other farmers I observed during milking would walk among the herd, supervising the herdsmen and giving instructions as required.

be used, however again based on observation and 'mind' as main tools. While the reputation of a farmer does play a role in another's farmer to buy an animal from him,[52] the final decision will ultimately be based on a personal assessment. The buyer will either personally or via a relative/farm manager/trusted herdsman visit the seller's farm, and have a cow or a bull's dam and/or offspring milked before his or his representative's own eyes, both morning and evening. Some may even stay for two days, to ensure that the seller doesn't cheat by not milking the cow before the day of the 'test'. The price for the animal is then set through negotiations, based on the observed performance and other desirable traits. Interestingly, animals that were born through AI usually fetch higher prices, based on the farmers' assumption that the semen used in AI usually comes from pure Friesian bulls. Similarly, a few 'highly modernised' farmers focusing on the breeding and sale of animals are said to maintain records of their animals' milk-yields and pedigree, and may also fetch higher prices for having these.[53] When buying in cattle-markets, a potential buyer will only have his own experience to rely upon, in addition to the information given by the seller which may or may not be true.[54] Probably as a consequence the animals on cattle-markets have the reputation of being of an overall lower quality.

All in all, it is through his selection of cattle that the individual farmer inscribes his personal values and objectives into the animals, the choice being influenced both by his traditional values and his objective for higher milk- and hence monetary income. In doing so he again relies mostly on his own senses, experience and personal networks, as no structures or procedures are in place to which these could be delegated.

Feeding Cattle: Constrained By Land

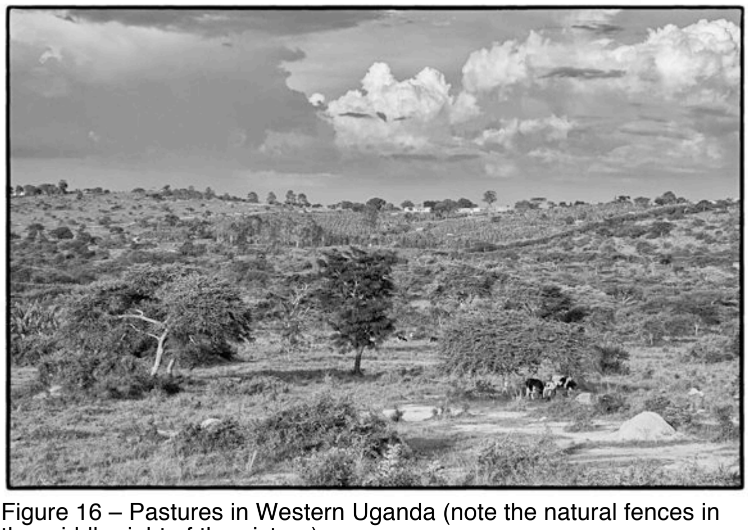

Figure 16 – Pastures in Western Uganda (note the natural fences in the middle-right of the picture)

Since in pastoral times herds of cattle were free to roam the land, animal nutrition was closely linked to this ability to move. A herder could walk with his cattle to richer pastures once those they were grazing on had been depleted, or could go to fresh sources of water during the dry season. The privatisation of land put an end to these practices, as it made much of the land and water no longer freely accessible. From then on, those Bahima who had settled down had to do with the limited land and water resources

[52] One breeder was even said to use his good reputation to his advantage, buying animals from other farmers and selling them as 'his own'.

[53] Note that I was not able to conclusively find out in how far this is the case. It was confirmed by several sources to be the case in Kenya, were a more extensive recording scheme does exist. Interestingly, many farmers there see the records *as such* as a sign of quality, and are less interested in reading what these say about the animal's performance. For Uganda I was told that records play a key role in Rwandan cattle traders' efforts at purchasing cattle. Based on a Rwandan policy aiming at increasing that country's milk production, traders have been buying up the best animals from Western Uganda. These traders pay a premium for animals with records, as they don't have the time to perform a visual check the way the Bahima do it.

[54] My translator told that once a purchase is made some farmers may go and visually check the milk-yield of the relatives of the animal they have bought, in order to decide whether it is worth keeping in the herd.

they had at their disposal, with this land putting constraints on their ability to feed their animals (Figure 16). An additional complicating factor has been climate change, in that - according to the interviewed farmers - since 1999 the dry seasons have tended to last longer. Especially the dry season during my field research (i.e. 2009) was said to have been particularly dire, with several of these farmers having lost animals as a result. During my stay on the farm my hosting farmer even had to keep his nephew's herd for some time, as the latter didn't have access to a water dam and would have lost many of his animals in case they would have stayed on his farm.

As a consequence of this change, the concept of carrying capacity of the farmers' land has become an issue of concern for them. Similarly, the traditional approach of establishing prestige by keeping large numbers of cattle has become difficult to combine with a limited amount of land. Many of the interviewed farmers were aware that they may be overgrazing their pastures by having too many animals, and believed that they might produce more milk overall if they reduced their herds to such a number that all their animals would be well-fed. In addition, water became an even more crucial factor, as access to it determined to a large extent the amount of milk that could be produced.

Figure 17 – Bairu huts on a Muhima farmer's land

Adapting to these shifts required new forms of knowledge and practice. From pastoralist times, farmers still[55] have Runyankole names for different species of grass, and can assess their respective nutritional value. According to the scientists - who did a survey of Bahima pasture management - farmers would generally let cross-breeds graze on the more nutritious pastures, knowing that pure-breed Ankole can do with less. This knowledge however is not enough in order to determine the total quantity of fodder available in a limited plot of land, and the farmers still found it difficult to determine whether or to what extent their pastures are being overgrazed. According to my interpreter some would use the body condition of their animals as a rough indicator, or see whether grass had the time to mature and produce seeds. Most interviewed farmers however felt that this was an area where their previous ways of knowing were inadequate and their knowledge was still lacking.

In order to increase the amount of grass available to their cattle virtually all farmers practice so-called bush clearing.[56] In this highly labour-intensive task - usually undertaken by external

[55] This knowledge is getting lost, however as children attend school and spend less time on the farm.
[56] In addition to increasing the pasture area, bush clearing is also part of the farmers' attempt at reducing ticks, as bushes are usually the means through which ticks manage to get on cattle, removing them reduces the risk of animals being infected.

paid labour or by Bairu living on the farmer's land[57] - the large bushes found on the land are cut and burned, making space for grass to grow (Figure 17). Another practice performed by many of the interviewed farmers is the subdivision of their land into paddocks separated by natural fences or - more rarely, since it is more expensive - barbed wire. Once these structures are in place, animals can be let to graze on one paddock while the other paddocks have time to recover.[58] More recently, the US NGO Land O'Lakes has also been promoting practices such as the seasonal growing of fodder crops to be used during the dry season, as well as the planting of pastures. Adoption of these practices has only been sporadic, however.

Overall, the privatisation of land brought with it new pressures and constraints, requiring the farmers to adapt their practices regarding pasture management and animal nutrition. However, for some farmers these are not enough. NAGRC's Ruhengere State Farm complained of many surrounding farmers bringing their animals to graze on the farm's unused pastures during the night, a 'tactic' probably used by them to overcome the limitations of their land and still be able to maintain their socially important high numbers of cattle.

Health Management: Shifting Dependencies

Regarding health management, the introduction of high-yielding dairy breeds and the privatisation of land have also reshaped the way in which farmers prevent and treat their animals' diseases. Western Uganda is home to a number of diseases affecting cattle, the most notable being East Coast Fever (transmitted by ticks) and Foot-and-Mouth Disease. As was described in the historical background in Chapter 5, during pastoral times the health management was dependent on the farmer, his knowledge of herbs and traditional treatments as well as his ability to move his herd(s) in case of disease outbreaks, supplemented with the occasional support of the omutsikiri (medicine-man). Now however moving herds away from disease outbreaks is not an option any more,[59] and the high susceptibility of the new dairy breeds has made the use of synthetic drugs an actual requirement and an inherent part of Bahima farming practice.


Figure 18 – A private veterinarian's drug store

Farmers usually acquire their knowledge on the use of these drugs from external actors. Drug dealers in small towns will provide advice to them upon purchase of the product (Figure 18). Private

[57] Families of Bairu are given a plot of land to clear on which they can grow crops and keep part of the harvest. After a few years of use they are then expected to move on to the next plot, leaving the old plot to be used for cattle grazing.
[58] I was unable to determine the actual source of this practice. I suspect that it may already have been introduced by the British, and/or promoted by NGO's - most notably Land O'Lakes - whose task it has been to improve dairy production in the region.
[59] Movement of animals in general - as for transport and sale - is now regulated by the government to prevent the spread of diseases.

veterinarians can also be called upon to provide treatment or advice, even though one veterinarian told about the reluctance of many farmers to do so in order to save costs. Drug companies and NGOs also provide regular radio programmes in which drugs are presented and advice given on their use, as do the governmental veterinary service and the National Agricultural Advisory Services (NAADS). Some drug companies also regularly offer so-called 'sensitisation seminars' in town halls, a combination of promotional activity and training in appropriate drug use. An important actor in the training of dairy farmers up to 2009 had been the US NGO Land O' Lakes, which ran a 7-year programme on dairy sector development in the region, in which they provided a range of training and extension activities. By the time of my research they had moved on to other regions of the country, however.[60]

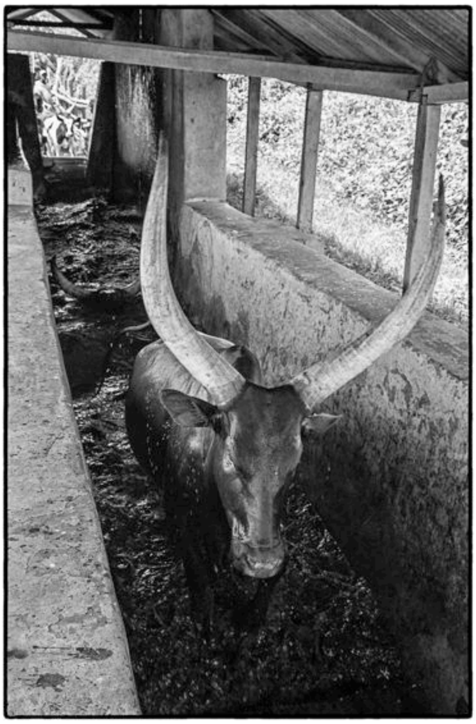

Figure 19 – Ankole being driven through a dip-tank

Besides subsidising part of the veterinary services and its radio programmes, the government as such is not much involved in providing advice to Bahima dairy farmers regarding health management. As far as governmental advice goes, the focus of the agricultural extension service NAADS is more on supporting smallholder-farmers by promoting a range of income-generating activities.[61] It does maintain some control in order to limit the risk of epidemics, however, in that e.g. livestock movements and trade is directed through permits, as is the occurrence of cattle-markets.[62]

These knowledge- and information providers notwithstanding, the drugs are often not applied in exactly the way their manufacturers intended. This begins with disease-prevention. Arguably the most laborious and intensive use of such drugs - and one that is practiced by virtually all farmers - is the treatment of animals against ticks, which are the vector organism for the transmission of East Coast Fever. Cross-breeds are most susceptible to it, and hence need the treatment in order to survive. This also involves the Ankole, in case there are any on the farm, which despite their relative resistance to the disease are also treated as a means to reduce the overall tick population on a farmer's land. In order to eliminate those ticks that have stuck themselves on them, cattle are either driven through a dip-tank filled with diluted acaricide (Figure 19), or sprayed using knapsack-sprayers. Several brands of acaricide (tick-killing pesticide) are available on the Ugandan market, including brands such as DecaTix, TacTick, ProtAid and Cooperthion. They are usually sold in drug shops, or by company stores in larger towns. Not all the

[60] Land O' Lakes' involvement covered all aspects of modern, industrialised dairy farming, including health, nutrition, marketing and co-operative formation. While they had formally left the region by 2009, they were still providing occasional support in the management of the Ugandan Crane Creameries Cooperative Union that they had helped found.

[61] Some interviewed farmers reported having attended NAADS events in order to e.g. get advice on setting up a banana plantation or raising goats. NAADS' effectiveness is limited, however, and in 2009 it was shaken by a huge corruption scandal when the extent to which some of its personnel misappropriated funds became apparent.

[62] Shortly before my field research cattle markets had for instance been closed down due to an occurrence of Foot and Mouth Disease.

acaricide found on the market is genuine, however, as in some cases fake products with low efficiency are also sold, adding an element of uncertainty to the whole procedure.

In addition to the information obtained by drug sellers and/or private veterinarians, instructions are also available on the acaricide labels. Not all farmers are literate or fluent in English, however, and farmers will often ignore these or combine them with their own considerations. I could for instance observe how one farmer opted for a higher dosage ‘to be on the safe side’.[63] The same applies to the use of protective equipment when dipping or spraying, which is not used despite official recommendations to do so. Reasons mentioned by the farmers ranged from it being impractical via the effects not being felt to protective equipment costing money. In the same vein, I could observe how a bucket used for diluting the acaricide was used for milking the next day.

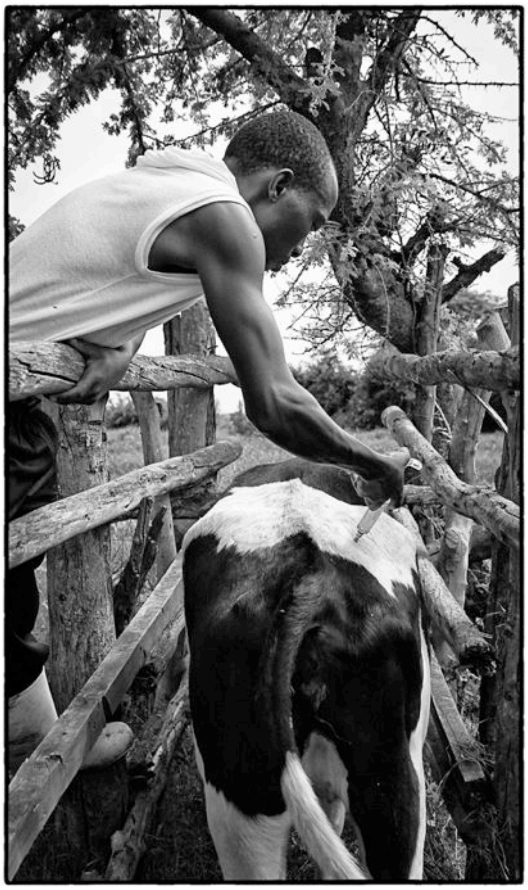
Figure 20 – Treating a cow with oxitetracycline

Prevention of diseases by combating ticks is only one side of health management practiced by the Bahima. Another is treatment once they occur. Here again especially cross-breeds are the ones that are mostly affected. On the farm where I stayed for a longer period of time no day would pass without an animal being treated, mostly against East Coast Fever (Figure 20). Farmers usually buy their drugs from drug shops that are run by private veterinarians, who also provide farmers with the necessary information on their use. Whenever possible the farmers will treat the animals themselves, however.

Here, too, farmers often do not apply the drugs in the way intended by the manufacturers. Many drugs being sold are broad-spectrum drugs, such as the antibiotic oxitetracycline. It addresses a wide range of different afflictions and diseases. According to one veterinarian this may at times result in farmers using them too indiscriminately for diseases that are not accurately diagnosed. This is echoed by a story told by my interpreter on how as a result of a large-scale government campaign against tryps in the 1960s (including large-scale cutting of trees and spraying from planes) many older farmers got a general idea that if a cow suffers from diarrhoea or cough then 'it has tryps'. They would then treat it against it, without however taking any blood samples. In his words, 'tryps became part of culture'.[64] Similarly, another veterinarian highlighted how some farmers may treat their sick animals with lower doses than those recommended in order to save money, or many use ‘polypharmacy’, i.e. combining two drugs in the hope that this will increase their

[63] This same farmer regularly sent the water from his dip-tank to the seller, who provides a free service of determining its remaining tick-killing efficiency. A similar service - albeit paid - is available by the state veterinary services.
[64] This does not apply to all diseases, however, as e.g. East Coast Fever is well known and accurately diagnosed by most farmers.

effectiveness. The situation is similar for deworming, which may be done only once every one or two years. In most cases this results in a failed treatment. Combined here again with fake drugs that are available on the market and most farmers' practice of not recording the treatments that they administer, this makes it difficult to accurately assess whether a drug has had any effect. Last but not least, while the drugs' labels do indicate a period during which a treated animal's milk is not fit for human consumption, this recommendation is never adhered to. As the milk being sold is never tested for drug residues, there is no formal requirement to do so either.

The general situation is thus one whereby farmers are more and more confronted with sick animals, as through cross-breeding their herds' vulnerability to diseases has increased. While synthetic drugs are available to treat them, these are for many farmers still a relatively unfamiliar technology. Contrarily to the past, in which they mostly relied on freely available herbs, they now have to contend with new elements and actors that have become part of their networks. Their use of these drugs is thus characterised by a combination of trial-and-error and the at times rather scattered acquisition of training and information about them from various sources. The networks and mechanisms that are in place in industrialised countries through which adherence to the drug manufacturers' script for their use is ensured are less pronounced here: illiteracy and limited to no legislation or enforcement means that farmers' individual preferences and considerations play a more important role in shaping drug use. Nevertheless, these drugs have become a crucial element in maintaining the farmers' herds productive, and their livelihood has thus become dependent on their stable supply.[65]

Marketing Milk: New Networks and Social Orders

Figure 21 – Milking a cross-breed dairy herd

The introduction of synthetic drugs into Bahima farming is only one consequence of the wider process of the emergence of the Ugandan dairy market, whose main focus is milk production as such. As milk production changed, so did the identity of many Bahima as well as the networks through which this production is performed.

Milking practice in itself has not significantly been impacted by this change, except for the number of times that the cows are milked. This number mostly depends on the distance to the closest milk-cooler to which the milk is sold. Farmers close to coolers may milk twice, once in the morning and once in the evening. The majority (including all but one farmer that I interviewed) however will only milk once in the morning, as coolers are too distant and their owners are unwilling to come and fetch milk twice for cost-reasons.[66] (Figure 21).

[65] This is particularly pertinent as in the 70s the civil unrest in the country halted drug supply, resulting in the death of most cross-breeds found in the country at that time. See chapter 5 for more details.
[66] Note that during the rainy season the roads to some farmers may be so bad that milk will not be fetched at all.

The daily procedure of milking cows is still very much based on traditional Bahima practices. As part of their milking practice, herdsmen will usually separate the calves from their mothers sometime in the early afternoon, letting the cows graze alone for the rest of the day in order to replenish their milk. Early the next morning the herd will be led to a paddock where the calves are kept, and one-by-one calves will be let to go to their mothers to suckle a bit.[67] Once this suckling has activated the cow's 'milking reflex', a herdsman will push the calf away and start milking the cow until the udder is dry. Calves will then be left with the mothers for some time until they are separated again and the next milking-cycle is initiated. While milking, the legs of a cow will be tied, and if required a range of traditional methods of the Bahima may be applied to be able to milk her. When for instance a cow has lost her calf[68] a herdsman may sing a song to the cow or have it smell specific herbs or the skin of a slaughtered calf before milking (Figure 22). These are used to trigger the 'mother instinct' of the cow to have it allow itself to be milked. Developed during pastoral times, these practices are applied 1:1 on the cross-breed animals as well.[69]

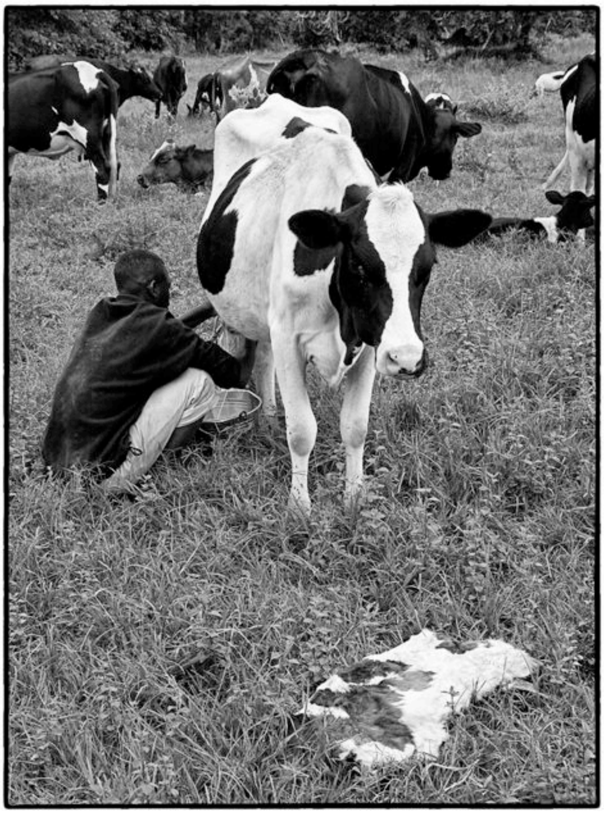
Figure 22 – Milking a cow with the help of a calf-skin

It is in what happens with the milk after it has been milked that the most significant changes can be found. In the past, milk was either directly consumed or processed into ghee. This home consumption is still there, if the farmers I interacted with are any indicator, with milk still being the Muhima's favourite beverage by far, and ghee being part of the Bahima daily diet. This however only affects a small fraction of the milk being produced daily on the farm. In addition, the bulk of the milk is now redefined as commodity, being measured and assessed and paid for, with an underlying network enacting it in this way.

The first step in this enactment can be observed once it has left the udder. Once a bucket has been filled it is brought to the supervising farmer or farm-manager for him to check it, before it is poured into a larger milk-can (the same aluminium milk-cans used in industrialised countries). Good cross-bred animals may yield up to 15 litres or more, while weaker ones may produce only 2-3. Some farmers owning an Ankole-herd may milk that one as well, while others mentioned that they did not bother and used that milk either for home consumption or for use by the herdsmen. Once all cows are milked the total

[67] It was interesting to observe here how without a word being exchanged one herdsman would indicate that he wanted to milk a specific cow, and his colleague would always know and release the corresponding calf, illustrating again the people-based knowledge that the farmers and their herdsmen have of their animals.
[68] Either due to disease, or because the farmer had it slaughtered early on as it was a male calf born during the drought and the farmer wanted to reduce the milking-stress on the cow.
[69] Their basic approach was aptly summarised by one farmer: 'What we did with our Ankole, we now do with our Friesians.' It could also be observed e.g. during milking, where the daily practice was identical to he way Roscoe described it in 1923 (Roscoe 1923).

yield of the herd is measured, by adding the known volume of each full can and using a combination of buckets and cups to measure the rest.[70] Milk yields fluctuate between the dry and rainy seasons with the dry season on average yielding about 1/3 less milk than the rainy season on the farms we visited.

Figure 23 – Receiving milk at a milk- cooler

By then a truck may already have arrived coming from the cooler (or operated by a middleman), whose driver and helpers will load the filled containers on the truck and leave empty ones behind. Some more distant farmers may have to bring the containers to a road crossing where the truck will pick them up, or will delegate that task to an omucunda, a - usually poorer - person owning (and transporting the container on) a bike. The total production will be written down in a book kept by the farmer, and will form the basis for the future payment. Payments are usually transferred via a rural bank on a bi-weekly basis. Prices fluctuate according to supply and demand, with the highest prices being paid during the dry season, and the lowest in times of rain when production is at its highest. Distance to the cooler also has an influence, as transport costs are offset against the payment to the farmer. As there are a large number of coolers to be found in the region,[71] there is a certain degree of competition between them. Ways to outcompete the competition include higher and/or faster payments and in some cases even the supply of inputs such as barbed wire or drugs.

At the milk-coolers each can will be checked individually using four tests: the organoleptic test in which the milk is checked by eye for detritus, a density test using a lactometer in order to determine whether the milk has been diluted with water,[72] a test using a reazurin-tablet to check for the presence of micro-organisms caused by bad handling during milking, and finally an alcohol-test to determine whether the milk can be pasteurised without coagulating. If the outcome is negative for any of the cans, it will be rejected and no payment will be made. The milk that has passed the test however will be poured into the cooler, where it will be kept until a cooling truck picks it up and transports it to one of the larger dairy processing plants in the capital Kampala.

It is through this network performing delivery, milk testing and payment that milk is enacted as a commodity and translated into cash for the farmers. The impact of this network on farming practice shows itself through the farmers' interest in introducing cross-breeds and maximising their milk yields. The focus is on quantity, not quality (the Ankole-milk with

[70] On the farm where I participated in milking a 15 liter bucket and a 0,5 liter cup were used
[71] In Rushere there were (as of late 2009) at least 20 such coolers (Figure 23).
[72] Apparently this may be done by farmers to fake higher yields, or by omucundas who might divert part of the milk for their own consumption

higher fat-content and arguably better taste fetches the same price as the milk of cross-breeds), and the network's mechanisms for power and control - the sales records, the tests - focus on ensuring that the milk is marketable and not diluted in any way.[73] Milking practice as such has not been impacted, and there is also no control regarding the use of drugs, as there are no tests checking for residues.

Figure 24 – Building site of the UCCCU dairy plant

This focus on marketing and quantity has also begun impacting the way farmers organise themselves. So far farmers have been selling their milk to coolers on an individual basis. Starting in 2000 and until 2009 an American NGO - Land O' Lakes - implemented a project in the region whose objective was to develop dairy farming in the region, most notably around Rushere. It did so by training farmers in a range of 'modern' practices, such as bookkeeping, recording and growing hay. A large effort was also put in organising farmers into 'primary societies', small groups of farmers who would pool their efforts in marketing their milk, in the hope of achieving a better price through economies of scale. Response among farmers was lukewarm, with initially only 32 farmers agreeing to give it a try and form such a group. By the time I did my research in late 2009, 23-28 such groups had been formed, however.[74] These in turn were members of UCCCU, an umbrella organisation for primary societies of dairy farmers throughout South-western Uganda (i.e. not limited to Bahima farmers). With the support of Scandinavian donors[75] a plan was hatched to build a dairy processing plant in Mbarara, which would be owned and run by the farmers themselves, enabling them to gain more profit from the milk they were producing and selling and - e.g. through producing powder-milk - even reach markets in Kenya and Rwanda.

The impact of these projects' attempts at further integrating farmers into markets by organising them seemed to have been mixed. I visited the UCCCU processing plant during my research, and while the main concrete structure stood, construction had been halted due to lack of funds (Figure 24). Funding was to be assured by spending a fraction of the payment of each litre of milk sold through the primary societies on the building of the plant. When I asked farmers subsequently about it, some were indeed members of a primary society, but disliked selling milk through them as the payment wasn't that good. In other words, there seemed to be no feeling of solidarity to the whole endeavour, it being instead perceived as one option for milk marketing among many. As of 2014, the plant still does not seem to be in

[73] Note that there is said to be a parallel market for rejected milk in Kampala, which may be tampered with by adding chlorine (to kill micro-organisms) or sodium bicarbonate (to lower acidity), and then sold for a lower price mostly to poorer people.
[74] As my interview with the Land O' Lakes representative took place after my field-visit, I was not able to follow up on the performance of these groups.
[75] Most notably the Danish International Development Agency and the Swedish Co-operative Centre.

operation.[76] While a more thorough investigation would be needed to draw any conclusions, these findings might indicate that enrolment into the wider network of Uganda's dairy sector has not yet shifted the Bahima's social networks from being based on kinship and friendship - strengthened through empaano - to being based on commercial relations.

The limited success of common marketing notwithstanding, the move from a pastoral livelihood towards a livelihood based on the cash-based marketing of milk has also led to a corresponding shift in the identity of many Bahima, who now view their farming as a business. The corresponding inflows of cash are visible throughout the Western Ugandan countryside: One scientist for instance reported how during the duration of the project two of the project farmers managed to 'upgrade' their housing from mud-houses to concrete houses with tin-roofs. Similarly, several of the farmers interviewed owned cars, and all had facilities such as solar power, TV's, mobile phones etc. Furthermore, as I was visiting farmers in the town of Rushere - the region's 'dairy hub' which can only be reached via (regularly maintained) dirt-roads - I witnessed the building of the first ATM there. In other words, through their business of dairy farming have increasingly integrated themselves in - and become dependent on - the networks carrying Uganda's cash-based economy.

Facing the Changes

Overall, the Bahima can be understood as a community of people sharing a domain of interest - cattle and dairy farming - and the practices going along with it. These practices are an enactment of both their cattle-centric ethnic identity as former pastoralists, and of the increasing move towards 'farming as business' characterised by cash income through milk production and sale.

This move towards dairy farming comes paired with shifts in the network of which they are a part. Due to the privatisation of land moving herds to new pastures is no longer an option, and the Bahima have to learn to live in a context where land is a limited resource. The introduction of exotic breeds and their crossing into the Bahima herds brought with them a range of linkages to - and dependencies on - new or existing actors such as NGOs, veterinarians and drug dealers, and they strive to learn new practices in nutrition and health management. Similarly, the translation of milk into a commercial commodity has had them establish linkages to milk coolers, who in turn influence the way they manage their milking practices as well as brings a new self-understanding of the farmer as businessman and - to some extent - cattle as a commercially productive asset. The Bahima thus now enrol and interact with a new and wider network of actors upon whom his livelihood increasingly depends and which bring him to change and adapt his ways of farming.

At times these network-changes put in question their social order based around the Ankole cattle, as with the wish to maintain large herds on limited land, or even the matter of keeping Ankole at all. Here, the Bahima both stick to their established knowledge and practices and learn to integrate new ones where they can. At the same time many are on the lookout for new knowledge and information regarding their new breeds, and it was interesting to observe how almost every farmer I interviewed would ask me about dairy farming practices in Europe. With all these changes, and the uncertainties that they bring along, however, farmers still rely on their own senses and experience as main basis to decide upon, and support is mostly maintained in networks of relatives and friends.

[76] UCCCU's website (www.ucccu.or.ug) still only shows an 'artistic impression' of the processing plant.

It is within this situation of the Bahima that the scientists come in, who saw themselves as having the means to help the farmers in adapting their farming to the changing requirements. It is to their ways of knowing that we turn next.

6.1.2. Ways of Knowing in Animal Science

When looking at the ways of knowing of animal breeding scientists, it is important to define them first. Animal breeding is a scientific discipline that focuses on one specific aspect of animal husbandry, namely the improvement of livestock performance through breeding, usually in terms of productive performance and corresponding farmer income. The scientists in this sense form a community of practice based on this discipline as their domain of interest. Their backgrounds may differ (in the case study they included Austrians, Kenyans and Ugandans), but they share a similar academic training, and in their scientific work in this field use the same approaches and tools.

In addition to being experts in their discipline, these scientists usually are also well-versed in other aspects of modern, industrialised dairy farming, knowing at least the basics of e.g. animal nutrition, marketing and/or pasture management. The focus on this section however will be not be on the ways of knowing underlying industrialised dairy farming as a whole. Instead it will limit itself to those aspects relevant to the case study. These include first the key concepts of industrialised animal breeding through which the scientists understand breeding and that were applied in the research project, describing the values, visions and heterogeneous networks underpinning them. Second, the practices of animal breeding applied in the research project will be outlined, i.e. the approaches and conceptual tools through which the scientists tried to make sense of the Bahima's farming and livelihood.

Cattle as Production Asset

As was told in Chapter 5, science-based animal breeding has its origins in the Industrial Revolution and its increasing demand for livestock products by a growing urban population. Robert Bakewell was the first to use what could be called 'scientific' rigour in structuring his breeding efforts. He thus was the starting point for what would become a whole academic discipline centred around the breeding and optimisation of agricultural livestock. The narrative on which this academic discipline is based is still very much coloured by its origins. The current debate about the ongoing 'Livestock Revolution' envisions a comparable development to the Industrial Revolution that transformed 18th Century Britain: urban populations are growing worldwide, along with a rise in welfare and the corresponding increase of the demand for livestock products. Science-based animal breeding is therefore understood to face the challenge to develop livestock breeds that are able to satisfy this growing demand. The main focus is on increasing overall production and efficiency, while at the same time reducing any negative environmental impact that this may have.

This focus on efficient and sustainable production results in animal breeding scientists maintaining a specific understanding of the role of livestock in general, and dairy cattle specifically. Their main - and more often than not only - role is to be the means through which inputs - grass, fodder, water, drugs etc. - are to be transformed into marketable outputs, most notably milk and meat. In other words, they are a productive asset around which farming systems are built that are meant to ensure the animals' input supply and provide an optimal environment for their biological production processes. In order to fulfil this role, some of the animals' key biological processes have to be optimised. It is then the role of animal breeding science to identify and understand those, and to find ways to improve them.

Actor-networks underpinning the enactment of 'breeds', and their implications

A key concept used by both scientists and by industrialised farmers in optimising the performance of livestock is the concept of 'breed'. How this concept is to be understood is still hotly debated within the scientific community, and as of today the Food and Agriculture Organisation of the United Nations for instance has not agreed upon a globally valid and agreed-upon definition. The use of specific names to refer to livestock that are phenotypically similar most likely came hand-in-hand with the domestication of animals. However, as Chapter 5 already illustrated, the use of selective breeding - i.e. the targeted breeding to achieve specific, desired traits within a livestock population - meant that specific types of livestock were created that embodied the values and farming objectives of the group of farmers that had done the breeding. These 'breeds' did thus not exist in a void, but were supported and maintained by a whole 'biosocial collectivity' (Holloway et al., 2009), i.e. a heterogeneous network of people, livestock, tools, infrastructure and practices. In industrialised countries these collectivities are usually so-called 'breeder societies', i.e. established institutions that co-ordinate the breeding efforts with and through large numbers of associated farmers, and thus maintain the 'purity' of their respective breed.

Put differently, the concept of 'breed' as it is enacted by breeder societies in industrialised contexts - and by the breeding scientists supporting them - is a way of classifying livestock into different segments (i.e. recognised 'breeds') that each represent specific traits and their corresponding values and production objectives. The heterogeneous networks that enact these breeds - i.e. breeder societies - can in turn be understood as 'classification infrastructures' that entail and maintain a specific moral and social order (Bowker & Star, 1999). It is 'moral' in that through a breed its corresponding values are enacted and perpetuated, e.g. through high-yielding Holstein Friesians whose breeding efforts are guided by the values of high productivity at lowest possible cost. And the order is 'social' in that 'breeds' are used as repository of trust, with e.g. again Holstein Friesians being seen by farmers as a trustworthy means for a farmer to increase the milk yield in his/her herd. It is 'social' also in that through its maintenance of a breed a breeder society can maintain 'biopower' (Holloway et al., 2009). This means that it is able to co-ordinate and control the breeding efforts of its associated farmers and thus the genetic makeup of their cattle, to collect royalties for the distribution of the animals' semen, and to contribute to the development and stabilisation of a wider livestock sector by imposing on the owners of animals of such a breed - through the care that this breed requires - a specific way of managing their animals and shaping their agricultural production.

Records as Key Element Stabilising Heterogeneous Breed-Networks

A key element to co-ordinate and stabilise the heterogenous networks that enact a given breed are so-called 'records', standardised[77] quantitative measurements of an animal's performance over time and descriptions of its phenotypic characteristics stored on physical media (paper, computers). Starting with Bakewell's efforts at systematising these among his farmers, records and recording practices have become the backbone of modern breeding. Initially performed by farmers with the help of simple measurement tools (scales, buckets), this task has increasingly been delegated to computerised machines. In the German farm that I visited and where I helped milking, for instance, milking took place in an automatised carrousel (Figure 25). Each cow was equipped with a chip, and the carrousel monitored the

[77] Standards for recording are maintained by the International Committee for Animal Recording (ICAR; www.icar.org)

amount of milk that was collected by the milking machine and stored this information in the farm's computerised herd database (Figure 26). While this carrousel was still operated by people (including myself) and milking took place twice a day, more advanced milking stations exist that allow the cow to be milked automatically whenever she feels like it, with the milking data still being stored electronically.

Figure 25 – Automatic milking carrousel

The main reason for the key role of recording in science-based breeding is the possibility for increased precision. According to the scientists, measuring and recording over time allows for a more accurate assessment of an animal's performance. For example, measuring and recording a cow's milk yield on a daily basis throughout its whole lactation period (thus generating a so-called 'lactation curve') gives a detailed picture of the development of an animal's productivity throughout one calving. The alternative of observation and memory may give a general impression of a cow's average yield. It may however be biased towards animals with a high daily average, which may still have a lower milk production per calving than animals with lower average yields but also a longer lactation period. The same applies to measuring the weight of animals using tools, where mere observation by eye may not capture small but at times significant changes.

Figure 26 – Computerised recording

Recording also allows for an increased control and co-ordination of livestock production. Recording of data on 'immutable mobiles' (Latour, 1986) such as written or electronic records and breeding catalogues allows breeder societies to control the breeding efforts of large numbers of geographically distant farmers, guiding their breeding efforts towards the fulfilment of the society's breeding objectves. At the same time, as larger value chains for the trade in animals and animal produce become established, including chains that cross national borders, records enable authorities to track and control production and sale throughout these chains. This has gone so far that in industrialised countries all livestock is registered and tagged, with e.g. each cattle and sheep having its own, individual number and registry. This makes it possible even for outsiders of a farm to identify and check the performance of an animal, facilitates taxation as well as helps in tracking animal movement (essential for e.g. the control of epidemics) and tracing their produce on its way from the farm to the consumer.

It should be noted however that recording requires a more or less extensive heterogeneous network that has to be 'disciplined' on an ongoing basis (Porter, 1996) to ensure that its practices can be established and maintained. It includes measurement tools, measurement procedures, any infrastructure that may be required (e.g. crushes, milking carousels), as well as people that are able to read, write, operate the needed tools as well as understand and interpret at times relatively abstract tables and numbers. Furthermore, for records to be comparable - i.e. to become 'immutable mobiles' that can co-ordinate international breeding and trading - there must be a set of agreed-upon standards that guide recording practices. These have become embodied through the work and publications of ICAR, the International Committee for Animal Recording,[78] which guides and co-ordinates the spread and further development of animal recording practices, and thus ensures their compatibility and comparability among all its member states.

Recording has thus become a ubiquitous element in the global industrialised livestock sector, and a backbone of science-based breeding. Through it, information about animals is translated into numbers, stored on different sorts of media (paper catalogues, electronic media…), and by 'transcending both locality and culture' (Porter, 1996) makes it e.g. possible for someone in the US to 'know' the performance of a bull in the Netherlands without ever having been near the animal. For the scientists, the success of recording in guiding and stabilising breeding efforts worldwide has thus become a matter of conviction, exemplified by one of them stating that 'without records you cannot breed'.

As a result, in the industrialised livestock sector - and accordingly also for scientists - the performance and value of livestock is largely described in terms of numbers.[79] This represents a shift in perception and trust on behalf of those involved in livestock management and trade. While the experience of an individual farmer is still an important aspect of modern livestock keeping, it is now less based on observation and personal contacts, and more on the data obtained through instruments and records. If previously for instance judgement and reputation may have played an important role when purchasing an animal, this has now partly been replaced by breed catalogues and trust in numbers, the networks that generate them as well as the institutions that ensure their compliance and compatibility to international breeding standards. Similarly, it also implies a shift in power and values. Given the need to store numbers and the ease with which these can then travel and be shared, recording requires literacy (increasingly even computer literacy) as well as the willingness to openly share information with wider - at times even global - networks.

Actor-Networks of Control

Parallel to the linking and co-ordination of world-wide breeding through records, animal breeding science also developed the breeding methods themselves, offering more control over the processes of production and procreation. Artificial Insemination is probably the most widespread among them, making it possible to have a high-performing bull impregnate a

[78] http://www.icar.org
[79] Note however that not all animal characteristics are expressed quantitatively. Breed standards often also contain relatively 'vague' terms such as 'homogeneous', 'beautiful' or 'balanced', highlighting that in addition to numbers, a certain breed is also stabilised through the personal assessment and agreement of the members of a given breeder society.

huge number of cows, even across the globe (Foote, 2002). As mentioned above, a farmer in the US can now consult a bull catalogue online or on paper, use numbers and figures to assess the performance of bulls living in Europe without ever seeing them, order their semen and inseminate his own cows with it. The same applies to embryo transfer, which offers similar possibilities for the conservation and transport of cow gametes. Both technologies are further enhanced by synchronisation, a technique to have all cows in one herd be on heat at the same time and thus allow for a more co-ordinated and time-specific management of the herd's production cycle. As a result of these technological improvements breeds have become highly mobile, triggering an international trade in them including catalogues, mail-orders, royalties etc. Their enactment can in some sense be viewed as a kind of 'software' that breeders and farmers can use as input to their herd in order to improve its performance.

In parallel to animal breeding science improving these breeding methods, other scientific disciplines perform in-depth research on animal physiology, allowing for a better understanding and manipulation of biological processes. Research on fodder production and pasture management – including the use of fertiliser, improved grass varieties and mixtures – further offers possibilities to improve animal nutrition. Synthetic drugs and vaccines are being developed and improved on an ongoing basis to ensure the animals' health. Stable designs and machinery (e.g. for monitoring or milking) allow for an improved management of the animals. All these practices are aimed at an increased control over natural variables, thus offering the possibility to shape biological processes in such a way that they can perfectly be adapted to the predominant farming systems, needs and values.

Breeds in industrialised countries can thus be viewed as technologies in their own right, the values and priorities of their respective breeder groups being inscribed into the animals' phenotype and performance. They are bred with a specific environment and farming system in mind, thus contributing to the stabilisation of a given network around them. Holstein Friesian dairy cattle for instance reflect the wish for high milk production at low cost. To function at optimal level they require - and thus 'force' the farmer to adopt - a specific reproduction- and milking regime, as well as steady fodder supply and ongoing health management. To ensure all this in turn both requires and ensures the maintenance of an extensive network involving air-conditioned stables, AI- and veterinary services, specially grown pastures and fodder supplement companies etc.

Breeds in Developing Countries: Productive Asset and Genetic Resource

Things are less clear-cut when it comes to 'breeds' in developing countries. There is no globally agreed-upon definition of what a 'breed' is. According to one of the interviewed animal breeding scientists, 'a breed is a breed when enough people say it is a breed'. In this vein, breeding scientists usually designate as 'indigenous' breeds those breeds usually kept (and named) by smallholder farmers in developing countries and that over time been adapted to the environment and farming system from which they originate. In most cases these breeds do not have a breeder society 'owning' the breed and ensuring its maintenance and improvement, however.[80] Instead, to ensure that they are nevertheless clearly defined, such breeds are often characterised by scientists and described in corresponding scientific publications. Such publications can then become the starting point for further scientific research or breeding activities within the global technoscientific breeding network, enabling a

[80] Interestingly, such a society does exist for Ankole (a.k.a. Watusi) cattle, being based in the US and run by US-farmers (http://watusicattle.com).

wide range of actors to e.g. co-ordinate their efforts in that breed's conservation or wider productive use.

The reason for this scientific interest in indigenous breeds is that in the scientists' view these breeds are a crucial asset for the world's livestock sector as a whole. For breeding scientists, the different breeds' genotype are viewed as a kind of 'software' that can be combined and improved to combine specific traits or to strengthen some and weaken others. As indigenous breeds have evolved within a specific environment, they have potentially developed a range of adaptations and disease resistances that can be of use in these breeding efforts. Their genotype is thus seen as a valuable resource to be characterised, conserved and eventually used, for instance when adapting high-yielding breeds to a specific environment.

The same rationale underpins the scientists of this case study and their interest in Ankole cattle. Especially in the rapidly changing dairy sector in Western Uganda the Ankole are viewed as a valuable repository of environmental adaptation (e.g. drought- and heat-tolerance) and resistance to local diseases. Because of this, the Bahima's efforts at cross-breeding their herds with Holstein Friesians to increase milk yields are increasingly seen as a threat to agrobiodiversity. Thus, in a televised documentary on dairy farming that I watched in Uganda one scientist warned in an alarming tone that '[t]he hills are turning black and white', referring to the colour of the increasingly common Ankole-Holstein cross-breeds found on Western Ugandan pastures. Another pointed out to me how the numerous trucks on the Mbarara-Kampala road were all carrying Ankole cattle to the slaughterhouses, describing it as the systematic extermination of a unique breed.

This critique is not directed at cross-breeding as such, however. Cross-breeding has a long tradition in science-based breeding, especially in developing countries. During colonisation and subsequent development aid/co-operation cross-breeding was (and to some extent still is) seen as a prime means to combine the tropical *bos indicus* breeds (of which the Ankole cattle are part) with the temperate *bos taurus* ones (including Holstein Friesian cattle, as well as most other 'exotic' cattle being introduced in Western Uganda: Ayrshire, Brown Swiss, Jersey…). The former are viewed as 'well-adapted' to the tropical conditions from which they originate, but are at the same time 'poorly performing' in terms of production.[81] The latter on the other hand - after generations of being bred for high yields - bring the performance needed to meet the demands of the production/productivity paradigm. The problem in the scientists' view is that the cross-breeding of the Bahima is - in their words - 'uncontrolled' and 'chaotic'. It is the work of individual farmers each striving to achieve their own breeding objective, without any consideration for the impact this might have on the future availability (or rather loss) of pure-breed Ankole - and the tolerances and resistances 'stored' in them - as a resource for future breeding purposes. Furthermore, given the Bahima preference for Holstein Friesian as means to improve their herds' milk output, the scientists' fear that such uncoordinated breeding efforts targeted towards high milk yields alone may result in animals that are not adapted to the environment in which they are to live. It is in other words a kind of ongoing, un-co-ordinated experiment of the Bahima in their shift towards dairy farming that runs the risk of losing the Ankole as genetic resource while creating dairy cattle that are unable to live within the environment of Western Uganda.

Understanding Bahima Farming Through Science

[81] The terms 'well-adapted' and 'poorly performing' were taken from the description of the pure-breed Ankole in one of the PhD-student's dissertation.

It is with this critique in mind that the scientists' research is to be understood: they viewed their work as a first step towards bringing this 'chaotic' breeding process under (scientific) control. By mobilising the tools of science, they hoped to contribute to a result that ensures the farmers' income while remaining 'sustainable' in the sense of conserving biodiversity and generating productive breeds adapted to their environment. To achieve their aim, they deployed a number of research practices for understanding the cattle and the Bahima's farming, whose conceptual underpinnings are described below.

Figure 27 – Pure-breed Ankole herd on one of the project farms

In one part of their research, the scientists aimed to monitor herds of live pure-breed Ankole and of Ankole-Holstein Friesian crosses through on-farm data collection throughout the duration of the research project in order to analyse their respective performance. The traits to be analysed were a reflection of the scientists' underlying values: the focus was on daily milk yield, duration of lactation, calving intervals, age at first calving etc., i.e. all traits that are relevant to assess the overall milk production performance of an animal. Despite the pure-breed Ankole being 'well-adapted', the scientists described their performance for these traits as being 'late', 'poor' and 'low', highlighting their underlying objective of an early production of calves, long lactation periods and high daily milk yields in order to maximise milk production.

The scientists viewed breeds such as Ankole or Holstein Friesian as a kind of 'software' to be altered and combined at will, based on the breeder's objectives and needs. The aim of the analysis was therefore to identify the optimal crossing level (in cost-benefit terms) between Holstein Friesian and Ankole. Long-term cross-breeding to maintain cattle at a certain level requires extensive networks and complex breeding processes, however, something the scientists believed was not (yet) feasible in Uganda. Their research was instead understood as a starting point to maybe develop a so-called synthetic breed, i.e. a breed combination that exists in large enough numbers to maintain itself through mating within the population. At the same time, they were reflecting on alternatives to Holstein Friesians. While Holstein Friesians are arguably the acme of industrialised dairy farming, the demands they put on management, nutrition and care are relatively high, and as such often at odds with the prevalent conditions in Western Uganda. During the research the scientists therefore often mused whether there weren't breeds that were more suitable to be crossed with Ankole, including e.g. Grauvieh, Jersey or Swedish Red.

The second part of the scientists' research was to develop a software-based model of a farming system that included both an Ankole-Holstein Friesian cross-breed herd and a pure-breed Ankole herd (Figure 27).[82] This model would serve as a tool to understand and analyse such a farming system's economic and environmental sustainability, and enable the simulation of different management practices.

The inputs for the model were a combination of statistics (e.g. historical data for rainfall), as well as the performance data of Ankole and cross-breed herds collected on-farm for the first part of the research (Figure 28). STELLA, a simulation and modelling software was used for this purpose. Within the software the simulated farm was subdivided into four compartments, simulating precipitation, vegetation (i.e. pastures), livestock and market respectively. Each compartment consisted of a set of equations, part obtained from the literature and part developed by the scientists themselves. It is through these equations that specific processes were to be simulated over time.

Figure 28 – Collecting performance data

As with the monitoring of live cattle, the model was a means for the scientists to understand the process of change that the dairy sector in Western Uganda is undergoing. In contrast to the monitoring however it was not a way to 'map' these processes by collecting on-farm data. Instead, the model was a means to approximate reality and *experiment* with it by applying the theories of science-based breeding (Sismondo, 1999). These experiments, in turn, were meant to generate specific management advice that could be applied on-farm.

The main focus of the model developed by the scientists was to deepen their understanding of the carrying capacity of the farms. In contrast to their pastoral past in which they were able to roam freely, Bahima dairy farmers were now constrained in their access to pastures, having to find a compromise between their 'prestige by numbers' and the amount of grass that their pastures were able to generate to sustain their herds. The model was therefore meant to experiment with different management practices in order to find those alternatives that prevented overgrazing while maximising the farmers' monetary income. By using a computer simulation, the scientists were able to consider the dynamic nature of rainfall patterns (and corresponding growth of pastures) in their analysis and e.g. experiment with the impact of prolonged droughts.

In doing so, the model had the potential to become an 'epistemic and social glue' (Sismondo, 1999) through which the 'messy' world of Bahima dairy farming was 'glued' to the ideals and principles of science-based dairy farming both through the way in which it was depicted in the model and corresponding publications, and through the management advice that the model was expected to generate. This began already with the model's basic entry point: its focus was on increasing the efficiency and output of the farm in *monetary* terms while

[82] They had identified this farming system as a promising combination of pure-breed Ankole maintenance and dairy farming. See second small story for more details.

maintaining the sustainability of the natural resources required for production (most notably its pastures). The cattle, too, were understood as a production resource, with no value attached to them beyond their ability to function within a production-oriented farming system. For instance, one management practice that was simulated and proposed as alternative entailed the fluctuation throughout the year of a farm's cattle stock. Doing so would enable to adapt the size of the herd to the farm's fluctuating carrying capacity throughout the year. Farming objectives such as having a 'beautiful' herd or the role of cattle as a means to reduce risks and maintain social relations through 'empaano'[83] were not integrated into the model's equations.

In this way, money functioned as unifying value for the whole farm. Management options were assessed in terms of the money that they generated, be it through milk output or through what the model constructed as 'herd value', i.e. the monetary value of the herd on the market. By being valued in monetary terms, both outputs - milk sales and increase in herd value - were viewed as being to some extent interchangeable. This approximation however did not consider the fact that milk sales were needed to maintain the livelihood, e.g. by paying the salaries of herdsmen or the children's school fees, a shortcoming that the scientists acknowledged. Nor did it - again - consider non-monetary values inherent in animals, such as the social relations they represented or their aesthetic beauty.

This last point became most apparent in the scientists' difficulties in simulating the farmers' logic for keeping, selling and/or giving away animals. They did not find any unifying logic to which farmers adhered, forcing them to approximate it through a stochastic equation.[84] Again, while this equation made it possible to run the model, it did not account for the impact of empaano, the use of social networks to extend one's carrying capacity e.g. by letting one's cattle temporarily graze on a relative's land or other more complex decision-processes and strategies that the farmers might adhere to. The farm was instead modelled as an individual, closed unit.

These difficulties in addressing elements of the Bahima's ways of knowing through scientific means highlights how the scientists looked at the situation through 'glasses' that were shaped by the values, understandings and practices of their academic discipline. To some extent they were aware of this themselves. The need to consider what is called farmers' 'indigenous' knowledge has for a long time found its way into the mainstream of agricultural research for development, highlighting how farmers often have knowledge that is specifically adapted to the context they live in. Accordingly the scientists wanted to understand the Bahima's knowledge and to take it into account when developing new approaches and technologies for specific contexts. Their research therefore included elements through which they aimed to assess it and integrate it into their own work.

One study[85] - meant as input to the development of the model's pasture simulation - assessed the extent to which farmers knew different types of grass, and found out how they partly used them as indicator species to assess a pasture's quality. Similarly, another study was implemented to understand the rationale underlying the Bahima's breeding choices and approaches to intergenerational learning. Both were basically formal surveys, using a questionnaire with predetermined questions, part of them open, and part closed. The data thus

[83] The giving and receiving of cattle to establish and/or maintain social relations. See previous section.
[84] As sales were partly linked to a farmer's need for cash, a stochastic equation enabled to simulate the higher probability of a farmer selling an animal e.g. before Christmas or when school fees were due.
[85] As I was not able to interview the person having done this study in depth, it is not covered in my analysis.

collected was then to a large extent translated into numbers and fed into the scientists' analysis. This included the scientific validation of the farmers' knowledge of the nutrition levels of different grasses, the integration of the data into the model described above, as well as an essentially quantitative overview of the farmers' responses regarding their breeding strategies.

Put differently, the scientists conceptualised farmer knowledge as something external to them that could largely be captured through formal questioning during farm-visits. It could then be 'ordered' into formats that made it suitable for further processing and translation into scientific models and descriptions, without however putting these models and descriptions themselves into question. In their look at the farmers' livelihood they mostly stayed within the limits of what they saw as their own discipline, covering in depth those aspects directly related to animal breeding. Aspects like 'empaano' and the role of cattle in stabilising social relationships and serving as insurance were acknowledged, but not used in a discussion of the suitability of the models and approaches they were developing.

The Scientists' Role

These surveys point to an important element of the scientists' ways of knowing: the collection of on-farm data was a key element of the scientists' research activities. Put differently, the farm - including the farmer and his knowledge, the herdsmen, the cattle, the pastures etc. - was viewed as a 'data-mine' to which the scientist could come as an external observer and extract 'objective' data to be further processed and used. The bulk of this data took the form of numbers, which brought with them the promise of 'transcending locality and culture' (Porter, 1996), having the potential to processed, sent to and used by other animal scientists throughout the global technoscientific network. From being anchored in the mind of the individual farmer, knowledge about the farm was now delegated to documents and databases that would enable an external person without any direct exposure to the farm to assess its structure and performance. This represents a shift of knowledge from people to a much wider network in which 'things' - publications, software-based models - play an important role.

However, what was to be seen as data was defined by the scientists' research questions. As such it was viewed through the glasses of the modernisation-narrative underpinning their understanding of the development of the Ugandan dairy sector, and framed by their academic discipline, i.e. livestock breeding. The focus of their research was on determining an economically 'optimal' level of crossing between Ankole and Holstein Friesian, as well as on simulating dairy cattle management alternatives that would yield the highest economic returns while conserving environmental resources. It was thus not the extraction of something inherent to the farm, but rather an *abstract translation* of the farmers' reality into a format suitable for scientific processing. Some key elements - most notably the cattle's role in stabilising social relationships and securing support - were difficult to translate or were omitted completely, as the scientists had no suitable tools to capture them accurately.

The primary audience of such translations were not the farmers themselves. Instead, the scientists' aim was to generate scientific publications - theses, posters, articles in scientific journals - for a scientifically schooled readership. These publications were basically the scientists' knowledge made immutable and mobile, a theoretical view on the situation as opposed to the practical knowledge of the farmers engaged in it. They were expected to enable external actors such as other scientists or policy-makers to learn about (the scientists' interpretation of) the Bahima's farming system, ideally being used as basis for further research, the development of new knowledge and technologies and/or inform policies for the further development of the Ugandan livestock sector. The publications however were the product of a specialist expertise that was at home in academic circles and research institutes, but that did not go hand-in-hand with the specialist tacit knowledge that the farmers use in order to manage their farms and that may at times play a crucial role in running them effectively.

This in turn puts focus on the role that the scientists saw for themselves. They were the ones extracting the data from the farms (directly or with the assistance of an enumerator), as well as the ones interpreting it and translating it into scientific findings written down in publications. Even the knowledge of the farmers was viewed as something to either be validated through scientific means,[86] represented statistically or translated into formulae for modelling purposes. Their role as scientists was therefore to generate scientific knowledge about the ongoing changes taking place in dairy farming, and even - ideally and on the long run - provide technological solutions to the farmers (e.g. in the form of a management-advice generating model or through the development of a synthetic breed) which would help them improve and stabilise their income while maintaining the sustainability of their natural resources. Their ways of knowing thus enacted a social order in which farmers were passive data-providers, while scientists provided the knowledge and practices needed for a development of the Ugandan dairy sector that would eventually combine the conservation of Ankole with increased farmer income.

6.1.3. Small Story Reflections: Specialist Expertise and Tacit Knowledge

The in-depth, separate look at the respective ways of knowing of scientists and farmers makes it possible to highlight some key similarities and differences between the two groups. Beginning with the differences, the small story showed how the Bahima's ways of knowing are a combination of 'traditional' understandings and practices, and their cattle fulfil both the functions of production of milk for marketing purposes as well as reproducing and stabilising ethnic identity and cohesion. Their shift towards a sedentary lifestyle and the introduction of cross-breeds has put a certain pressure on them, with the now delimited land standing at odds with their wish to have large herds, or the cross-breeds forcing them to acquire new knowledge in order to keep them alive and productive. As a consequence they are striving to combine their pastoral values, practices and identity with those required by stationary dairy farmers integrated into a wider, cash-based market. The backbone of the actor-networks through which their ways of knowing are embodied is the farmer in direct interaction with his herd, being the repository of knowledge about the animals, and the main source of decision-making power.

The scientists on the other hand have ways of knowing that are shaped by their origin in the Industrial Revolution. Their narrative of a Livestock Revolution views a similar growing demand for livestock products in Uganda - including its dairy sector - with science playing a key role in providing the knowledge and technologies required to meet this demand. This knowledge in turn is not limited to people, but is instead delegated to a number of non-human actants, including written records for keeping information about animals or software-based models that aim to represent a given farming system. These in turn enact a specific ontology of cattle and of farming, with the former being viewed both as productive assets and genetic

[86] As when determining whether the farmers' assessment of the nutritional value of grasses corresponded to the results of a chemical analysis of these grasses.

repositories whose traits have to be conserved and optimised to ensure maximum productivity.

Regarding similarities, the Bahima have already begun integrating some of the science-based practices of animal husbandry and animal breeding into their daily farming practices. Since the cross-breeds have ‘forced’ them to use synthetic drugs in order to keep them healthy, they have had to acquaint themselves with the use of these drugs and in some cases even enrol the help of laboratories in order to measure the effectiveness of their dip-tanks. Similarly they have an expressed hunger for additional knowledge on the ins and outs of industrial dairy farming, with e.g. issues of carrying capacity of their land being of primordial interest to them. Similarly, the scientists have an expressed wish to understand and consider the farmers’ ‘indigenous’ knowledge in their work. Their approaches in doing so are however still very much shaped by their own ways of knowing, as they are mostly attempts at quantitatively assessing this knowledge through surveys or by verifying its scientific validity.

This last point leads to a key issue worth remembering when looking at the ways of knowing of Bahima and animal breeding scientists. Drawing on Collins and Evans’ Periodic Table of Expertise (H. Collins & Evans, 2007), an important element to consider is the importance of tacit specialist knowledge in order to be able to interact with or even contribute to the specialty of a specific group. It is most easily understood in relation to the Bahima: the small story showed how most of them will have grown up on their farm and acquired an intimate knowledge of their animals, their land and the social networks through which they enact their ethnic identity and ensure vital forms of support. Interacting with these actants in their actor-network requires a form of knowledge that cannot easily be written down or transferred orally, if at all. Rather, it requires the ‘lived experience’ in order to be understood and come to expression. A rather simplistic example can be given from my own experience. During my stay with one farmer and on the state farm I often herded cattle with herdsmen and experienced firsthand the difficulty in keeping a herd of one hundred animals together and steering it to its intended destination, especially if said destination was a crush where they were to be measured. Comparing this with the ease with which I milked cattle on the German farm - basically just sticking the milking unit of the milking machine to a cow’s udder, with the machine taking over both milking and recording of the milk yield, I had an inkling as to why recording worked in Germany while it wasn’t met with as much enthusiasm by the Bahima. The same however applies to the scientists’ tacit knowledge. This knowledge is much more than what is contained in their textbooks and told by teachers during lectures. Through their interactions with fellow scientists, visits of farms throughout the world and work with their analytical software and scientific approaches they have acquired a ‘feel’ for the possibilities and potential inherent in their approach to livestock breeding. Here, too, it took my stay on German and Austrian farms and talks with their farmers for me to really grasp what it was that the scientists had been talking about up to then when it comes to science-based breeding. At the same time the tools and approaches they use result in a specific enactment of livestock and the actor-networks underlying their ways of knowing imply a tacit distribution of power and social orders that are rarely addressed by their scientific discipline.

It is this difference between specialist expertise - that which is visible, can be observed and written down - and tacit specialist knowledge - that which can only be grasped through lived experience - that should be kept in mind when reading the following two small stories. It has implications on the scientific knowledge that the research project generated and the social orders that it enacted, which is the subject of the next two small stories.

6.2. Second Small Story - The Travel of Technoscience

With the ways of knowing of scientists and Bahima thus described, the next step is to look at the research project as such. More specifically, the aim is to look at starting with the initial idea of an Austrian scientist a whole actor-network was set up with the aim to generate objective, scientific knowledge about a specific farming system of the Bahima. This actor-network entailed specific social orders in power and control, which had their impact on the kind of knowledge that was being generated through it.

6.2.1. Generating Research Ideas From Afar

The story begins in the early 2000's, with an Austrian animal science professor's growing involvement with research on animal breeding in Africa. While he initially had neither knowledge nor experience with developing countries, he began supervising a range of students dealing with tropical livestock production subjects. While the first such student came from Austria (and would eventually become his research assistant), subsequent ones increasingly came from developing countries, including Uganda.

The funding and framework in which this supervision of students took (and is still taking) place was/is provided by the OeAD, the Austrian Agency for International Co-operation in Education and Research. Within it, students of e.g. Uganda are given academic training in Austria, and perform thesis research in their home countries under Austrian and international[87] supervision. While academic training in animal sciences is also available in East African institutions, several (former) students reported that the limited facilities available there (most notably laboratories and libraries) make it more difficult to effectively perform PhD-level research there. By pursuing their education in Europe instead, these students can therefore be trained in the use of some of the most advanced technologies available in animal breeding (e.g. DNA-testing and the use of modelling software), applying these to problems faced in their home countries. It is, in other words, a mechanism to further strengthen the involvement of developing countries in the global scientific endeavour. While universities and research institutions are already widespread on the African continent, a mechanism like the OeAD both helps in overcoming their current weaknesses, and strengthens the (personal) ties between European and African institutions.

Personal Interests and Funding Flows

The first Ugandan student the professor supervised had already done her Masters research in Austria, and was subsequently interested in pursuing PhD-level education. As she approached the professor, he was happy to comply, proposing to go look for a research topic in the country itself. And it was on this trip that the idea for a first research project on Ankole-cattle was born. In the words of the professor:

We agreed that we'd [travel to Uganda] and first collect ideas. And on that trip we saw the Ankole cattle, and I was very much impressed by them. And [the Ugandan student] was as well. And I thought we could do something about Ankole.

The topic of the research was thus the result of a chance encounter with Ankole during a field trip, highlighting how a researcher's personal interest is often a strong guiding factor in the orientation that a research project takes. Another important guiding factor however is funding. At about the same time as the professor's interest in the Ankole-cattle was raised, he

[87] Usually supervision was provided by scientists based in one of the CGIAR-institutes.

was approached by the head of the Biotechnology Thematic Group of the International Livestock Research Institute (ILRI) in Nairobi, one of the CGIAR-Institutes[88] with a thematic focus on livestock. Part of this funding is tied, meaning that if for instance Austrian funding is to be accessed, then any research activities need to also involve Austrian academic institutions. For ILRI - as for most research institutions - access to funding is what keeps the institution afloat and ensures the salaries of its employees, and being able to implement projects goes beyond the mere willingness to generate scientific findings. It was this Austrian funding that ILRI researchers were hoping to access when they proposed a joint collaboration with Boku.

The professor jumped on the opportunity, and after some discussion both institutions jointly decided to submit a proposal to research the breeding decisions underlying the management of Ankole cattle to the Austrian Development Agency, which was eventually approved. This first project - Ankole I - was not limited to Uganda, but also involved on-farm research with Ankole cattle-keepers in Rwanda, Burundi, Tanzania and Kenya. Involving a range of Ugandan and Austrian PhD-students, the project was eventually completed, publications written and the farmers' knowledge of their cattle translated into a scientific format.

From Personal Interest to Extending the Livestock Revolution

The need to identify promising research topics and ensure their funding is an ongoing effort of scientists through which their secure both their academic standing and their livelihood. Thus when Ankole I was completed in 2007 the professor and his research assistant looked for new opportunities to submit another project proposal through which they would build further on their research on the topic. In their own words, this time they 'felt that it's a good idea to work somewhere where [they] have at least some experience and some feeling of what's going on as a European in Africa'. During their previous field visits they had become increasingly aware of the way in which Western Ugandan farmers were shifting towards dairy farming by introducing cross-breeds of Ankole with Holstein Friesian on their farms. They had also met several Bahima farmers who kept both a herd of pure-breed Ankole and of Ankole-Friesian cross-breeds on their farms. They were intrigued by this approach, interpreting it as a 'new' farming system that had emerged as the region was changing. Given their scientific background they felt that this was a domain in which their expertise could be made to bear. They therefore decided to jointly develop a follow-up project - aptly named Ankole II - which would have as its aim to find out in how far this system was environmentally and economically sound.

The scientists' comment is telling in that it highlights one key aspect of the travel of science. As Latour points out, 'the global is local at all points'. Or put differently, even the 'universal' endeavour that is science depends on individual scientists who have acquired their knowledge and skills within a given context. When a research project is thus planned, it is not a matter of the 'universal' tenets of science being applied to a specific context, but rather the application of 'local' knowledge obtained in one context on another. The growth and intensification of Ugandan dairy farming was thus framed by the scientists as a development process comparable to the one Europe had undergone, and to which they could contribute with their expertise. Through their involvement in the project they would therefore apply the lessons and technologies they had learned in European/industrialised dairy farming and livestock

[88] Consultative Group of International Agricultural Research Institutes. See Chapter 5 for the origins of the CGIAR.

breeding in Uganda. In this way the research project was right from the start inscribed with a development narrative with its roots in Europe.

They went on to suggest the project to their partners at ILRI, who in the professor's wording were only 'moderately happy' with it. The partner's main research topic was biotechnology, after all, whereas Ankole II would have a focus on production systems. However, since at that moment Ankole II was the 'only thing on the table', funds were required to keep ILRI's activities going and in order to maintain the good working relationship that had been established through Ankole I, they were willing to go along and join the project. The proposal was jointly submitted to the Austrian Development Agency, and funding was approved over a 3-year implementation-period from 2007 to 2009, including the recruitment of two full-time Ugandan PhD-students and the corresponding research activities.

A range of factors thus colluded to have the Ankole II project take the shape that it had. As the professor and his assistant were based in Vienna - and given the tied nature of the Austrian funding to which they had access - they were able to take the lead in the development of the project proposal while the research partners at ILRI took a backseat-role. The idea on which the research proposal was based was thus mostly the product of the interests[89] and specialist, scientific expertise of the Austrian scientists, based on their knowledge of Uganda and of what they thought they could contribute to its development in terms of 'European' know-how in animal breeding. Their 'power' in deciding on the research agenda resided predominantly in their access to funds. The farmer community-to be covered by the research was at this initial stage half a continent away, meaning that its influence on the project was limited to the impression it had left on the professor and his assistant, supplemented by some additional background information and statistical data obtained from various Ugandan sources.

The Project in a Nutshell

Building on their expertise, the scientists designed the Ankole II research project based on the following development narrative: They understood that the Bahima were moving towards an increased integration into national, regional and maybe even global dairy markets, and thus more and more assimilated into a cash-based economy. In doing so they were introducing high-yielding dairy breeds into their herds, to the detriment of the pure-bred Ankole. As these were viewed as a genetic resource to be conserved for future breeding eventualities, their aim was to find technological alternatives to the current trend. The objective of the project, then, was to assess the 'economic and ecological sustainability' of what was perceived by the scientists as a 'new livestock farming system' in South West Uganda in which farmers kept both cross-bred Holstein Friesian-Ankole dairy cattle and pure-bred Ankole, which they saw as an interesting alternative combining economic development with genetic conservation.[90]

The project's backbone would take the form of the work and publications of two Ugandan full-time PhD-students, who would be recruited for that purpose. One of them would focus his research on the animals themselves, monitoring herds of a select number of farmers over a determined period to determine their performance in a set number of parameters. The second would then also use this data in order to develop a model of the farming system under observation, in order to be able to simulate a number of different livestock management

[89] The decision to include a modelling-part in the research project was a direct consequence of the professor having been trained in modelling techniques.
[90] Note that after the project was initiated a second, beef-producing region was also included into the research. This one has however not been covered by my research.

methods. Data was to be collected on-farm. A number of farms would be chosen, a sample of animals on each farm selected, and then regular measurements would be made on them, combined with additional data provided by the farmers.

In addition to the PhD-students, a number of MSc-students would also join in the project. One Boku-based Austrian student would collect and analyse grass samples collected on the farmers' pastures, while another would make a questionnaire-based investigation of the farmers' breeding strategies. Finally, a Ugandan MSc-student based at Makerere-University in Kampala would implement a grazing-trial with Ankole and cross-breeds on a state farm also involved in the project. All these students' findings would eventually flow into the work of the PhD-students.

Last but not least, the timeframe of the project was set by the requirements of the Austrian Development Agency (ADA) which was funding the research. This meant that according to the proposal the scientists had four years to deliver outputs agreed beforehand. These were to be trained (mostly Ugandan) academics, their respective theses, a number of peer-reviewed scientific publications as well as presentations and posters for subject-relevant scientific conferences. The academics were to return to Ugandan institutions in order to further strengthen the presence of science-based ways of knowing on animal breeding in the country. The publications in turn would become part of the scientific 'canon', immutable mobiles that could be consulted by a global audience of scientific peers, donor- and government representatives, providing knowledge about the farming system under study and offer avenues for further research and/or policy-making.

Enrolling Local Legitimacy

While the project was managed through ILRI in Nairobi and the bulk of the training and research was to take place at Boku in Vienna, institutional anchoring in Uganda itself was also needed. On the one hand this was part of the development narrative of ADA and a precondition for its funding. Its aim is to contribute to a transfer of industrialised/Austrian know-how and technologies to developing countries, making the involvement of local institutions in implementation a prerequisite. The anchoring also had practical reasons, however, as Ugandan institutions would provide a home-base both to establish and maintain contact with necessary actors in the field - most notably the enumerator (see below) - and to serve as channel for the funds through which many of the key activities (e.g. workshops, data collection) and logistic aspects (e.g. transport of the researchers in the field) were to be financed. Last but not least, the involvement of Ugandan research institutions would provide the project with a crucial element of local legitimacy. From being a research project initiated, managed and funded from abroad, it would become a project contributing to the capacity building of Ugandan research institutions.

The National Animal Genetic Resource Centre (NAGRC) would eventually become the institution of choice to provide this local anchoring. NAGRC had been inaugurated in 2004, being one result of the 2001 Animal Breeding Act.[91] It is a parastatal with some 300 staff, being partly funded by the state, and having to raise the remaining funds on its own. Its mandate is to spearhead breeding in the country, providing farmers with top animals at subsidised prices, and thus provide an alternative to the private sector breeders who may not necessarily have the country's best interest in mind. Its central facilities are located in

[91] The institution as such already existed before under full governmental control and funding, being previously known as the Animal Breeding Center.

Entebbe near Kampala, and it has a total of 11 state-run farms where it maintains herds of livestock from the whole range of Uganda's available breeds. As it had both a mandate related to the project's research topic, had been a partner in the Ankole I project and was the home institution of the professor's first Ugandan student, it was highly suited for that purpose.

NAGRC's director was therefore approached by the scientists from ILRI and Boku as to whether there'd be interest for his institution to participate in the Ankole II project. As with ILRI, the project had already been designed by the professor and his assistant, meaning there was little room left for NAGRC to adapt it to its capacities and requirements. Instead he was presented with the proposal 'as is' with the suggestion for the institution to join in its implementation. Nevertheless, here too project funds functioned as an interessement device motivating the institution to join. Due to livestock not being a main priority of the Ugandan government at the time (Ebner, 2010), NAGRC was chronically underfunded and had difficulties in maintaining its state farms operational, let alone invest in the future development of the institution. Its interest in the project was therefore probably[92] based on the opportunities that it provided, including the opportunity to train its staff (one of the Ugandan PhD-students was eventually selected from among its scientists) and provide funding to perform research activities in the field (one of the trials of the project was performed on one of NAGRC's state farms). Last but not least, given its mandate, the research outcomes of the project were of direct relevance to the institution.

Another Ugandan institution brought on board - further strengthening the project's local legitimacy - was the Veterinary Faculty at Makerere University. Its scientists, too, had been doing research on Ankole cattle in parallel to the Ankole I project with Norwegian funding, however without any exchange between the two projects taking place. The faculty only got involved[93] when one of the ILRI scientists - participating both in Ankole II and in the Norway-funded project - invited them to the initial planning workshop of Ankole II. There was thus no clear overall institutional strategy guiding the research intervention, its institutional set-up being based instead on personal networks and preferences, tactical alliances to meet donor requirements and a chance encounter offering a win-win situation to the institutions involved.

Last but not least, the two Ugandan PhD students were also recruited. The one student collecting on-farm data and doing research on the animals had already been provided by NAGRC. The second was recruited through an open process, the choice eventually falling on a young researcher from the National Agricultural Research Organisation (NARO). While there was no direct institutional involvement of that institution in the project, one of the requirements of the OeAD funding this student's scholarship was that he would be expected to return to NARO once his PhD was completed in order to strengthen the capacity of local institutions and not contribute to a brain-drain.

With the enrolment of the Ugandan institutions and the two PhD-students, the project had completed the move from being the idea of an Austrian professor to being a full-fledged network involving institutions in Austria, Kenya and Uganda. The network was kept together through the research proposal and the ADA-funds tied to it, aiming to deliver within four years the outputs as per the proposal. In so doing it would eventually contribute to the travel

[92] I was unfortunately not able to interview NAGRC's director throughout my stay in Uganda.
[93] They would appoint and supervise the MSc-student doing research on Ankole vs. cross-breed grazing patterns on one of NAGRC's state farms, as well as serve as administrative back-up.

to and further strengthening of Western technoscience in Africa: it would generate scientific knowledge about a farming system that had hitherto not been described scientifically, and would provide additional training to Ugandan scientists in the ways of knowing of science-based breeding.

6.2.2. Enrolling Farms for Knowledge-Generation

Research within Ankole II was to be on-farm. As opposed to on-station research, where most variables are under the scientists' control, on-farm research is assumed to be closer to the reality and messiness of farming practice, giving it an additional claim of authority (see also Livingstone, 2003). However, at the same time as the scientists allowed for some of the uncontrollability of life on a farm - e.g. by not influencing the farmers' management decisions - on-farm research also required them to control certain variables in order to maintain scientific standards of accuracy. To do so laboratory conditions had to be replicated on the farm to some extent, the lab had to be 'extended' (Latour, 1983) to also cover and control that part of farming practice that was addressed by the research. This 'extension of the lab' would however require setting up and stabilising a whole heterogenous actor-network throughout the duration of the project, by convincing the various elements of which a farm consists - most notably farmers, herdsmen and cattle - to scientific knowledge-generation.

A key element to achieve this aim and collect the data they needed was to be the enumerator. Since the scientists were not able to be permanently in the field to collect data on the farm, they needed someone who was able to visit the farms on a monthly basis throughout the duration of the project in order to collect the necessary data. The scientists therefore hired a private veterinarian through NAGRC who would take over this role, keeping him enrolled through a contract and the payment of a salary. To ensure that the data he'd collect would adhere to the scientists' standards, he was drilled in data collection by having one scientist accompanying him during the first three months of measurements and training him in the use of the different measurement tools.

Enrolling Farmers: The Promise of New Knowledge

Before this could take place, farmers had to be found and hired, however. The scientists had identified a set of criteria that these farmers had to fulfil in order to be relevant for their research. First was of course the need for them to have the farming system they wanted to analyse, i.e. keep both (a) Holstein Friesian-Ankole cross-breed herd(s) and (a) herd(s) of pure-breed Ankole. Second was the need for the farmers to be interested in having the scientists do research on their animals. Last but not least, for practical reasons their farms had to be located in such a way that they could relatively easily be reached by car. With the private veterinarian's help they visited farms in Kiruhura District close to Mbarara and identified and approached a number of farmers who fulfilled these three criteria.

Eventually 17 farmers were found who agreed to become part of the project and have measurements done on their farm. All of these farmers were male, ranging in age from their late 20s-early 30s to over 80. All but one had had some degree of education, with the youngest of them even having gone to university. Most had land between 100 and 350 ha, with one having 750 ha, and all having their own water dams, providing them with water even during the dry season. All derived part or all of their cash income from the sale of milk to milk-coolers in their vicinity. A few were absentee farmers with jobs or political functions in urban centres, delegating the management of their farm to their wife (in one case) or to a farm manager. In addition to these farmers, one NAGRC state farm with both pure-breed Ankole and cross-breed herds was also included. The scientists' aim had been to get a somewhat randomised selection of farms. However, the selection's inherent roadside bias (R. Chambers, 1983) and the criterion to have farmers who maintain a *separate* pure-breed Ankole herd might have resulted in a somewhat biased sample. Definitely asserting this might require more extensive statistics on the different farming systems present in the region, which were not available at the time of the research. My translator and my own's subjective assessment however was that the sample may have tended towards farmers that were wealthier and thus able to afford separate herds.

When the farmers were approached by the scientists and the enumerator with the request to do research on their farm, most of them saw a similar chance for themselves. They were part of the growing trend towards dairy farming happening in Western Uganda, and all had cross-breeds that were forcing them to learn and adopt new practices. While a certain element of courtesy and hospitality vis-à-vis the scientists and trust in the meaningfulness of scientific research was also involved for some, they also saw the scientists as experts on their new, 'modern' cross-breeds. Having them on their farms on a regular basis would thus provide them with a chance to learn more about the cross-breeds' fodder needs, health management and breeding practices, and thus provide them with advice on how best to manage these relatively 'new' animals. In addition, having a private veterinarian (i.e. the enumerator) visit their farm for free on a regular basis was an additional interessement device deployed by the scientists that caught the farmers' interest, as he had been instructed by the scientists to provide them with advice and occasionally offer free treatments courtesy of the project. Getting the farmers on board can thus best be viewed as mutual enrolment, as there was no real 'merger of interests'. Up to the point where the scientists visited them, the farmers had not been involved in the project at all, and their role was to be one of passive data-providers and subjects of research. For the farmers, the enumerator and the scientists held the promise of new knowledge about the cross-breed cattle that had become the core of their dairy farming practice.

Enrolling Herdsmen and Cattle: Authority, Money and Brute Force

Convincing the farmers was however only a first step in the scientists' effort of extending the lab to their farms. A next step was to also enrol the other actors working and living on them. First were the herdsmen, whose task it would be to bring the herds to the crushes – long, wooden structures blocking the animals in their movements – and stay with them until the enumerator had performed all his measurements, a procedure that could at times take several hours. While the enumerator tried as best as possible to combine his visits with dipping or spraying, i.e. when the animals anyway had to be put in the crushes, this was not always possible. But even if it was, such visits always meant a higher

Figure 29 – Tagging a calf

workload for the herdsmen. At first their bosses' authority was sufficient for the herdsmen to perform this task. As the project progressed and the farmers' interest in would wane or even turned into open hostility some herdsmen had to be paid by the enumerator in order to still be able to complete this task.

Figure 30 – Wooden cattle-crush

The cattle finally weren't given much choice. On each of the 18 farms up to 30 animals were selected by the scientists, covering the whole age and sex range. They were assigned into three groups,[94] and tagged at the ear to enable even outsiders to quickly identify them and tie them to their respective performance measurements. Whenever a calf was born from that group it would also be tagged by the enumerator (Figure 29), measured at regular intervals and records on it kept. As with the herdsmen, the cattle had only to be 'enrolled' on average once every month for a few hours in order to be measured. The interessement devices used - a rather cynical term here - were the herdsmen's herding sticks and the crushes that both drove them together and kept them 'interested' enough (rather: stuck) to endure the discomfort of measurement (Figure 30). Some animals resisted by moving or trying to push the enumerator away, but while this did make measurement both difficult and tedious, the crushes were usually strong enough for this resistance to have any major effect.

With the enrolment of the farmers, their herdsmen and their cattle the project had all the elements needed to generate the scientific knowledge that the scientists were aiming for. From then on the 17 farms and one state farm that were part of the project were to represent all farms with cross-breed and Ankole herds in the region. They were to be the scientists' key repository out of which data would be extracted that would contribute to the scientists' research and publications.

6.2.3. Data Collection: Generating Numbers and Specialist Expertise

When it came to data extraction, it was through their or the enumerator's regular visits to the farms that the farmers' daily practice would be 'mined' for data relevant to their research. The kind of data that was to be collected had been decided upon beforehand by the scientists based on their research questions and focus of interest. For the first three months one Ugandan PhD-student and the enumerator went together, using this as an opportunity to train the latter in the use of the measurement tools. Afterwards the enumerator would go alone, with the scientists only joining on occasion when they were in the region for a farmer workshop. The 'home base' for the measurements was the district capital of Mbarara: the scientists would stay in a hotel, while the enumerator lived there. As the farms were quite

[94] Pure-bred Ankole, F1 (i.e. 50-50) cross-breed and higher than F1 cross-breed (i.e. more Holstein Friesian than Ankole).

Figure 31 – Enumerator determining the weight of cattle using a tape measure

distant (from 10 to 70 km on at times rough dirt roads) they did their measurement visits by car when the scientists were there, or by motorbike when the enumerator was alone. Each visit would last from a few hours to a morning/afternoon at most, mostly depending on the number of animals to be measured. At times the farmer himself would be present, at others only his farm manager and/or the herdsmen.

The farmers' cattle were a key element of the scientists' research, and data obtained by measuring them were the backbone of their findings. They had thus to be 'disciplined' (Porter, 1996) in order to be able to translate their bodies into numbers using measurement tools. Their weight and body condition score were obtained when the animals were driven into a crush and constrained there. For the weight the scientist or enumerator would measure the animal's circumference at the shoulder with a weight measuring tape, enabling him to determine the animal's weight (Figure 31). For the Body Condition Score the scientist/enumerator used their own experience in combination with written guidelines for BCS determination, resulting in a score from 1 (too thin) to 5 (too much fat). Here the 'measurement tool' was the combination of a trained 'expert' and the guidelines. As they were constrained in the crush for prolonged periods of time, the cattle usually became restless after a while. This made the measurements both tedious and difficult - and probably of varying accuracy - and led on a few occasions even to cattle breaking out and injuring themselves or each other.

Milk production was measured during morning-milking with the help of milking buckets. Due to the distances from his home to the farms the enumerator could not always be present on time to do these measurements himself, however. For this purpose the farmers were therefore given buckets with markings, and asked to do the measurements themselves with the help of the herdsmen, and provide the enumerator with the results as soon as he arrived.

The pastures were also subjected to scientific measurement. One Austrian MSc-student visited several of the project's farmers and collected grass-samples on their pastures. In addition, a grazing trial was set up on the NAGRC-run state-farm that had been enrolled into the project. In it, small herds of cross-breeds and pure-bred Ankole were let to graze on small parcels of grass in order to observe their respective grazing behaviour.

Last but not least, the farmers themselves were also subject to measurement. At first and during each subsequent visit the farmers involved in the project were asked a series of questions meant to map the state and evolution of their farm management practice over time. The data thus collected covered topics such as changes in staff, animal health and drug application, pasture management etc. Some of this data was easy for the scientists to obtain, some less so. The scientists told how especially questions regarding the farmers' total number of cattle were highly sensitive. Reasons for this ranged from comparing it to asking e.g. a European about his salary or savings, fear for possible taxation[95] or the Bahima's assumed cultural belief that if someone counts one's animals some of them might die. In order to overcome this reluctance the scientists had to use indirect questions and personal observation to nevertheless obtain relatively accurate data.

Up to this point the bulk of data-collection consisted in the enumerator obtaining a range of numerical values through questionnaires and measurement. These were numbers that were determined by the scientists' academic practice, and thus part of the latter's specialist expertise. In addition to these numbers the scientists saw personal farm visits as another crucial part of their research. Most of them - including most of the Ugandan scientists, who had different tribal backgrounds - were not familiar with the Bahima farming system and Bahima culture. In the words of one scientist, being there personally, seeing the sights and chatting with the farmers therefore enabled them to 'get a feel' of the farmers' context, gathering impressions and images that would provide some kind of 'felt context' to their data and findings. It was in a sense the scientists' attempt at acquiring the interactional expertise (H. Collins & Evans, 2007) required to put the numbers they were obtaining in their context. These visits were however usually relatively short, lasting no longer than a few hours or a morning/afternoon at best, and the expertise they acquired through them - while difficult to assess - was probably still relatively limited. As a consequence the main knowledge the scientists gathered about the farm were the data they collected and translated into scientific knowledge following the established understandings and practices of science-based animal breeding.

While their focus in quantifying cattle was on determining their productivity, the scientists knew that the Bahima had their own logic for breeding choices that were not guided by milk production alone. To capture this logic - which they referred to as 'indigenous knowledge' - an Austrian MSc-student was given the task to do a survey on the Bahima's breeding strategies. Data was again collected through short farm visits, during which farmers were asked to respond to a number of leading and open questions from a (pre-tested) questionnaire. 18 project- and 20 non-project farms were involved in data collection, with the latter being selected based on the criterion that they recently had begun cross-breeding for dairy production. The results were then coded, and ultimately presented in the form of a narrated overview of the frequency of the different answers, thus giving a general impression of different aspects of breeding among the Bahima.

This survey did generate some telling findings such as the Bahima's increasing focus on monetary profit[96]. It however also entailed some shortcomings as described by van Asten et. al. (van Asten et al., 2009). The interaction between scientists[97] and farmer were limited to a few hours, most of which was spent on going through the questionnaire that consisted of pre-determined questions based on the scientists' understanding of what was relevant to know. There was no time to build trust between interviewers and interviewee, to experience the materiality of farming practice and thus capture some of its complexity and tacit elements - the specialist tacit knowledge and even specialist expertise that determined the farmers' daily

[95] At the time of the research in late 2009 there was no tax on cattle, having been abolished the year before.
[96] Several farmers for instance mentioned how the tradition of slaughtering the main bull when the head of the household died had been replaced, as now just selling the bull was also seen as enough.
[97] During his data-collection the MSc-student was accompanied by one of the PhD-students for translation purposes.

farming practice - or to address issues of power. This meant that the research was pre-determined rather than exploratory, with the questions being strictly limited to breeding issues. The Bahima's social networks of mutual support - and the ways in which cattle play a crucial role in establishing and maintaining them - were for instance not problematised beyond the statement that a certain number of farmers were guided by such considerations in their breeding choices. The scientists' focus was strictly on the cattle, not on the wider networks through which the Bahima's farming practice was enacted and their livelihood secured. The farmers' ways of knowing were thus constrained by the limits of the scientists' academic discipline, and crucial elements were lost in translation.

What You See is What You Get

Whenever the enumerator had visited the farmers and collected the data, he handed over his records to the veterinary professor at Makerere University, who oversaw that it was computerised and sent via Internet to the university in Austria and the other research centres involved in the project. There the PhD students went about to do the actual data analysis, using specialised software for modelling and statistical analysis. Eventually this would yield their research findings on a range of issues related to the farming system under study, including the optimal cross-breeding level between Ankole and Holstein Friesian, suggested alternatives for livestock management etc.

Overall the scientists' process of data collection and generation of findings through regular measurements of tagged animals kept in crushes and questionnaires applied on responsive farmers was their attempt to bring the seemingly chaotic cross-breeding process of the Bahima down to a manageable format, to 'extend their lab' (Latour, 1983) to the farm and extract controllable data which they could analyse using their established methods and thus generate scientifically valid knowledge ready to be peer-reviewed. In the same vein they did what Latour describes as 'inverting scales' by turning a larger (and unknown) number of farms having both Ankole and cross-breed herds into a more manageable number of 18. Through their research these would then become representative for all farms in Western Uganda adhering to such a farming system now and in the future. The knowledge they generated in this way was however exclusively shaped by their own specialist expertise, belonging more to academia than to the farmers' lived realities. There was not enough time for the scientists to be exposed to farming and the Bahima's specialist tacit knowledge, and thus and acquire the interactional expertise required to understand Bahima dairy farming from within the latter's own lived practice. Their findings were thus filtered through their methods and understandings, the ontology of the animals presented in their publications was a reflection of their own understanding of it, and their findings inevitably pointed towards the farms being 'cogwheels' in the market-integrated and science-based dairy farming system that the scientists themselves envisioned for Uganda.

6.2.4. Leverage and Control

Ultimately, the scientists' research findings were not meant to stay within the university and the research centres. Instead, their hope was that their work would have the potential to impact the Bahima livelihood through changes in their breeding practices. As with Pasteur's research on Anthrax, in which his work on a vaccine entailed a shift of French agriculture by extending Pasteur's initially lab-based vaccination to farms throughout the country (Latour, 1983), the knowledge the scientists' research was expected to generate was to 'leverage' Bahima farmers towards an approach to breeding that would combine increasing milk productivity with the conservation of the Ankole breed.

Mapping as Means of Control

To do so, they intended to generate scientific knowledge about the system and construct analytical tools that would enable external actors (research agencies, government…) to assess and understand the process, and act upon it based on this understanding. The understanding itself - rooted in science-based breeding as it was - 'fitted' in their imagination of modernisation and development, focusing on increasing production while not jeopardising the resources upon which this production is based, or - to quote the research proposal - 'ensure ecological and economic sustainability'.

This effort can be compared to the mapping of France in the 17th century, whose aim was also to bring the country under centralised control, creating tools - maps - to do so (Livingstone, 2003). The scientific publications that were the intended output of Ankole II can be similarly viewed as 'maps' of a specific production system and its potential as future model to be emulated by others. Their 'mapping' of the process of change was thus not so much a means of bringing an 'uncontrolled' process under control, as it was about trying to shift control from being distributed among individual farmers to it being (also) exerted through external, science-based control structures (e.g. government institutions with facilitation by scientific institutions) through the intermediary of their 'maps'.

For this external control to be possible, they had to translate the knowledge about the Bahima's approach to breeding that they had generated into a mobile format. In practice this format took the shape of dissertations, publications in scientific journals as well as slide-shows and presentations on scientific conferences. The initial target group for these formats was the wider scientific community. More specifically, it were the journal editors, the doctoral committee of the two PhD-students (one member of which was one of the Austrian scientists) and any audience they would meet at scientific conferences. On the long run however especially the journal articles were meant to be appropriated by the wider scientific community, and perhaps even used by governmental and international development institutions. While these external actors may up to then never have been directly exposed to the Bahima in the first place, they could through these publications learn about them and then act upon that knowledge by using it e.g. in the formulation of further research and of policies for the dairy sector.

Securing Ongoing Engagement

The scientists' generation of scientific findings about Bahima dairy farming were not meant to be limited to the Ankole II project alone. Instead, they saw it as one more step in their continued engagement with the Bahima and the process of change that Ugandan dairy farming was undergoing. Once Ankole II was completed, they planned to find funding for a follow-up project that would build on this project's achievements. The aim of this follow-up project would be to move beyond the mapping of farming practices and involve farmers in a breeding programme and all practices this involves, most notably co-ordinated breeding and the ongoing and systematic recording of animal performance. In preparing for this follow-up project, one of the scientists even seized the opportunity to visit the Ugandan Minister of Agriculture and lobby for the establishment of a nation-wide animal recording system.

Thus the scientists' work through Ankole II fulfilled two main objectives. It was first of all the attempt to 'map' the Bahima's farming system through publications and models, literally putting it on the 'scientific map' as a starting point for further engagement by enabling external actors to gain knowledge about it and act based on this knowledge. In addition they wanted to do part of this further engagement themselves through a follow-up research project. Ankole II was thus not seen as a single event that was limited in time, but as a further step to strengthen their foothold in a thematic and geographic area of research that would help them secure further funding for their future academic work.

6.2.5. Small Story Reflections: The Limitations of Travel

This small story was a description of the research project, its origins, purpose and implementation. It showed how starting with the ideas of an Austrian professor a whole network was set up in order to extract data from farms and generate scientific knowledge based on this data. This description then enabled to analyse some its underlying processes, the orders it enacted, the possibilities and limitations of the knowledge that it generated and the wider process of which it was a part.

Regarding one of these processes, the small story illustrated how a research project is about more than knowledge-generation. Both for Boku and for the other institutions involved research projects are ways to secure funding, essentially 4-year slices of money through which scientists can finance their academic work and ultimately also their livelihood. Here the power of a European institution came to the fore in that it had access to such funding by virtue of its nationality. This put the Austrian professor in a position to set the research agenda and shape the research questions according to his capabilities and interests.

Regarding the research project's knowledge-generation, the previous sections illustrated how it was in essence the adaptation of the Austrian scientists' 'local' knowledge into a new - African - context. The Austrian professor and his assistant would have a leading role in supervising the PhD-students who did most of the research, meaning that their understandings, approaches and tools were what the Ugandan scientists learned and applied on the farms. Through these PhD-students and the Ugandan institutions for which they worked this knowledge would become 'Ugandan', thus contributing to the 'universality' for which science is known, but which is in essence the travel of specific tools and practices from one location to another. The involvement of Ugandan counterparts thus played a key role in blurring science's underlying locality.

The enrolment of farms as data-providers brought another aspect of knowledge to the fore. These farms were enacted as 'data-mines', motivated by the hope for knowledge in the case of farmers, delegated authority and payments for the herdsmen or even brute force in the case of cattle to yield the data that the scientists needed for their analyses. The scientists did try to acquire a 'feel' for the farm from which their data came, however they were limited in this by the 4-year time-horizon of the project, geographical distances and the wider requirements of academia that put priority for university-based training and publishing over time spent on a farm. As a consequence this effort fell way short of what would have been needed in order to acquire the interactional expertise needed for them to fully understand the Bahima's ways of knowing. In addition, the surveys and software-packages used in the research imposed their own limited perspective on the Bahima's livelihood, constraining the scientists' view on those aspects that could be quantified. This made that the scientists' work was a 'science of parts' (Thompson & Scoones, 2009) in that through their data collection they generated an understanding of the 'technical' breeding aspects of the farmers' livelihood, framed by the tools' analytical scope and their underlying logic of as production assets. While the scientists did scratch the surface of the cattle's role in stabilising Bahima society, this was not problematised in relation to the new values and development paradigms that they themselves stood for. Their focus on modernisation and productivity was in line with the Bahima's shift in values towards 'farming as business' brought about by the introduction of private milk-coolers and the emergence of a wider dairy market. However, by not addressing the underlying social networks, ethnic identities and power relations, the view on Bahima farming created through the tools they used and the data that they collected became more of a vision of how 'things should be' according to the understandings and narratives of the scientific mainstream. The scientific knowledge generated through the research project thus remained essentially the specialist expertise of science-based livestock breeding, ultimately only offering a limited perspective on what the Bahima were doing and how they understood their livestock management and breeding.

Ultimately the research project can be viewed as being part of the enactment of the global, technoscientific network underlying science-based livestock breeding and the 'travel' of this network to new localities. It kept several research institutions operational, brought specific tools, understandings and practices to Africa in the shape of the now graduated Ugandan PhD-students, and brought the Bahima into its fold through publications, presentations and a model through which external actors could acquire knowledge about them and exert control. During this translation of Bahima farming into scientific formats certain key aspects of their ways of knowing got lost, however. In addition, throughout the research project the farmers were envisioned as relatively passive providers of data and of access to farms. In practice however they had their own agenda and objectives regarding the research project, which impacted its implementation. It is to this issue of social orders within the research project that we turn next.

6.3. Third Small Story - Underlying Social Orders

While in the second small story the main focus was on the networking efforts of the scientists in their attempt to translate a research idea about Bahima farming into scientific findings, in this small story we will look at the actual interactions between farmers and scientists. Underlying this interaction are the social orders inherent in their respective ways of knowing. Two moments will be looked at in turn; first the places in space and time where farmers and scientists met during farm visits and workshops, and second the scientists' attempt at introducing the Bahima to animal recording. First however the stage will be set in which these moments occurred.

6.3.1. Tenuous Linkages

Using Actor-network Theory, the Ankole II research project can be viewed as being enacted through a heterogeneous actor-network involving farmers, scientists, herdsmen, cattle, crushes etc. Setting up the network was however not a one-time affair. As a basic tenet of ANT emphasises, actor-networks need to be stabilised, and enrolment is an ongoing process. Success in the Ankole II-project thus hinged on a well-functioning, ongoing linkage between farmers and scientists.

This linkage was however rather tenuous by design. The scientists were fully in charge of implementing the Ankole II research project. They had been tasked by the funding agency to spend the funds in accordance with the project proposal, and deliver the expected scientific outputs. Despite the research being on-farm, most of the decision-making took place at a large geographical distance from the farms being studied. The proposal had been written in Austria in collaboration with scientists from ILRI in Nairobi. A planning workshop was held in Mbarara, the biggest town of in Western Uganda, involving scientists from Boku, ILRI, NAGRC and Makerere University to decide on the practicalities and logistical details of project implementation, without any involvement of farmers (who had not yet been identified by this stage). But even after the farmers had joined the project, all main decisions regarding project implementation were taken by the relatively small team of animal breeding scientists. Most of the time, when based in their respective home institutions they would communicate via e-mail. During their field visits - usually coinciding with the implementation of a feedback workshop - they would stay together as a group in hotels in urban centres, discussing the project and taking decisions during lunch- or dinner-breaks, during the long car-drives between Kampala and Mbarara or when driving to the farmers. There was thus always a large degree of disconnectedness in space and time between the scientists' decision-making regarding project implementation and the farmers' livelihood.

This was due to several reasons. For one, there was already an institutional and even personal distance between research institutions in Uganda and those outside of it. The funding for the project originated in Austria, from the Austrian Development Agency (ADA). Given its tied nature,[98] it was dependent on the involvement of Boku, and was as a consequence based on Boku's institutional networks within the research community. In the case of Ankole II these were the personal ties the two Austrian scientists had formed with staff from ILRI's Biotechnology Thematic Group based in Kenya, shaped and strengthened by familiarity through previous co-operation and a number of face-to-face meetings. Linkages with Ugandan institutions such as NAGRC were also existing but less pronounced, as Boku-ILRI co-operation took place in a range of countries, whereas co-operation with NAGRC was limited to projects in Uganda.[99]

Figure 32 – Dirt road leading to one of the project farmers

The linkages with the farmers in Western Uganda were even more tenuous. In addition to a lack of familiarity and a language barrier for some of the scientists[100], the farmers lived at long distances from each other and from the urban centres in which the researchers were based. They could only be reached through dirt-roads, some of which were of mediocre quality (Figure 32), making the use of a 4x4 car a prerequisite in order to bring teams of scientists to the farms. In other words, the geographic conditions made that the establishment and maintenance of linkages with the farmers was a relatively costly affair, and thus only limited to - in the scientists' view - the most essential form of interaction, i.e. on-farm data collection and the feedback workshops.

[98] Austrian funding of CGIAR-research require the involvement of an Austrian research institution in it.
[99] Until then had until then been limited to their joint involvement in Ankole I.
[100] Some farmers' fluency was limited to Runyankole with some basic knowledge of Luganda, making direct communication in English with the Austrian and Kenyan scientists difficult.

6.3.2. The Scientists' Taking of Data and Giving of Knowledge

The scientists were aware of the tenuousness of their linkage with the farmers. Combined with the fact that the farmers' main role in the project was that of data-providers, they knew that their research as such would only be of little direct benefit to the latter. They therefore wanted - in their words - to 'give something back' in return for the trouble the farmers were going through, in order to make sure that they would stay motivated to collaborate with the project. To do so they mobilised a range of interessement devices through the farm visits and the feedback workshops that took place.

(Mostly) 'Taking' Data Through Farm Visits

Within my research I was only able to observe those visits done with the whole team of scientists, accompany the enumerator on several of his farm visits and reconstruct the others based on the interviews of the farmers and the scientists. Given the gaps in data that this entails, only some general reflections on them are given.

There were different 'kinds' of farm-visits throughout the research project. The first visits were done by one of the PhD-students together with the veterinarian/enumerator, asking farmers for access and - once permission had been obtained - tagging the animals and performing first measurements. Subsequently, the most frequent contact the farmers had with the project were the monthly visits of the veterinarian/enumerator himself. He lived in Mbarara, and would usually travel alone on his motorbike to the different project farms, visiting them in the morning or afternoon in order to take the required measurements. In addition to these, some farmers were visited by Austrian MSc-students either collecting grass-samples or doing a survey on the farmers' breeding strategies, as well as farm-visits by the whole team of scientists following a feedback workshop.

In all cases, these visits were tied to some form of data collection, be it the measurement of cattle, interviewing the farmer with the help of a questionnaire or collecting grass samples. Due to distance and difficult access, these visits were usually limited to a few hours. Initial contact would be made with the farmer by mobile phone, and the enumerator and/or scientists would travel to the farm by car, or by motorbike in the case of the enumerator's measurement visits. In accordance with their task to collect data, most of the farm-visit would be spent close to the animals, either at the crush or in the pastures. On occasion they would be invited by the farmer to have some tea and cookies later on, offering the opportunity for further questioning and data collection. Once all tasks had been completed the scientists would leave again, driving to the next farmer or going 'back to base' in Mbarara.

Given the relatively short duration of their stay, the farm visits generally offered very little room to interact informally with the farmers, establish relationships and gain personal trust. According to the scientists this wasn't their main purpose, either, being mainly the opportunities for the scientists to gather their data, either directly or through the enumerator. Nevertheless, in order to make the visits worthwhile to the farmers, the enumerator was encouraged to provide some advice and even some treatments free of charge on the occasions of his visits. On one visit by the scientists to one farmer I was also able to observe how one of the scientists would go at lengths to describe the benefits of recording to him, hinting at that even the scientists may have provided advice on an ad hoc basis. There was no system to this, however, and most of these visits were thus a predominantly unidirectional affair. The main 'giving back' was to take place during the feedback workshops.

'Giving back' Knowledge Through Feedback Workshops

A total of four feedback workshops were held throughout the lifetime of the Ankole II project, out of which I was able to attend the last two. The feedback workshops were the place and time where the contacts between farmers and scientists were the longest and most extensive. On the last two, the workshops were held in conjunction with backstopping visits by a team of scientists: the PhD-students, their Boku-supervisor, an ILRI-representative and other scientists with stakes or interest in these workshops (MSc-students, myself,[101] the NAGRC-director and professor from Makerere on the third workshop, guests from another ILRI-project in Uganda on the fourth). These workshops were meant as the main channel through which the scientists would inform the farmers about project progress. Furthermore they were to be a a platform through which the scientists could 'give knowledge back' to the farmers in return for them providing access to their farms, thus ensuring the latter's ongoing motivation and support.

Figure 33 – Feedback workshop

For the last two workshops, the team would usually meet up in Kampala, and travel with two cars from NAGRC to Mbarara. There they would stay in a hotel where the workshop agenda would be discussed and fine-tuned. The workshop itself was then held the next day, in a school building in a village some 40km from Mbarara (Figure 33). The team of scientists would arrive there in the morning and prepare everything (e.g. drawing flip-charts, arranging teaching aids etc.) while waiting for the farmers. The farmers themselves always arrived up to 2 hours later, having had to milk their cows before, and some of them coming from relatively far by car. While everyone was waiting for the last people to arrive and the workshop to begin, farmers and scientists would usually sit apart from each other, with little interaction between the two groups.

Once it began, the workshop was held in a 'classical' format, i.e. with the farmers sitting on the benches and the scientists in front or on the sides, with one scientist at the front holding the main presentation. As some of the farmers were not very fluent in English a translator was also used. In the first workshop I attended this job was taken over by the professor in animal nutrition from Makerere University, who was fluent in Runyankole. On the second it was the responsibility of the enumerator. During the presentations the presenter did most of the talking, interrupted only when other scientists were asked to jump in and strengthen a specific point, or when farmers were given the opportunity to ask questions regarding the topic of the presentation.

Content-wise the presentations covered a number of topics that the scientists deemed to be relevant for the farmers. The first two workshops - which were also open to other, non-

[101] I include myself here as I was perceived to be part of the scientists' team by the farmers attending the workshops.

project farmers but which I did not attend - were said to have covered the purpose and activities of the Ankole II project as well as a range of issues regarding dairy farming, such as animal nutrition, animal recording and health management. By the third workshop the scientists were able to report on some of the progress of their work, albeit in a format that the scientists openly admitted to the farmers was perhaps too academic and might need to be put in simpler terms at a later stage. In addition, in both workshops the bulk of their presentation-time was dedicated to promoting the benefits and presenting the basics of animal recording.

Conceptually speaking, as data collection in the Ankole II project can be viewed as 'extending the lab' to the farm (Latour, 1983), the feedback workshops can be seen as extending the university classroom to the farmer community and co-producing a specific way of structuring society and understanding farming (Jasanoff, 2004). Through these workshops the scientists wanted to enact a social order in which they were positioned as the knowledge-creators, whose data-collection and -analysis would lead to insights and findings of benefit to the farmers that could be 'given back' through teaching. The farmers in turn were marked as the pupils and knowledge-receivers, who were to be taught these findings and the 'modern' farming practices with which they were intertwined. Farming practice, finally, was understood and represented by the scientists as something that can be visualised and taught orally. Knowledge about for instance recording was translated into flip-charts and slides, and in combination with the presenters' narration was expected to have the farmers understand and adopt the practice. The interaction between farmers and scientists during these workshops was thus one of teacher and pupil in a formal schooling setting, with the scientists providing format and content and the farmers being allowed to ask questions within its preset frame.

6.3.3. The Farmers' Attempts at Securing Support

While the scientists envisioned a relatively passive role for the farmers as data-providers and receivers of knowledge, the farmers themselves had their own, pro-active agenda in letting the scientists do research on their farm. In addition to their goodwill, one key motivation to giving them access to their farm was the hope to acquire new and relevant knowledge about their cross-breed cattle. What they had done in this way was basically try to enrol the scientists into their own actor-networks as sources of knowledge and support. However, despite this overlap in interests, differences in the respective roles that farmers and scientists had envisioned for each other led to tensions as the project went on.

The first issue that cropped up was the farmers described as a lack of direct exchange between them and the scientists. The most frequent interaction that they experienced with the activities of the Ankole II project were the monthly visits of the veterinarian/enumerator. Due to a range of administrative difficulties at NAGRC, the enumerator's salary payments were often delayed for several months. As a consequence, and since there was no formal agreement for him to provide free advice and treatments he tended to only do the bare minimum required to get his data and leave afterwards. The situation was similar when e.g. MSc-students came to collect data on the farm. According to several farmers they would come, perform their survey or collect grass samples, and then leave again, with little to no time for prolonged informal interaction. But even the workshops, didn't provide farmers with the answers they had been hoping for. In the words of one farmer, they were very much a unidirectional affair, with the scientists telling what they thought was of relevance to the farmers, which wasn't necessarily what the farmers were interested in. Given the classical format of the workshops, there was no room for them to raise their own questions and cover them in depth. There was still a big gap between the science-based ways of knowing of the scientists as written down and presented during the workshops - *their* specialist expertise - and that of the lived farming practice of the farmers with all its material opportunities and constraints. What the farmers had hoped for was an exchange among peers on the best way to keep cross-breed cattle, ideally an exchange at the interactional level of expertise. The limited exposure of the scientists to Bahima farming practice and the farmers' limited acquaintance with scientific ways of knowing however precluded such an exchange. The same applied for the classical, unidirectional format of data-collection and knowledge-transfer provided by the scientists, which was a top-down social order to which the farmers were ultimately unwilling to adhere.

The Untangling of the Project's Actor-network

As a result, and with time, most farmers lost interest in the work of the scientists, and did only the bare minimum to support their activities. To begin with, some did not use their authority to have the herdsmen adhere to the scientists' instructions. As these were supposed to bring the herds to the crush and keep them there until the measurements were done, with the interest of 'their' farmer gone some herdsmen saw no further incentive to walk the extra mile either, sometimes literally as in bringing the cattle to the crushes. On several occasions the enumerator arrived on a farm without the herds being in their crush, and had to leave again without any data having been collected. On others he had to resort to paying the herdsmen in order to gather the animals for measurement.

Another problem cropping up were the cattle themselves. Waiting in the crush in the scorching sun while being measured put them under stress, and on more than one occasion they tried to break out. In one instance on one farm they were even successful with it, destroying a crush in the process. On another farm, the closeness of the Ankole- and cross-breed herds for measurement purposes resulted in the respective bulls picking a fight with each other, with the cross-breed bull being seriously wounded as a result. In addition, any time spent measuring meant that there was less time for the animals to graze in the pastures, something which their owners viewed as a direct loss of productivity and income for them. As a result, and with the costs and effort of the scientists doing research on their farms accrued without any resulting direct benefits for themselves, the farmers' level of cooperation decreased, with some not answering the enumerator's calls, or - as in the case of the farmer whose bull got wounded - leaving the project altogether and forbidding the enumerator to collect any further data on his farm[102].

Turning the Workshop-Tables

The reduced effort in securing access to their farms was a first resistance of the farmers vis-à-vis the scientists. The second were the feedback workshops, which were the main platform through which farmers and scientists interacted with each other face-to-face. Through these, the farmers tried to bring the scientists to fulfil their second intended purpose, namely that of providers of direct and tangible support.

This issue of tangible support was probably raised for the first time during the second workshop, with the scientists mentioning the possibility to purchase material for the farmers

[102] This dissatisfaction with the project also impacted my research. Since the project farmers had first seen me as I was observing the project workshops, they assumed that I was part of the team of scientists. So by the time I came to interview them towards the end of the project, most farmers strongly voiced their discontent, complaining to me about the ways in which the scientists had handled their interaction with them.

to strengthen crushes[103], as well as raising the prospect to organise a study tour to dairy farmers in Kenya. By the time the third workshop was held, most farmers were visibly feeling dissatisfied with the way the project was progressing. While that workshop was still for the most part implemented following the agenda that the scientists had intended, it was also the farmers' first open attempt at securing support. It was set up in the usual classical format, with the scientists presenting their research findings and the professor in animal nutrition from Makerere University serving both as overall facilitator and as translator from English or Luganda to Runyankole. In the first part, one of the PhD-students presented his current findings up to then, followed by the Kenyan scientist from ILRI making an elaborate and interactive presentation on the benefits and potential of animal recording. Up to this point, the farmers attending the workshop were relatively quiet and listened politely.

Once these presentations had been held, pending issues regarding project implementation were raised. This is when the farmers became much livelier, making a case of how the project was causing them trouble and costing them time and effort, without any direct benefit to them. One farmer even mentioned how 'time is money', referring to how nothing visible had thus far come out of the scientists' work on their farms. From being a classroom where the scientists had intended to teach, the farmers used the points of leverage that they had - collaboration with the project and access to their farms - as a starting point to turn the workshop into a platform in which they negotiated the obtaining of tangible support from the scientists.

Being thus put under pressure, and with the director of NAGRC taking the lead, the scientists promised again the provision of material to build or improve crushes, as well as the supply of bulls at subsidised prices, the organisation of a study tour to dairy farmers in Kenya and the renting of NAGRC's earth excavator to help farmers in building water dams. The character of a negotiation-platform became most apparent when the NAGRC director stated how farmers should put pressure on NAGRC to provide this support, while in return NAGRC would put pressure on the farmers to implement accurate animal recording on their farms. As this discussion progressed, the enthusiasm of the farmers grew visibly. By the end of the workshop, a spokesperson of the farmers took the word, stating that they now had 'seen the light' and recognised the benefits of animal recording. They would therefore set up a recording association through which they would mutually support each other in recording the performance of their animals. By the end of this workshop everyone left happy, the scientists due to the farmers' positive response to recording, and the farmers hoping for a variety of support.

However, subsequent developments - while information about them is sketchy - did not warrant this optimism. On the farmers' side, the recording association did not survive its first meeting. While some farmers told that it was due to the chosen chairman having too many other ongoing activities to adequately manage such an association, other farmers apparently weren't inspired enough to elect another chairman and continue nonetheless. One farmer even stated that the primary purpose of the association had been to have a platform to organise the study tour and exert pressure on NAGRC to fulfil its promises. On the scientists' side administrative difficulties between the project partners after the workshop meant that funds could not be released to pay for the promised support measures, and by the time of the fourth feedback workshop none of them had been fulfilled.

[103] One scientist described this promise of providing material for the crushes as a 'token of goodwill' vis-à-vis the farmers.

When this fourth and final workshop began, the farmers didn't even allow for any classroom-teaching to take place. Taking the lead in the discussion right from the start, they put the scientists to an ultimatum, threatening with the complete exit of all farmers out of the project if the scientists didn't follow up on the promises they had made. The premature end of the Ankole II project was only just averted by the rhetorical skills of the Kenyan ILRI-scientist. Openly confessing all the organisational difficulties they had encountered - including their inability to fulfil any of the promises - and apologising profusely for the trouble this had caused to the farmers, she was able to convince them sufficiently to stay in the project until its completion and leave the option open to participate in the follow-up project that the scientists were planning.

A Clash of Social Orders

It can be argued that if the disbursement of funds had worked as planned, things would have turned out differently. However, looking at the unfolding situation while considering its underlying social orders and corresponding actor-networks also points to crucial differences in the farmers' and scientists' respective ways of knowing as an explanation for the resulting tensions.

As was mentioned above, the scientists saw themselves as knowledge creators and teachers, using on-farm data-collection to generate insights which they believed were of value to the farmers, and 'giving this knowledge back' through the classical trainings in the workshops. Among scientists, information transmitted orally or inscribed on written media is common currency, and the prime means through which knowledge is stabilised and shared. Within the academic context, data collection and -analysis to generate knowledge combined with a workshop-format to 'give it back' may therefore seem like an appropriate means to generate and transfer knowledge. For the Bahima, on the other hand, knowledge sharing and stabilisation takes a different form. Knowledge about their animals for instance is acquired through direct interaction and observation with the animals, and the application of this knowledge does not result in a written publication, but in a well-managed heterogeneous network, i.e. a farm that fulfils the social and productive functions that its farmer expects from it. Similarly, the inscription devices through which they learn are not so much PowerPoint-presentations and papers, but rather other farmers' farms, their animals and pastures, inscribed not with text but with the 'language of practice'.

This may explain the interest of the farmers in informal interaction with the scientists rather than the classical format they were offered. Bahima take great pride in their knowledge of cattle, up to the point where some may dismiss any expert advice coming from someone who doesn't own cattle himself, as some veterinarians said to have experienced. Learning from their neighbours is thus one of their main sources of new knowledge and information. Accordingly, and similarly to their learning from neighbours they were seeking a dialogue with the scientists in which there was room to combine their own expertise and local knowledge with the additional information and experience that the scientists could provide about the requirements of cross-breeds. Their interest in a study tour to Kenya, too, was basically an opportunity to learn from peers about *their* ways of handling high-yielding cattle-breeds.[104] Such interactions would have enabled them to also include their tacit specialist knowledge in the debate, and thus identify opportunities to learn and improve that

[104] One farmer even asked me - viewing me again as a member of the scientists' team - whether it would be possible to organise a study trip to dairy farmers in Austria, for which he was willing to pay himself.

were close to their own context and possibilities and that they would be able to directly ‘write down’ on their farms.

The attempts at obtaining tangible support can be viewed in a similar vein. The scientists approached the issue of the development of the Ugandan dairy sector - and their role within it - from a perspective that was ‘out of time’ (Scoones & Thompson, 1994). Their time-horizon was not limited to the vagaries of a single year. It was more long-term, as could for instance be seen when they argued for the traceability of produce as an argument in favour of animal recording, the introduction of which in Uganda would take years and significant resources at best. At the same time they were constrained by the 4-year cycle of their research project and its requirement for pre-determined outputs after its completion. While they did aim for long-term engagement through follow-up projects, achieving this was dependent on the whim of funding agencies that lay beyond their control. The farmers’ perspective on the other hand was ‘in time’ (Scoones & Thompson, 1994), meaning that their interest in enrolling the scientists was to obtain benefits - crushes, breeding bulls, an excavator to improve access to water - that would help them meet the pressing needs of the ‘here-and-now’ that characterised their livelihood.

6.3.4. Attempts at Transferring Animal Recording

While the workshops themselves illustrate the social order that the scientists strived to enact, their promotion of animal recording throughout the project provides an insight into their inherent transfer of technology-thinking. Their efforts at promoting recording were not part of the initial project design. They however became a crucial element in the scientists’ attempts at giving something to the farmers in return for their access to the farms, this time in the form of a concrete practice.

The scientists’ idea to promote animal recording among the Bahima originated from their regular on-farm data collection of the animals’ performance. As this activity was equivalent to animal recording - the backbone of science-based breeding - and given the farmers’ ongoing efforts at improving the milk output of their herds through cross-breeding, the scientists saw it as a promising technology to teach to them, as well as a starting point for further engagement with these farmers during a follow-up project.

Enrolment Through Stories, Buckets and Binders

While animal recording was probably already addressed in the first two feedback workshops, it was brought forward forcefully when the Ankole II project manager at ILRI was replaced. Taking over this role was a Kenyan scientist who had personally and actively been involved in setting up a functioning farmer-run animal recording association in Kenya. This experience from Kenya was in the scientists’ mind when they set out to motivate the project farmers to adopt animal recording practices.

Their main platform to do so were the feedback workshops. While these workshops were initially meant to be a means to tell the farmers about the outcome of their research, in the last two sessions this feedback was repackaged in a format that would illustrate the benefits of animal recording and encourage farmers to apply it on their farms. To do so, a number of pedagogical tools were deployed. These ranged from asking farmers themselves what the benefits of recording would be,[105] via illustrating the practice and effectiveness of recording

[105] The farmers gave a number of answers to this that seemed to indicate that they either remembered the lessons from the previous workshops, or had been trained in recording previously.

e.g. by drawing a lactation curve on flip-charts and telling how Kenyan farmers earned a premium on animals with records, to telling how international animal- and milk-trade would require traceability of produce and was thus not possible without recording.

Figure 34 – The binders with the farmers' herd records

The scientists also used a couple of interessement-devices in the hope to further stabilise the farmers' interest in and involvement with animal recording. During the third workshop the participating farmers were each given a plastic bucket with volume markings on the side that the scientists had brought from Austria.[106] The idea was that these buckets would make it possible for farmers and herdsmen to measure individual animals' milk yield themselves. This would both help farmers in accurately keeping track of their animals' daily milk yields, and at the same time make the enumerator's work much easier.

In the final workshop they even went a step further. With the support of the Kenyan ILRI-scientist, the performance-data of the project-farmers' herds had been fed into MISTRO, a dairy management software package. This package is owned and developed by an Australian software-company, and had already been put to use in the Kenyan recording association. With the help of MISTRO, the scientists made a binder for each farmer containing all the performance data collected on his herd and presenting it in tabular form (Figure 34). Knowledge about animals was thus delegated to the binders, ideally - and in combination with the tags on the animals' ears - making it possible for anyone reading them to gain an accurate overview over the animals' performance over time. Using them on a long-term basis would require training the farmers in interpreting the tables, however, and linkages would have to be created and maintained between the farmers, the animals and whatever network of people, institutions and computers was eventually to be put in place to operate the software.[107]

While the scientists did put effort in showing the advantages of recording to the farmers, and were carefully optimistic when after the third workshop the farmers told them about the recording association that they wanted to set up, they acknowledged that telling about recording during two feedback workshops would in itself not be enough for the farmers to adopt the practice. As the Kenyan scientist put it referring to her own experience in Kenya, what they needed was an 'evangelist', preferably a young farmer who was 'burning' for

[106] Such buckets were apparently difficult to find in Uganda. A tentative search I did in the markets and shops of Mbarara didn't yield any results.
[107] Due to the tensions between farmers and scientists there was not much time left during that workshop to extensively introduce the function and use of the binders to the farmers, something that has to be kept in mind when thinking about the farmers' response to them.

animal recording and for spreading it among his fellow farmers. In a similar vein, other scientists said that the main obstacle to animal recording among the Bahima was the latter's 'lack of awareness' of the practice's benefits. They needed to be 'convinced', a word that was repeatedly used and implied that if they were told about it often enough they would finally realise its benefits and adopt it willingly. Animal recording was thus viewed by the scientists as a practice that could be transferred to the farmers 'as is', given sufficient awareness and convincing.

The Farmers' Response to Recording

Efforts in getting farmers to adopt animal recording were not a primer in Uganda. In the 1990s, a project with Danish funding aimed to set up a Dairy Master Plan, which included the introduction of a national recording scheme. By 2009 what was left of this project was a stock of recording booklets, copies of which were at times distributed by NAGRC to farmers throughout Uganda when performing activities together with them.[108] The US-funded NGO Land O' Lakes, too, had set up a comprehensive system of bookkeeping and animal recording consisting of three separate recording books, training farmers in their use so that they could better monitor and improve their farming business. According to one Land O' Lakes employee, the farmers' response to these booklets had been lukewarm at best, however. While for some farmers animals with records might fetch a premium price, none of the interviewed farmers who had attended trainings by Land O'Lakes had been systematically recording their animals' performance.[109]

Animal recording as such was thus no new practice for (some of) the Bahima.[110] Nevertheless, the hitherto limited response to it was echoed by the project farmers' reaction to the scientists' attempts at 'convincing' them of its benefits. For most of the participating farmers recording did not make any sense given the extensive knowledge of the animals they already had. None of the interviewed farmers mentioned using or being interested in the binder, and the buckets were mostly left unused. One farmer pointed out how he could not link the tag numbers in the binders to his animals, as he knew them by name and not by number. He told how recording as promoted by the scientists was 'too advanced' for their current level of farming, pointing out how animals were usually handled by herdsmen who were both illiterate and often only moderately motivated to work, and how milking took place on pastures and under pressure to avoid the milk turning sour in the sun. Even the farmers' announced intention on the third workshop to set up a recording association didn't survive that association's first meeting. Some farmers acknowledged the superiority of recording for selecting the highest yielding animals over their own memory-based approach relying on average estimates. For the majority of the farmers interviewed however the obstacles to implementing it on their farm were too high and there were no wider structures or incentives in place in which animal recording would make sense.

Some project farmers had a somewhat more positive response to the scientists' efforts at introducing recording, however. The wife of one farmer was said to have enthusiastically embraced it.[111] Another project farmer had also tentatively adopted a simplified version, recording the milk yield of his animals on a weekly basis. He had however an academic

[108] Up to then such activities had not yet involved any Bahima.
[109] One had tried for some time, but failed to do so continuously as he had found it to be 'too tiresome'.
[110] This may have been one reason why some farmers were able to identify the benefits of animal recording during the third workshop.
[111] Unfortunately she had died in a car accident a few months before I interviewed her husband, making it impossible to ask her anything about her recording in person.

degree in law, ran a micro-credit business and was described by my interpreter as being 'very exceptional'. Last but not least, two of the project farmers were absentee-farmers, leaving the day-to-day running of their farm in the hands of their farm managers. These managers - both in their late 20s to early 30s - had received training at an agricultural college. Inspired by their training they had set up rudimentary herd (…but not performance) recording schemes for the herds they were managing, one of them even aiming to computerise it on the long run. As a whole these were exceptions, however, and the majority either did not see any use to the practice or viewed its application as impractical given their context and existing knowledge.

Of Actor-networks and Social Orders

The scientists viewed recording based on an understanding of what could be achieved with highly integrated, functioning actor-networks as they can be found in industrialised countries. In these, cattle are part of a wide and complex network in which everything is optimised for a safe, maximum (milk) output and farmer income. Recording is an inherent part of this, often being computerised and requiring no additional physical effort on behalf of the farmer while milking. Cattle are viewed as quantifiable entities whose main purpose is to generate direct economic return. Systems are in place to register and monitor individual animals on a international basis, legislation ensures the adherence to procedures and maintenance of standards, and being enrolled in this wider system provides direct benefits to the farmer in terms of opportunities for marketing and trade (or is even legally required to begin with e.g. when it comes to the traceability of produce). Furthermore, there is a general trust of the farmers in this actor-network, including in the accuracy of the system and the appropriate use and usefulness of the information that it generates. In other words, in such a setting recording is not only borne by the understanding and awareness of the farmers that practice it, but because a social order and its corresponding extensive actor-network is in place, with mechanisms that discipline its many, heterogeneous actors, whose benefits are visible to the farmers that are part of it and that enact cattle in a specific, production-oriented way.

The Bahima on the other hand operate in an environment with no such actor-networks in place and in which cattle play a somewhat different (albeit changing) role. Their main concern from a dairy production point of view is the on-time delivery of fresh milk to the nearest cooler. Milking is done by mostly illiterate herdsmen who usually only stay for a short while on the farm. The only requirement at the coolers is to have relatively uncontaminated milk, and once it is accepted it is poured into the cooler, with no systems in place to enable it to be traced back to its origins. Viewed in terms of corresponding social orders there are also significant differences. The farmers are mostly operating on their own or in social networks based on kinship and friendship, and are reluctant to disclose information about their farming to outsiders. They often perceive the government as unreliable, cheating in marketing and trade is not unheard of, and personal contacts and personal experience are therefore the most trustworthy resource to fall back upon. Furthermore, the role of cattle is not limited to production. While high-yielding animals are important, non-measurable aspects such as their beauty or the relationships that they stabilise also play an important role, as does the farmers' knowledge about them which is part of their pastoral identity as cattle-herders. In other words, for the farmers, working with memory, visual verification and personal experience is the approach through which they maintain control and that makes most sense in their context. These differences in underlying actor-networks and social orders were however not addressed through the scientists' unidirectional approach based on transferring a package through workshops, trying to raise the farmers' awareness and trying to convince them including through the use of an 'evangelist'.

6.3.5. Small Story Reflections: Social Orders in Knowledge-sharing and Control

Towards the end of the project, the linkage between farmers and scientists was fragile at best. While ultimately the scientists were able to stabilise this linkage long enough to collect the data required to generate their findings and produce scientific outputs, they were still faced with a large degree of skepticism from the farmers. I could feel this myself whenever I would visit the farmers in order to interview them. As they initially always viewed me as being part of the scientists' team, most of them voiced their complaints about the scientists' approach and their broken promises before I even had had time to begin with my interview. The reason for this skepticism is not the scientists' research as such, which after all did address some of the pressing questions the Bahima found themselves confronted with, such as carrying capacity and optimisation of milk yields. Instead, the core suggestion of this section is that a key contributing factor was the discrepancy in the social orders underpinning the scientists' and farmers' respective ways of knowing.

On the one hand there was the scientists' approach to knowledge transfer, premised on a relation of teachers (the scientists) and pupils (the farmers), the workshops serving as classroom and the scientists' knowledge enacted as information that can be told and visualised. While most farmers had indeed let the scientists access their farms in the hope of acquiring new knowledge, this format didn't meet their expectations as it wasn't their usual approach to learning and knowledge-sharing. They had hoped instead for an interactive relationship between peers that would enable them to specifically address those issues they experienced on their farms. In combination with this, they wanted a relationship through which they could initiate and achieve discernible change 'in time' (Scoones & Thompson, 1994), that is in the here and now on their farms.[112] Their attempts at obtaining tangible support in return for access to their farms should be viewed as their attempt to achieve this notwithstanding the project's 'out of time'-approach to achieving impact through knowledge-creation.

The scientists' work on introducing farmers to animal recording - one of their key attempts at 'giving back' something to the farmers in return for access to their farms - shows another dimension of this discrepancy. The scientists' perception of the practice was underpinned by the broader vision they had of it based on its extended use in industrialised contexts and its role as backbone of the successes of science-based breeding. Their approach hinged on explaining the practice, illustrating its benefits and future promises, and trying to encourage farmers to adopt it by providing them with buckets and binders. It rested on the assumption that the farmers would take up recording based on their perception of its inherent merits, irrespective of their own situation, values and farming practices.

However, despite its key role in modern breeding, recording as the scientists envisioned it failed to resonate with the project farmers. While some of the latter were aware of its potential advantages, they had many practical reasons - from illiterate herders to milk-coolers not requiring it - not to adopt the practice. In addition, tagging animals and keeping records put in question their self-understanding as repositories of knowledge about their herds and opened up their farms to the potentially prying eyes of outsiders, including state taxation. While the scientists were aware that a few workshops would not be sufficient to 'convince'

[112] It was for instance noteworthy that the one interviewed farmer who was still enthusiastic about the project when I interviewed him could indeed account for having acquired tangible benefits - including being given one bull - as a result of having been part of it.

farmers of recordings' benefits, their approach to transferring it to the farmers based on classroom-teaching was inherently linear, and meant that such context- and self-understanding-related issues were not addressed. Accordingly, there was no room to adapt and translate recording into the farmers' context.

All in all, despite a promising starting point with mutual interest from both sides, the ways of knowing of both farmers and scientists did not change as a result of their interaction. The Bahima continued with their 'business as usual', whereas the scientists generated scientific findings in a closed system that went unchallenged by the farmers.

6.4. Concluding Thoughts: Missed Opportunities

The three small stories of this chapter each showed different aspects of the case study. By contrasting the ways of knowing of the Bahima and of the animal breeding scientists, it was shown how both were striving towards 'modernising' and improving production and income for dairy farming in Western Uganda, be it through the adoption of new practices or through research. Differences were found in the underlying actor-networks, with the farmers' ways of knowing being based on the farmers themselves, whereas the scientists delegated much of their knowledge to measurement tools, written records and a wider network of processes and institutions. The second small story argued that the research project represented a part of the 'travel' of industrialised animal breeding approaches to Africa, resulting in a specific, science-based view of the Bahima's farming system. The third small story finally showed how despite underlying mutual interests, differences in the social orders underlying ways of knowing of the farmers and scientists - most notably a teacher-pupil approach vs. interactive learning as well as the scientists' transfer-thinking - led to tensions within the project and the farmers' unwillingness to accept recording as part of their farming practice.

This is not to say that the research project was a failure. From the point of view of the scientists its objectives had been realised. Theses and publications had been written, degrees awarded, and the Bahima's breeding system had been put on the 'scientific map'. Some very few farmers too did benefit from the project, either through tangible support or through interactions with the scientists. Most of the others however didn't get anything useful out of it, despite the scientists' good intentions. Overall however it could be argued that this case study can be used as an illustration of a missed opportunity for dialogue, exchange and mutual learning between farmers and scientists, despite both 'parties' being interested in contributing to the development of the Bahima's dairy farming system. For the farmers, the project did not offer the spaces they were looking for to learn to better manage their dairy herds, and the scientists too missed an opportunity to 'open up' (Scoones et al., 2007) their research to the farmers' opinions and views and to contribute to the generation of interactional expertise between farmers and scientists, thus producing scientific knowledge that is closer to the farmers' realities and needs.

A fruitful interaction between the two ways of knowing could arguably have been achieved with the appropriate preconditions and more time. But here the approaches and expectations clashed: the scientists' approach was linear in terms of the collection of data, generation of findings and feedback through a classical format, with scientists as knowledge-generators, farmers as data-providers and control ultimately being delegated to external actors. This stood in stark contrast with the farmers' informal, interactive and people-based approach to learning combined with their focus on tangible, (relatively) short-term results, as well as their wish to retain control of their farming and maintain their ethnic identity as cattle-herders.

Compounding this, geographical distance, funding requirements and the project's 4-year time-horizon to achieve pre-determined outputs provided little room for informal, frequent and open interaction in which mutual learning and the challenging of each other's values and assumptions could have taken place.

Despite the setbacks, the scientists were interested in continuing their research with the project farmers in a follow-up project, and in the last feedback workshop the farmers had - somewhat reluctantly - even given their approval. The scientists' intention - and one of the conclusions from their theses - was to set up what they called a community-based breeding programme involving the Bahima, helping them in finding the optimal (in economic terms) degree of crossing between Ankole and high-yielding breeds. The growing trend towards dairy farming as business among them was seen as an indication that such a programme would find the farmers' support. Their existing breeding practices such as empaano and the ongoing selection for specific traits were seen as an asset in this respect. The shifts in values and power relations that joint breeding efforts would entail were however not problematised, and while the importance of the farmers' knowledge was acknowledged, how this knowledge was to be integrated was not addressed. The emphasis was instead on the need to make farmers aware of the potential benefits to be gained. Despite several attempts, the scientists ultimately did not manage to garner to the funds to implement such a research project. It is however likely that many of the underlying assumptions and values that led to the difficulties encountered in Ankole II would have persisted in and impacted the follow-up project as well.

While it was not possible to observe and analyse the introduction of a community-based breeding programme among the Bahima, such an introduction of a science-based selective breeding approach was what the second case study was about. It is to this that we turn next.

Chapter 7 - Ethiopia: The Transfer of Selective Breeding

From the Bahima and their Ankole and cross-breed cattle in Uganda we move on to the Ethiopian Highlands of Amhara Region (Figure 35). These are the home of the Menzei, sedentary mixed crop-livestock farmers with a turbulent history. The most recent change they have been subjected to is found in the climate they live in, with the increasingly erratic nature of the Belg rains. Since as a consequence these farmers have increasingly come to rely on their sheep production, the scientists came with the idea of implementing community-based breeding in order to maximise the benefit they get out of their animals. The objective of their research project was to try out this relatively new approach to selective breeding, in which the 'community' of farmers participating in it were meant to have a leading role.
This case study does not only differ from the previous one in terms of the farmers and the

Figure 35 – Farming landscape in Menz Region

research aims of the scientists. For a number of reasons it was not possible for me to live among the farmers and do any in-depth participatory observation of their livelihood. In addition, my interpreter had an urban background, and therefore did not have the 'insider' information that my Muhima interpreter in Uganda could provide. Accordingly, this case study will not go as much in-depth regarding the farmers' ways of knowing of animal husbandry as was the case with the Bahima and their cattle. Instead, the focus will be on looking at community-based breeding as a practice based on specific actor-networks, imaginations and 'scripts'[113] (Akrich, 1992). The first small story will take a closer look at community-based breeding by describing its implementation procedure and analysing its underlying logic. In the second small story the 'translation' of this practice into an Ethiopian context will be described, illustrating and analysing the ups and downs of the research project through which this translation was to be achieved.

7.1. First Small Story - Selective Breeding and Community-based Breeding

The origins of community-based breeding can be traced back to selective breeding as it was developed by Robert Bakewell in Great Britain in the 18th century (Wood & Orel, 2001).

[113] In her work Akrich argues how any technology is always based on specific assumptions and imaginations of how the world is set up, how the technology fits in it as well as how and by whom it is to be used. The designers of a given technology *'in-scribe'* these into it. Similar to a film script, these inscriptions then create a 'framework of action together with the actors and the space they are supposed to act' (p.208).

This breeding practice including its further technological refinements and improvements was at the basis of the successes of the industrialised livestock sector in terms of productivity and growth. With the advent of development aid, one of the aid sector's ambitions was to bring the technological successes of industrialised countries to developing countries, selective breeding being one of them. According to the project scientists, however, none of these attempts to introduce selective breeding programmes to smallholder farmers had so far been successful. Their main critique directed against these efforts was that they were all based on nucleus-schemes[114] that were supposed to be centrally run by governments, without any active involvement of the farmers themselves. As a consequence these schemes usually did not continue to operate after aid agency funding was gone (Kosgey & Okeyo, 2007). Another point of critique was that such schemes usually entailed bringing in high-yielding animals and/or germplasm from industrialised countries, without considering their suitability to the environment or farming system in which they were to be used. Ethiopian sheep production had also seen several such attempts, however without any lasting results (Tibbo, 2006). Community-based breeding as understood by the scientists aims to overcome both these shortcomings of previous attempts.

While the concepts of conservation of animal genetic resources and the participation of farmers in development efforts are already well-known in development projects and research world-wide, their combination into community-based Breeding is a relatively new phenomenon. According to one of the interviewed scientists - an authority in livestock breeding in developing countries - what existed thus far was a 'collection of recipes' on how to involve farmers in collective breeding. The research project covered by this case study was, then, an attempt at consolidating this scattered experience into an established approach. The hope was that by implementing the approach in practice valuable experiences could be gained that could eventually be translated into a 'how-to' manual for community-based breeding. This manual could then be used by other institutions - research institutes, NGO's, agricultural extension services - to implement similar approaches elsewhere. While the context of the trial was Ethiopian, the assumption was that with some adaptation community-based breeding could be used in any other smallholder farmer setting throughout the world. These adaptations notwithstanding, community-based breeding implies specific ways of understanding and practising livestock breeding that put certain demands on the farmers and animals involved in it, which will be covered next.

7.1.1. Conserving Indigenous Animal Genetic Resources

To begin with, community-based breeding has an underlying purpose that goes beyond the needs of the farmers that are supposed to implement it. Its starting point is the frequent unsuitability of germplasm from industrialised countries for developing contexts. With growing urban populations and increased demand for livestock products under the 'Livestock Revolution' many farmers are perceived to be shifting towards high-yielding animals, to the detriment of indigenous livestock breeds that are increasingly displaced or even disappear (Rege et al., 2011). However, in addition to indigenous breeds being well-adapted to a given context - as opposed to the highly productive breeds that are internationally widespread - these breeds are seen by scientists as a valuable animal genetic resource and 'safety net for the future' (FAO, 2015) that has to be conserved to ensure the long-term sustainability of animal production. In FAO's words,

[114] A 'nucleus' refers to a flock/herd of animals where breeding takes place. Animals from these flocks are then distributed to farmers to be used as means of production.

Losing animal genetic resources is like losing a global insurance policy against future threats to food security. It undermines capacity to adapt livestock populations to environmental changes, emerging diseases or changing consumer demands.

According to FAO, 'much of the world's animal genetic diversity is maintained by the farmers and herders of developing countries'. Smallholder farmers who keep these breeds are thus viewed as the guardians *of* a valuable resource for global livestock production as a whole, that has to be secured in order to remain available for future breeding efforts.

It is this 'guardianship' of animal genetic resources by smallholder farmers that is expected to be secured through community-based breeding as the scientists envisioned it. Moving away from past efforts of introducing 'exotic' breeds to developing countries, the aim now is to increase the productivity of indigenous breeds through targeted, selective breeding, making them competitive vis-à-vis the high-yielding, 'exotic' breeds that farmers might otherwise be interested in. In this way it aims to ensure that smallholder farmers keep these breeds out of their own will, and thus maintain these breeds as genetic resource on behalf of the global, technoscientific network centred around livestock breeding. While it thus does not intend to coerce farmers in their choice of breeds, community-based breeding can nevertheless be viewed as an external attempt at influencing farmers' livestock management and breeding trajectory for the benefit of external networks and institutions.

7.1.2. Involving Farmers Through 'Participation'

Since in the past government-run schemes have failed due to them not considering the interests of famers, community-based breeding aims to give a leading role to the farmers themselves. To do so, it has integrated principles of 'participation' in its approach (Cooke & Kothari, 2001; Cornwall, 2008; Okali et al., 1994). More specifically, it is a version of selective breeding that is simplified in order to make it understandable to and implementable by often illiterate farmers, and includes mechanisms by which these farmers are meant to take all key decisions in its implementation As with selective breeding, instead of having an individual farmer select the best animals from within his/her flock, farmers are expected to join their flocks and breeding efforts together and select from within this much larger population. Selection pressure will thus be higher and genetic improvement consequently much faster. At the same time, all farmers participating in the scheme - understood as' the community' - are meant to be actively involved in setting up and implementing the underlying breeding network, from deciding which traits to select for, via the selection itself to the sharing of animals among them. The assumption is that in doing so the breeds thus developed will be ideally suited to the farmers' needs and resources. This in turn is expected to generate 'ownership' of the process by the farmers, ideally ensuring that they maintain it and create a fledgling breeder society that is able to exert the permanent role of guardian of the livestock breed while at the same time meeting the farmers' interests. 'Participation' in this sense is introduced in order to generate the institutional permanence that previous breeding schemes had failed to achieve.

Since selective breeding implies a number of relatively complex activities, the breeding process is initially expected to be facilitated by external research and extension organisations, enabling the communities to identify joint selection traits, translating these into breeding programmes and providing guidance in their successful implementation. However, in order to ensure a close fit of the breeding activities to the farmers' context and interests, the community as a whole is to be consulted by the scientists on all activities to be undertaken in relation to breeding, and is meant to be given the last say in all key decisions regarding their implementation. On the long run however (one scientist estimated that this could even take up to 10-20 years) the farmers are expected to acquire the knowledge required and eventually take over all related activities with minimal further input (ideally none) by external institutions. It is, in other words, an attempt at having farmers acquire and implement a - for them - new, science-based way of understanding and practising livestock breeding.

Through 'Participation' community-based breeding is thus meant to generate well-adapted breeds that combine the farmers' needs and wishes with the external need for conservation of animal genetic resources, as well as farmers that are able to implement a simplified version of selective breeding (mostly) based on their own knowledge and resources, and thus function as the permanent 'guardians' of their breed for the benefit of both themselves and of external breeding networks and institutions.

7.1.3. Imagining the Farmer Community

Another key element of community-based breeding is contained in its name: the 'community' of farmers jointly participating in the breeding effort. This community is to be the actual 'user' of community-based breeding, applying the breeding approach in order to improve the genotype of its sheep. As is the case with any technology being designed, this community is imagined by the scientists - the 'designers' of the technology that is community-based breeding - to be and behave in a specific way (Oudshoorn & Pinch, 2003).

Regarding its structure, and similar to breeding societies in industrialised countries, the farmers and sheep participating in community-based breeding are to form what Holloway calls a 'biosocial collectivity', i.e. an 'intentional [grouping] in which what is at stake in a set of social relationships is a fundamentally biological issue' (Holloway et al., 2009). In this case the biological issue refers to the genetic improvement of the population of sheep. The people in this grouping do not necessarily have to be part of an existing administrative or social unit, however, consisting instead of farmers interested in participating in such a breeding programme. It is thus not (only) based on social ties, but mostly on the larger sheep population that is obtained - better: 'enacted' - by combining the individual farmers' flocks together into one large flock for breeding purposes. Where possible, however, this biosocial collectivity is to be structured around communal shared resources (e.g. common pastures) in order to facilitate management and co-ordination.[115]

For successful breeding gains to occur, this community has to be disciplined and act in unison in its breeding efforts, subjugating individual preferences and priorities to the needs of the larger collective. This disciplining is also not a one-time affair, given that the scientists' objective is to have farmers become the guardians of their breed on a permanent basis. The farmer's active interest to participate in such a process is therefore a prerequisite. It is hoped to be achieved through the promise inherent in the approach, namely that of offering the farmers better breeds on the long-term that generate more income while being well-adapted to their environment. In addition, finding individual 'champions'[116] among the farmers and ensuring their active involvement is seen as an additional means to strengthen the community's commitment to these efforts. These are supposed to follow the scientists' advice by the letter, and with the expected positive impacts motivate other farmers in the community to follow their example.

[115] Since sheep usually mate while grazing, the sharing of rams is made easier when farmers share the same grazing areas.
[116] In 'development speak' the term 'champion' is used to refer to farmers who are particularly innovative in their farming and/or show a high degree of enthusiasm and willingness to learn specific new farming technologies.

However, willingness alone is not enough to be part of the community. For practical reasons of ease of management and in order to create a large enough population of sheep to achieve significant genetic gains, these individual flocks have to have a minimum size (e.g. 5 sheep). This means that poorer farmers with less sheep than the required minimum may not be given the possibility to be directly involved in the breeding efforts. Due to these requirements, and despite community-based breeding's ambition to contribute to poverty alleviation by increasing the income of smallholder farmers, it is an approach that is explicitly not suited to the poorest of the poor.

7.1.4. Enacting the Community by Generating Preferences

Once sufficient interested farmers with enough sheep are found, the next step is to determine and streamline the farmers' individual breeding priorities into a format that is suitable for a simplified selective breeding approach. Thus, so-called 'objective breeding traits[117]' - i.e. those traits in the animals that are to be improved through community-based breeding - have to be identified. This will be the first moment of making a breeders' community out of a hitherto more or less loose amalgamation of farmers, by turning their possibly diverse individual sheep trait preferences into a common set that is to become 'their' breeding objective around which their future breeding efforts are meant to converge.

To do so, the scientists have developed a number of 'tools' to - in the words of one of the scientists - 'find out how farmers think' regarding breeding objectives and preferred traits. According to the scientists these tools are especially useful in capturing those traits that farmers may not mention through a formal survey as they might take them for granted. The three tools are meant to be used in parallel, to cross-check the validity of the individual tools' findings and to make sure that the most important traits have indeed been accounted for.

The first tool is a set of so-called '*choice cards*' - inspired by choice experiments used in economics - that the Boku scientists had already applied in projects in Latin America and East Africa. They are a set of cards depicting sheep with different traits, such as different colour, different size, different tail shapes and sizes, lambing interval etc. The traits are determined beforehand through a formal survey, and then drawn on a set of cards. An individual farmer is then given six cards, and asked to chose on each card which animal s/he preferred. The data thus collected is compiled and analysed statistically, providing a ranking of the most favoured traits. A key advantage of this tool according to the scientists is its ability to capture to what extent farmers value 'invisible' traits such as lambing interval, libido and mothering ability.

A second tool is the '*own flock ranking experiment*'. Here an individual household is gathered around its sheep (usually in the morning before the sheep have left to graze) and asked to identify its best, second best and third best ewe, as well as their worst one. By performing the exercise in the presence of the whole household, its individual members can help each other out in recalling details and giving answers. Their choice and the reasons why these were chosen are written down, as is the animals' life history and reproductive performance as told by the farmers. In addition, the chosen animals are weighed and measured. Through this method 'invisible' traits (e.g. size at birth, mothering ability, lamb

[117] 'Objective' not as opposed to 'subjective', but in the sense of them being the *objective* of the breeding effort. There is disagreement among animal scientists regarding the appropriateness of this terminology, however.

survival) can be identified, as the farmers' continuous exposure to the animals allows them to get to know these for their individual animals.

A third and last tool to be used are what the scientists describe as '*group animal ranking experiments*'. The purpose of these experiments is to have farmers identify desirable traits from animals they are not familiar with. They are asked to judge these animals (ideally animals which have already been used during the own flock ranking experiments and on which data is thus already available), ranking them and explaining the reasons behind their ranking.[118] They are then provided with background information about these animals that had previously been obtained from their owners, and are asked whether they would change their ranking given this additional information.

Overall, these three tools can be viewed as a special type of survey of the preferences of the farmers, enabling an external actor - the scientists- to identify both explicit and tacit trait preferences of the individual community members. In order to turn these individual preferences into those of the community, the data collected by the scientists is statistically analysed by them, resulting in a set of traits that are preferred by the majority of the farmers, and that the scientists then consider as the farmers' objective breeding traits. The generation of these traits is therefore not a procedure that is performed by the farmers themselves, but instead requires external facilitators as well as the use of specialised tools and methods of analysis. While this procedure is the basis for common breeding efforts that promise potentially much faster genetic gains, it also silences any outliers in the community that might exist and whose preferences might differ from the mainstream. In addition, it 'fixes' preferences in time that might otherwise have been more fluid and subject to the vagaries of the market(s).

7.1.5. From Preferences to Breeding Plans

While the farmers have now been united around common objective breeding traits, their sheep are still a relatively loose and uncoordinated entity, one that furthermore is still unknown to the scientists. The next step is therefore for the scientists to collect data on the sheep population that is to be improved through selective breeding. Based on those traits that have been identified and that can be quantified, the scientists then go about measuring and making written records of all the farmers' sheep. In addition, these sheep are all given ear-tags in order to identify them individually and separate them from animals that do not belong to the population. In doing so, the sheep are turned into a population that can be identified and whose breeding course can be set using the data that has been collected.

Once the population has thus been generated out of the farmers' individual flocks, the next step is to develop so-called breeding plans. There are different ways to do so, usually requiring the use of computers. Stochastic models simulate the population at the level of individual animals, providing more detail but also requiring much more computer power (from hours to days depending on the population size) and probably also control over the individual animals during implementation of the breeding plan. Deterministic models on the other hand use quantitative population genetics to determine gain and inbreeding of a given population, allowing for fast computation of many different breeding alternatives. For both cases the idea is to make simulations of the population's breeding behaviour under different breeding conditions in order to identify those options that show most promise for improving on the identified trait preferences. It is, thus, another step in which specialist knowledge and

[118] The actual procedure is a bit more complex than this, entailing further subdivision and randomisation.

advanced tools - computers - are required in order to determine the direction that community-based breeding is to take.

In this case the scientists decided to use a deterministic model. In terms of software they opted for ZPlan, a software package developed over the past 40 years by the University of Hohenheim in Germany, and aimed at assisting breeding organisations in optimising their breeding plans and -efforts. According to its developers, it allows to 'calculate annual genetic gain for the breeding objective, genetic gain for single traits or per selection group and also return on investment adjusted for breeding costs.' (Karras, Kominakis, & Spandonidis, n.d.). Using ZPlan however requires that the preferences on which the breeding plans are to be based have to be both quantifiable and limited in number. This means that the scientists have to bring down the main preferences that are identified with the farmers to a relatively small, quantifiable set using statistical means. Based on the population data and the trimmed-down preferences and using ZPlan, the scientists then make a number of software-based simulation runs, which allow them to identify a series of possible breeding trajectories and corresponding breeding plans.

In a following step the scientists then ask the farmers to choose among the different plans the one that they are most interested in pursuing. Once this is done, the procedure - facilitated by the scientists - of moving from individual farmers with individual preferences to a 'community' united around a common breeding objective - is brought to a close.

Two points are to be highlighted here. First, the trait identification exercises imply a specific 'performance' of sheep breeding (Mol, 1998). From each farmer or family having their own trait preferences based on their individual tastes, experiences and management strategy, through the tools and subsequent trimming-down the scientists generate what they view as the preferences of 'the community', whose representativeness rests on the tools and subsequent statistical analysis of these many individual preferences. Together with the breeding plans these are what 'glues' the individual farmers into a 'community' of breeders. The verb 'gluing' is meant here in Sismondo's sense (Sismondo, 1999), in that the exercises and plans combine the theory of selective breeding with the farmers' actual, messy breeding practice involving themselves, their sheep and their environment. The success of this breeding performance following the tenets of selective breeding will thus depend on the farmers' willingness to adhere to both these preferences and the breeding plan that they have chosen.

Second is the social order that is inherent in this alternative performance of breeding. In community-based breeding outsiders with higher education - the scientists - have a leading role. It is on their implementation of the three tools and the subsequent statistical analyses that the 'representativeness' of a small set of traits rests, and their ability to use ZPlan as well as the scientific know-how contained in it that the 'promise' of the potential breeding success of the different breeding plans is based. The farmers thus have to trust in their authority and ability, since they have neither the skills nor the means to perform such calculations themselves. In other words, while community-based breeding aims to give a lot of decision-power to the farmers, much of that power is still in the hands of the scientists.

7.1.6. From Breeding Theory to Breeding Practice

Once the community has been set up by joining farmers through preferences and a breeding plan, and - in parallel - the sheep population has ben generated through measurements and tags, the actual breeding can start. Simply put it consists of three elements: management, recording and selection.

First comes management. An accurate selection of the sheep depends on the comparability of the animals. This is achieved by ensuring their health, sufficient nutrition and overall adequate management by their owners so that the main variable that is checked through measurements is the performance of their genotype according to the identified preferences. Accordingly, the scientists have to combine breeding with measures to ensure this. One way to do so is to control the animals' health and treat any illnesses and/or disease outbreaks. Another is to control the farmers' sheep management - a disciplining of the farmers of sorts - by providing them with trainings, fodder crops and punctual advice. The underlying aim of the scientists is to achieve *uniformity* in the farmers' management and the sheep's health, for selective breeding to function as intended.

Figure 36 – Enclosure and sheep during a selection workshop

Recording begins already before the breeding plans are made, in that the farmers' population is tagged and measured. Subsequently the preferred traits are measured at regular intervals among the population's ewes and lambs in order to monitor the animals' performance over time. The need for regularity of these measurements means that an enumerator living with the farmers - ideally one of its members - has to be appointed with the task. The enumerator stores the collected data in one simplified recording book for each individual farmer containing information about his/her specific sheep, as well as in a complete record for the whole population. In addition, any newborn lamb is tagged and thus added to the population, and monitored henceforth. Two things are achieved in this way: first, the animals are quantified, i.e. their performance is translated into a quantitative format that is suitable for further software-based processing and analysis by the scientists. Second, information about these animals is made mobile: from recording books it can be fed into computers and sent via the Internet, enabling 'selection at a distance' by the scientists without them seeing the animals themselves. Obviously, the functionality of this mobility and distant selection depends on the accuracy and reliability of the enumerator.

The third aspect is selection. Its purpose is to identify those male lambs that are later allowed to procreate. The selection is based on the lambs' performance in the desired traits, combined with their pedigree, i.e. the performance of their mothers. Selection itself takes place in so-called selection workshops held twice a year, during which the farmers bring the best animals as 'selected from a distance' and communicated to them by the scientists, based on the records that have been produced thus far (Figure 36). A set of the highest performing rams among these is then presented to the farmers, from which they choose their favourites considering those important but non-quantifiable traits such as colour and tail shape that cannot be captured through quantitative recording. After the trait selection exercises and the choice of the breeding plan, this is the only moment in which the farmers are given control again of the selection procedure.

In-between the workshops the sheep have to be disciplined in order for them to adhere to fit into the selective breeding procedures. The selected rams are left unharmed, whereas the remaining male lambs eventually have to be castrated - ideally before they reach sexual maturity - fattened and eventually sold. This in order to ensure that their genotype is removed from the population, and only the best are left to procreate. The selected rams are then shared among the farmers to ensure that they are able to mate with all available ewes.[119]

By thus allowing only a small fraction of the highest performers to procreate, community-based breeding increases selection pressure on the overall population, eventually achieving targeted evolution of this population and thus much faster genetic gains than would be the case if the sheep were allowed to breed randomly.

This faster evolutionary speed notwithstanding, animal breeding is an ongoing effort, meaning that its perspective on time is not punctual, but based on permanence and long-term effects. Several generations of sheep have to come and go before results even become visible to a farmer's eyes. Accordingly, support by external scientific institutions is also expected to take many years. Nevertheless, the long-term aim of community-based breeding - as well as its promise - is that the farmer community eventually takes ownership of the breeding activities with minimal to no external input. This however entails a whole transformation of the farmers and the way they understand and practice sheep-farming. They will have to move from being what scientists call 'mere' livestock keepers to becoming 'breeders', i.e. people with an active interest in the genetic improvement and maintenance of their breed, with the knowledge and skills to match. Eventually they are then expected to form a breeder association, a 'biosocial collective' built on and depending upon their shared sheep population and guiding its genetic development over time (Holloway et al., 2009). More than the proposal of a single practice, Community-breeding entails for the farmers a new business-model that they are expected to integrate into their livelihood.

This biosocial collective in turn is not expected to stand on its own. Rather, it is meant to become the guardian of its specific breed, and thus become part of the global, technoscientific network through which livestock breeding is enacted and controlled, maintaining its local breed and keeping it available as a genetic resource that can be used for other breeding efforts and breed adaptations elsewhere.

7.1.7. Small Story Reflections: Participating in 'Invited Spaces'

All in all, the steps described so far are the scientists' way of providing a simplified approach to selective breeding that is suited to the context of a smallholder farmer in a developing country. 'Participation' is understood as a key concept underpinning the approach, with farmers' involvement being integrated in the different steps in order to ensure that their context, preferences and opportunities are considered. It is viewed as the mechanism through which selective breeding can be adapted to the preferences and context of the farmers, turning an approach to breeding originating from industrialised countries into a 'universal' approach that can be applied even by smallholder-farmers in non-industrialised contexts.

[119] To prevent in-breeding, the farmers are organised in separate groups linked each to common grazing areas, and exchanging rams between each-other.

The degree of participation of the farmers is limited, however. While not a necessity of selective breeding as such, the scientists' stated aim of conserving indigenous breeds underpins the approach. As one of the scientists stated, if the choice was left up to the farmers they would probably all want to opt for high-yielding exotic cross-bred sheep. Community-based breeding aims to make that option less attractive to them by increasing the performance of indigenous breeds vis-à-vis high-yielding exotic breeds. In practice, participating in a community-based breeding programme based on these premises thus entails that the farmers have to limit their breeding choices.

Another constraint is also found in the actual animal husbandry practiced by the farmers. By joining in community-based breeding the farmers are expected to become a disciplined part of a wider, heterogeneous network on a permanent basis, centred around the shared population of sheep, by having an as far as possible uniform management (with the scientists' support), tagging their animals and having them measured and recorded on a regular basis, and adhering to a breeding plan in their decisions to keep or discard specific sheep. They thus subjugate their usual management and breeding practice to a 'higher goal' of improving the performance of their local breed. This whole process is guided by external actors - the scientists - whose know-how and tools are required to keep it going.

A third aspect to be considered is the enactment of sheep as such. Their purpose and use is not any more understood through the local context of the farmers, and knowledge about them is not constrained to the farmers' individual experience with them. Instead, it is viewed through the 'global lens' of the conservation of animal genetic resources, being not any more only a farmer's individual property, but a global breeding asset. In order to function in this way their performance has to be quantified and made mobile through the involvement of external actors, measurement tools, written records and ZPlan.

Overall thus 'participation' in community-based breeding is not understood in the sense that farmers are in full control (Pretty, 1995). Rather, it is the scientists' attempt at enrolling farmers into the global, technoscientific network through which science-based breeding is enacted, by combining the maintenance of a global good (the farmers' local breed) with the attempt at contributing to the farmers' economic furtherment. The broad targets and procedures of community-based breeding are set out by the scientists, and farmers are provided with 'invited spaces' (Cornwall, 2008) in which they are allowed to direct the course of the breeding programme within pre-set boundaries. It is a 'broad' approach to participation, in that all participating farmers are to have the opportunity to voice their opinions in the invited spaces that they intended to provide (Farrington & Bebbington, 1993). This participation however is also 'shallow', in that they are asked to approve activities and procedures that have been designed beforehand. It can thus be viewed as the inclusion of farmers into a specific social order in which - through the scientists - science-based selective breeding and its way of understanding of sheep takes center-place, and in which the farmers' trait preferences become an input to their enactment as genetic repositories and market-based breeding assets. While it does provide farmers with new opportunities in terms of learning new sheep management practices and eventually acquiring better-performing sheep, it also represents a new way of co-producing nature - the sheep - and the farmers' society - their way of organising and managing their sheep-breeding amongst each other - with its own limitations and constraints.

The above is a description of community-based breeding as intended by the scientists as they planned it. To translate it into an Ethiopian setting however required the enrolment of a number of actors with their own agendas and underlying actor-networks, and resulted in a number of adaptations and unexpected results. It is to these attempts at enrolment that we turn in the next small story.

7.2. Second Small Story - The Translation of Community-based Breeding

While the previous small story covered the theory of community-based breeding, its implementation in practice meant combining the interests of the farmers and scientists, two separate Communities of Practice with different approaches and understandings both regarding the research project as such and regarding breeding as a whole. The following small story will describe this process by at first focusing on the net-'working' that the scientists undertook in order to bring the different actors on board that were required for a successful implementation of the research project. This will be followed by a view of this whole endeavour from the point of view of the farmers.

7.2.1. The Origins of the Research Project

While selective breeding has a long and successful history, its implementation in developing countries has had mixed results. Community-based breeding has recently been offered as alternative, promising a more active involvement of farmers in the whole breeding process and thus a better adaptation to the specificities of their context. Practical experiences in community-based breeding had thus far however been few and far between. The team of scientists in this case study therefore intended to dedicate a whole research project to the topic, mobilising a combination of funds, material resources and personnel for a duration of four years in order to generate scientific findings on the approach.

This research project had two distinct purposes. First were the research objectives as determined by the scientists themselves. Their aim was to basically 'test' community-based breeding under different geographical and social conditions. Based on the lessons learned in the process, they would be able to develop what they called a 'public good methodology'[120] (eventually to take the form of a 'How to'-manual), enabling other development actors and agencies to apply community-based breeding in other contexts and settings. A second - implicit - purpose that was at least as important was to secure the scientists' livelihood and academic standing. While they received a fixed salary through the research organisations in which they were employed, the institutional survival of these organisations (and in some cases even the funding of some of the scientists' positions) depended to some extent on the acquisition of external research funding through research projects. In addition, publications, presentations and other written outputs and even academic degrees for some were other tangible outputs of such a research project that would enable the scientists to establish themselves in the academic field, strengthen their reputation and credentials and ideally contribute to securing future collaborations, further research funding and secure their income.

As with the first case study, the initial ideas underpinning this research project were the outcome of particular interests of the scientists and of their personal networks. The two scientists from Boku at the origin of the Ankole-project in Uganda were also closely involved in the initiation of the research project on community-based breeding. They had already

[120] In the sense of the methodology being freely available.

acquired some initial experiences with the approach in Latin America, and were personally acquainted with scientists from Argentina who had implemented it there. In addition, they were in contact with a Bolivian scientist based at the International Center for Agricultural Research in the Dry Areas (ICARDA; one of the research centres of the CGIAR) who increasingly saw community-based breeding as the most promising way to implement selective breeding among smallholder farmers. It was with him that the scientists from Boku met in Brazil in 2005 and developed the initial idea to turn the implementation of community-based breeding into a subject of systematic research. The move from this initial idea to a full-fledged research project however would eventually require the participation of a number of other institutions beyond Boku and ICARDA, to be enrolled into the project through a number of means (Figure 37).

7.2.2. Securing Funding and Institutional Anchoring

The first and arguably most crucial step was to secure funding for the research project. As with the Ankole-project, the Boku-scientists decided to submit a research proposal to the Austrian Development Agency (ADA) for funding, this time with the institutional collaboration of ICARDA through the Bolivian scientist. The purpose of their research fitted very well in the development narrative underpinning ADA's work. One objective underlying community-based breeding was after all the economic development of the participating farmers. Following the footsteps of the successes of selective breeding in industrialised countries, the performance of these farmers' livestock breeds would be improved as a result of their co-ordinated breeding effort, ideally leading to better economic returns through the commercialisation of their animals. Community-based breeding's second objective - the conservation of animal genetic resources by increasing the economic attractiveness of indigenous breeds - also fitted with ADA's approach of environmental sustainability, by promoting development without endangering biodiversity and genetic resources. Given these underlying promises of community-based breeding, funding by ADA was therefore an option.

A first research proposal had already been written during the meeting in Brazil in 2005 and had been submitted to ADA. The scientists' initial idea had been to implement this project in Brazil and Mexico, as they had already experience from these countries and had excellent connections there. However, this first proposal had been refused by ADA on the grounds that neither Brazil nor Mexico were target countries for Austrian aid. Not abandoning the idea, and true to the understanding of community-based breeding as a 'universal' technology through its use of participation that could be applied in a diversity of smallholder settings, the group of scientists therefore went on to think where else such a project could be implemented and which ADA would be willing to support. Their choice of country was mainly guided by their institutional needs and the networks and personal contacts they had. The country in question had to fall under ICARDA's mandate, and if possible involve co-operation with another CGIAR research centre as such collaborations were encouraged within the CGIAR-system and would improve their chances of acquiring funding. Eventually Ethiopia was chosen, as it was both part of ICARDA's mandate and the host of one of the campuses of the International Livestock Research Institute (ILRI) with which the Boku-scientists had working relationships through the Ankole-project. The new research project on community-based breeding would thus offer an excellent opportunity for ICARDA and ILRI to work together on a cross-cutting theme.

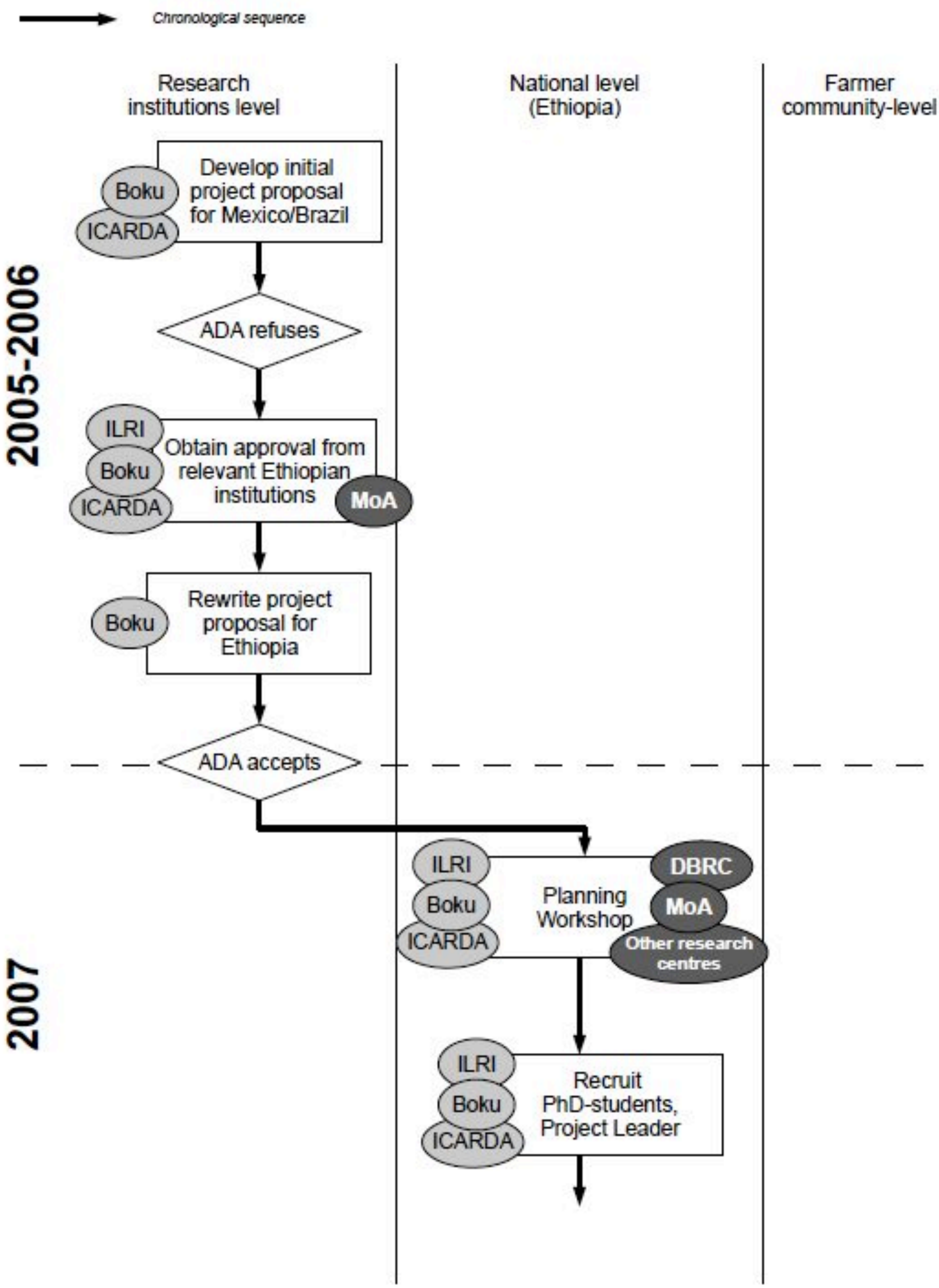

Figure 37 - From project proposal to planning workshop

Before an alternative proposal of doing research on community-based breeding in Ethiopia could be submitted to ADA, the small team of scientists from Boku, ICARDA and now also ILRI would however need to obtain the support from the Ethiopian Ministry of Agriculture and from Ethiopian agricultural research institutions. Doing so would both allow them to gain access to the sites where the research was eventually to take place, and would provide them with the local anchoring required to obtain legitimacy. Furthermore, the scientists envisioned that the Ethiopian research institutions would eventually have to take over the facilitation of community-based breeding once research funding by ADA had dried up, thus anchoring the approach within the Ethiopian breeding- and research system and ensuring its permanent continuation.

Obtaining an approval from the Ethiopian government proved not to be too difficult, as the promises of community-based breeding aligned themselves well with Ethiopian livestock policies at the time. According to recent scientific research, the production potential of small ruminants in Ethiopia remains under-utilised, despite growing markets in urban centres and in the Middle East (Tibbo, 2006). The Ethiopian government therefore had an interest to support an initiative that would improve the production of small ruminants and integrate this production into national and regional markets as a means to increase farmer income and contribute to poverty alleviation. At the same time the Ministry of Agriculture also wanted to conserve its indigenous animal genetic resources as an asset for the future. The research project thus provided a contribution and know-how for the Ministry to achieve its policy objectives.

The team of scientists approached the Ministry through existing contacts they had via the ILRI campus in Addis Abeba, presenting Ministry staff with a draft project proposal. This proposal was approved by the staff without any changes being made. However, since the idea of the research project was to test community-based breeding in a variety of settings, the Ministry was also asked by the scientists to designate four regions in which the research project was to take place, as well as the sheep breeds found in these regions that should be targeted by the breeding effort. Finally, in addition to the regions and corresponding breeds, Ministry staff also appointed four regional and one federal research institution(s) which were active in these regions, and which were to become the Ethiopian counterparts in project implementation.

The initial participation of Ethiopian institutions in the set-up of the research project was thus limited to the Ministry's overall approval of the proposal, as well as its choice of regions, breeds and corresponding local research institutions. The content of the research - the topic, objectives, methodology etc. - were still exclusively the product of the small team of scientists from Boku, ILRI and ICARDA as written down in their initial draft proposal. True to Ethiopia's authoritarian political regime, researchers from the local research institutions were not part of these discussions and negotiations, but were informed about its outcome once the decisions had been taken. Nevertheless, while their participation in the research project was imposed from above, it provided them with additional funding which was welcome given the often-underfunded status of Ethiopian agricultural research. In addition, such projects also often offer further training opportunities for their staff, as would eventually also be the case here.[121]

[121] One of the two PhD-students of the research project came from one of these research institutions. Another one would do his MSc-research within the project, and would eventually be given the possibility to do his PhD-studies in Austria within another research project.

With the Ethiopian institutions thus on board and after having obtained the required supporting letters and contacts, the scientists from Boku rewrote the proposal, in essence only replacing background information and statistics on Mexico and Brazil with the corresponding information from the Ethiopian livestock sector and its policies, in order to make a case for the need for a community-based sheep breeding programme in the country. The set-up and methodology of the breeding approach as described in the initial proposal was left untouched, as the scientists viewed it as an approach that was flexible enough to be adapted to (almost) any context.

Once completed, the proposal was again submitted to ADA in October 2006. As it now corresponded to ADA's requirements both regarding the underlying development narrative and the geographic location of the research, funding was eventually approved, and the implementation of community-based breeding in Ethiopia could begin. The wider stage for implementing the research project was set through the institutions enrolled in it thus far, with ADA having the biggest influence: its funding provided the means - but also set the limits - to implement activities, hire staff, purchase equipment etc. In addition, contractual agreements between ADA, Boku, ILRI and ICARDA set the frame for the total duration of the research project, the outputs to be achieved and the reporting requirements, and made the three research institutions responsible for meeting these. The Ethiopian Ministry of Agriculture was to be kept informed about project progress, and through its authority the local research institutions were tasked to join in and support the implementation of the project as outlined in the research proposal. The overall set-up of the research project thus had a distinct distribution of power and responsibility, with the scientists of Boku, ILRI and ICARDA being in control and having to ensure that objectives were to be achieved in the project's pre-set 4-year time-frame as per the project proposal.

7.2.3. Discussing Details and Imagining Farmers - The Planning Workshop

The first step of the actual implementation of the research project was the realisation of a so-called planning workshop.[122] The workshop took two days, gathering some 32 participants from Boku, ILRI, ICARDA, the Ethiopian Ministry of agriculture and local research organisations, as well as representatives from NGOs and projects also working with sheep production in Ethiopia. It was here that the first concrete actions were decided upon and responsible people appointed. No changes to the project plan itself were made during the workshop, however. ADA had already approved the project as it was described in the proposal, and since they were funding the whole endeavour - in the words of one of the scientists - were to be 'given what they had paid for'.

Instead, the main part of the discussion was focused on the involvement of the farmers in community-based breeding. In the proposal submitted to ADA the scientists had already made a case for the need for such a research project, using macro-economic statistics to argue that the poverty of Ethiopia's farmers could be alleviated by improving the performance of their livestock. Now however the discussion turned to the practicalities of involving live farmers and their sheep. Since there were no farmers - let alone sheep - present during the planning workshop this meant that the discussions were based on the scientists' *imaginations* of the farmers and their farms, as well as of their role in community-based breeding. While for many participants - especially those from Ethiopian research institutions - these

[122] As I did not attend this workshop, my information about it is limited to data obtained through interviews as well as through the workshop programme and minutes.

imaginations were based on personal experience they had acquired in working with smallholder farmers, they were imaginations nonetheless, without the 'reality check' that could have been achieved if the farmers had been present there themselves.

The first part of the discussion centred on the set-up that the farmer community would need to have in order to function effectively as basis for co-ordinated livestock breeding. In this discussion 'community' was not so much understood as an existing social network, and rather as a group of farmers joined together through community-based breeding into a unit - or biosocial collective (Holloway et al., 2009) - whose breeding efforts were to be co-ordinated through the research project. For this to work, the workshop participants set up a list of criteria that such a community should have to fulfil. These were:

- The community should have a total of around 400 sheep (eventually to become 420 during implementation)
- Each farmer participating in the project should not have less than 5 sheep (eventually reduced to 4 during implementation)
- It should use communal grazing/watering points
- Sheep should be a development priority in the area according to the Ministry's directives
- There should be no negative impact from and possibly synergies with any other projects in the area
- The farmers should be interested in the project and willing to co-operate with it
- The community should have (a) farmer(s) who were 'champions' with regards to sheep, to be used as entry- and contact-points

In other words, the basic set-up of the community was decided by external actors from a distance, guided by government directives and what the scientists' regarded as the practical requirements of the approach.

With these criteria thus set, the second part of the discussion centred on the geographical location of these communities. Throughout the country, a total of four regions were to be included in the research project: Afar, Bonga, Menz and Shambu. In each of these regions two farmer communities were to be chosen with whom the scientists would collaborate. With regards to Menz region - the focus of this case study - the choice of the communities was relatively straightforward. The region fell under the mandate of Debre Birhan Research Centre (DBRC), which was also the local research institution appointed by the Ministry to be the project's local partner organisation for Menz. DBRC had already been working on Menz sheep for over eight years in the scope of a cross-breeding programme[123], testing the viability of crosses between Menz- and Awassi-[124]sheep with the flocks of several farming communities in the region. Given the good relations that scientists from DBRC had with these farming communities, involving them in community-based breeding seemed an obvious choice.

Some scientists voiced their concern about this, however. Community-based breeding entailed breeding within a single breed, meaning that having cross-breeding with exotic breeds run in parallel might influence the results and run counter to the notion of conserving animal genetic resources. Ultimately it was decided to turn an obstacle into an advantage and

[123] At the time of the Planning Workshop this programme had already been interrupted for several years due to the occurrence of a disease among the seed rams that were intended to be distributed to the farmers.
[124] An originally Syrian sheep breed.

include one of the kebeles[125] in which DBRC had been cross-breeding in the project, based on the assumption that doing so would allow to 'test' the compatibility of community-based breeding with cross-breeding initiatives. The choice fell on a kebele close to the town of Mehal Meda with which DBRC-scientists had already been working for almost a decade. For the second community the workshop participants decided to identify a kebele close to Molale, a town some 60 km away from Mehal Meda. The assumption here was that farmers in Molale would not have been exposed to exotic sheep-breeds, and were too far removed from Mehal Meda to allow for any exchange of sheep between the two communities to occur. Here too, therefore, choices about the location of the farmer communities and their role within the research project were made externally, without any involvement of the farmers themselves.

There were additional topics covered during the planning workshop, most notably logistical issues as well as agreements on how to recruit the two Ethiopian PhD students who would follow PhD-studies at Boku in Austria and carry out most of the research activities to be done in the field. However, from the point of view of the processes and networks underpinning the research project, its main outputs were twofold.

First, it was the first time the Ethiopian research institutions were involved in discussions on project implementation. Their room for shaping the overall methodology and objectives of the project was very limited, since the project proposal had already been agreed upon between ADA and the scientists from Boku, ILRI and ICARDA , and approved by the Ethiopian Ministry of Agriculture. Control of and responsibility for the project thus lay with the 'international' scientists, whereas the Ethiopian scientists' contribution at this stage was more of a consultative kind, providing their knowledge about the regions and their networks with farmers in order to decide on the location and the type of farmer community to be included in the project. Nevertheless, the planning workshop was probably the first opportunity for many of the local researchers to get first-hand information about the project and its objectives, understand what would be expected of them, identify potential opportunities for themselves and thus possibly acquire a certain degree of ownership of its activities and objectives.

The second output of the workshop was a first conceptual concretisation of the farmer community that would form the backbone of the research project's community-based breeding approach. From an initially rather general understanding of it in the project proposal, it had now been narrowed down to specific geographical locales as well as a list of criteria which a group of individual farmers would have to fulfil in order to be eligible to participate in the project. It was now up to the local research organisations - DBRC for Menz region - to go to these locales with these criteria and find and organise the farmers and the sheep who would be willing and suitable to participate in selective breeding activities.

7.2.4. The Farmers Get Involved

As agreed in the Planning Workshop, DBRC was tasked to identify two localities where farmers would be interested to form a community for the purpose of joint sheep breeding. One was to be 'new' in that it would not have collaborated with the scientists before, while another would already have had working experience with the scientists through their cross-breeding programme. As this identification of the localities took place one year before my

[125] Ethiopian administrative unit corresponding roughly to one village.

first visit to the field, the description below is only based on what I was told by farmers and scientists.

The scientists from DBRC identified the ’new’ locality following established formal procedures, using official administrative channels to identify and approach the farmers. They contacted Molale’s Bureau of Agriculture,[126] and asked government representatives and Development Agents[127] to point out a kebele which might be suitable for participating in the project. Once this was identified, they drove to the kebele, talked to its chairman (a farmer), and asked him to gather the kebele’s farmers for a meeting. Having the Bureau of Agriculture call them to such meetings was not unusual for the farmers, as it is the Bureau of Agriculture’s task to co-ordinate agricultural activities in its woreda according to government policy, including e.g. the distribution of inputs (most notably artificial fertiliser), co-ordinating the farmers’ labour contributions in food-for-work programmes etc. (Davis et al., 2010). This time however the farmers attending the meeting were introduced to the scientists’ intention of implementing community-based breeding in their kebele. They were told of the purpose of community-based breeding, its potential for them as well as the activities that would be organised and support that would be provided for those farmers interested to join. In the end those farmers who were interested in participating in the research project as a result of the scientists’ presentation left their name on a list, expecting to be contacted again by the scientists once activities were to be started. In Molale, the farmers’ information about the project and its potential benefit for them thus depended on a presentation given to them by the local scientists’ accompanied by government representatives. Given that in later interviews some of them did not make any difference between scientists and the government, it is likely that many of them will have seen the research project as a government initiative in the line of their already existing food-for-work programmes.

For the second locality close to Mehal Meda the scientists from DBRC used their existing contacts in the woreda to identify suitable farmers. They had already worked together with farmers for almost a decade in three localities, distributing cross-breed rams and monitoring their performance over time. Activities had included more or less regular trainings of the farmers in sheep management, provision of health services and the regular measurement of the animals over time. While this cross-breeding programme had achieved a certain degree of success in terms of demonstrating a faster growth-rate and higher economic returns for cross-bred animals, these animals’ resistance to the environmental conditions in Menz weren’t as positive. In addition, the DBRC scientists perceived a lack of pro-active involvement on behalf of the farmers in the programme. As in another region covered by DBRC’s cross-breeding farmers had shown a very high eagerness to participate, they had shifted their efforts on that region, putting cross-breeding in Menz temporarily on hold with no more cross-bred starter rams being distributed to the farmers.

Here, too, the DBRC scientists initially went to the Bureau of Agriculture of the woreda in order to jointly agree on a kebele in which the research project would take place. This time however the scientists’ contacts to the farmers played a key role in the decision. As with Molale the farmers were asked to gather for a meeting where they were introduced to purpose and activities of the research project, and those who were interested in joining left their name on a list. Contrary to Molale however this time the farmers had had previous experience in working with the scientists, having known several among them personally over longer

126 Government institution responsible for co-ordinating all agriculture-related activities in a given woreda (district).
127 State agricultural extension agents allocated to each kebele.

periods of time and thus knowing more or less what to expect. Based on interviews with these farmers however for many they saw no difference as such between the work of DBRC and the new research project, seeing it instead as a continuation of the same process.

Both in Molale and in Mehal Meda the outcome of this first step of enrolling 'live' farmers into the research project was a list of farmers who were interested in taking part in the scientists' community-based breeding activities. The farmers themselves basically took a 'yes-or-no'-decision on whether to join, based on a classical presentation made by the DBRC-scientists. Up to this point their interest in joining the research project was thus mainly based on their experience with what they thought they could expect from the government and/or the scientists.

7.2.5. The Underlying Actor-network in a Nutshell

Once a number of farmers had been found both in Molale and in Mehal Meda who together with their sheep would be willing to become a community for the purpose of sheep-breeding, all actors required for implementation were in place. Before the actual implementation will be described, this section will take a closer look at its underlying actor-network, in order to better position the activities that will be described subsequently.

To begin with, the basis of the research project is the project proposal combined with the funds and the contractual agreement between ADA, Boku, ILRI and ICARDA. While in practice the researchers had a certain degree of flexibility regarding implementation, the proposal and contractual agreements nevertheless set a certain, non-negotiable frame to which the researchers had to adhere in terms of spending of funds and output delivery. It was the task of the scientists from Boku, ILRI and ICARDA to make sure that this frame was adhered to.

'International' Co-ordination

A key function in ensuring that implementation went according to plan and budget was held by an Ethiopian project manager, who had been recruited after the Planning Workshop. He was based at the ILRI campus in Addis Abeba, managing the logistics and administration of the project and serving as its focal point in the country. The bulk of the research activities were performed by two Ethiopian PhD-students who were hired for this purpose after the Planning Workshop. They would receive training at Boku in Vienna on advanced science-based breeding technologies, would set up data collection procedures in the four regions of the research project, analyse the data thus obtained and write theses based on their findings. In this they were supervised by two Austrian scientists from Boku, who were supported in this task by an additional Austrian Boku-scientist, two scientists from ILRI (including the project manager) as well as two scientists from ICARDA[128]. While there was some degree of fluctuation among the scientists from ILRI and ICARDA[129], these scientists together with the PhD-students became the scientific and co-ordinating 'core' of the research project. In other words, it was them who reported - and were accountable - to ADA, initiated, co-ordinated and supervised all key activities of the project, disbursed and monitored the use of funds,

[128] The nationalities of these scientists was relatively diverse, including two Ethiopians, one Kenyan and one German.
[129] Based on the research project proposal submitted to ADA there were more contributing scientists in the institutions mentioned. The details of the changes in staff and distribution of responsibilities among them however go beyond the scope of this case study and do not impact on the outcome of the analysis.

compiled the scientific data, analysed it and translated it into outputs such as publications, presentations, posters and eventually also the community-based breeding-Manual.

There was generally a very good team spirit among them. Some of the scientists knew each other from previous projects and collaborations, and there were ample possibilities for the others to get to know and trust each other. While they were stationed at their home bases in the respective countries they had access to very good Internet connections, enabling them to keep in contact via e-mail. On a few occasions they would have joint meetings in Austria, and would especially meet on several occasions in Ethiopia during the field visits to the farmers. Such visits could take up to two weeks each, during which they would stay in the same hotels sharing breakfasts, lunches and dinners, and would spend many hours crammed together in cars driving from project-site to project site. All this time spent together and opportunities of informal interactions meant that there was ample time and space for them to discuss the project, their observations and thoughts. On several occasions I could for instance observe how e.g. during breakfast the details were discussed on how to implement an upcoming workshop with the farmers and how a chat during a car drive became the origin of the revolving fund through which selected rams would be bought, and how dinners were used for strategic reflections on a follow-up project. They thus formed a small 'community of practice' within the research project, tied together through car-drives, meetings and the Internet, united by their aim to realise the project's objectives and willingness to undertake the activities required to do so, and sharing the same understandings and practices of animal breeding science. Since they were also the ones who were accountable to ADA and - through their experience, networks and means of communication - in the best position to acquire funds for a follow-up project, they were in control of the overall aim and scope of the research project and of the activities through which it was to be realised.

Local Research Centres

With the scientists from Boku, ILRI and ICARDA being the scientific and co-ordinating 'core' of the project, the local research centres in the four regions acted as a linkage between this core and the sheep-keeping farmers. In the case of Menz this was the task of Debre Birhan Research Centre (DBRC), which has as its official mandate the provision of scientific support to improve agricultural production in its region (Figure 38).

Figure 38. Buildings of Debre Birhan Research Centre

Their appointed role was to maintain a regular contact to the farmers, accompany the breeding efforts through treatments and training, as well as to supervise and co-ordinate data collection from the sheep population. Their involvement in guiding the project however was very limited. While representatives from DBRC had been invited to participate in the Planning Workshop, some of them were not able to attend due to other appointments, and for those present the scope of their contribution was limited to the clarification of practical details. In addition, they were physically constrained to their region with only very limited funds for travel. Internet access in the centre was also limited, as were to some extent their English skills, meaning that communication via e-mail was limited to issues of co-ordination and information exchange. While they did participate in the field visits in which the Boku, ILRI and/or ICARDA-scientists were also present, they usually did not participate in the extensive discussions that the latter were having about the project throughout their field visits to all four project regions, via e-mail or during their meetings in Austria. The DBRC scientists had consequently only a very limited influence on decision-making within the project, being basically restricted to the role of activity implementers.

At times, such a constellation led to unclarities in communication and implementation, most notably regarding the continuation of DBRC's research programme on cross-breeding. While the programme had been interrupted five years earlier for a number of reasons, new, disease-free animals had recently arrived and were ready to be distributed to the farmers. Initially some scientists from DBRC had therefore understood from the Planning Workshop that the distribution of these rams would continue in parallel to community-based breeding. The issue came up almost ad hoc during a dinner in a small restaurant in Mehal Meda after a workshop with the farmers, however, and led to a vehement discussion between the scientists from DBRC and those from Boku, ILRI and ICARDA. The latter strongly argued against the continuation of that programme, maintaining that doing so would render any efforts in community-based breeding pointless. While initially somewhat confused about the issue, the DBRC-scientists eventually complied, and the cross-breeding programme was stopped in Mehal Meda.[130] While eventually the DBRC-scientists would agree that this was probably the most sensible approach to take, this was nevertheless the most visible manifestation that it were the scientists from Boku, ILRI and ICARDA who were in control.

Their limited influence on the project notwithstanding, the DBRC scientists nevertheless did obtain a number of benefits from their participation in it. To begin with, DBRC's funds for activities were generally limited, meaning that opportunities to visit farmers and perform field activities weren't as frequent as the scientists would wish for. Through the research project however funds became available for transport and activities, enabling DBRC's scientists and technicians to go out again and participate in research. Even the research itself wasn't driven forward by them, it nevertheless provided them with new ideas and opportunities for observation and learning that would help them in their own work.[131] Furthermore, the project funds included funding for two Ethiopian MSc-students, one of which would eventually be a Technical Assistant from DBRC.[132] In other words, while DBRC's involvement in the project was imposed from above and limited their role essentially to technical assistance, the benefits of participation were numerous enough to motivate its scientists to do a good job.

Farmers and Farms

Last but not least, the final actors to be considered are the farmers, their pastures and their sheep. It was through them that most of the activities linked to community-based breeding practice were to be performed. They shared the same livelihood, and thus formed their own

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[130] A contributing factor to the DBRC-scientists' decision had been the fact that the Ethiopian government, too, had decided by then that Menz Region was to focus on improving its indigenous sheep breed.
[131] One scientist for instance reported how through the research project he had adopted the idea of the farmers keeping their own simplified recording booklets, which he had applied in another location of DBRC's cross-breeding programme.
[132] Through the contacts established through the research project this Technical Assistant would later be able to obtain Austrian funding for his PhD-studies.

‘community of practice’ with a shared understanding of their social- and farming practices. They were geographically bound to their locale - and consequently separated from the remaining parts of the actor-network - by their relative lack of means of transport and of communication.

The farmers in Mehal Meda had been working for almost a decade with the DBRC scientists on a research programme on the impact of cross-breeding. Since the research centre was however more than 100km away via dirt roads, the scientists had usually only been able to visit the farmers every few weeks. Through the additional funding of the research project however the frequency of these visits could be increased to once every fortnight.[133] Nevertheless, this meant that a certain degree of familiarity and trust had developed between some of the farmers - mostly those who were eventually to become the ‘champions’ of the research project - and the scientists. This familiarity was not so much present vis-à-vis the scientists from Boku, ILRI and ICARDA, however. They would have the most extensive contact with the two Ethiopian PhD-students[134], as these would participate in the preliminary field studies and help in the facilitation of all workshops. At times the PhD-students spent several weeks in a row in each project region, being based in a nearby town and visiting the farmers by car during the day. At times they were accompanied by the ILRI project co-ordinator. Exposure of the remaining scientists from ICARDA and from Boku however was limited to shorter field visits (three of which I joined), where they would spend on average 2 days in each region, getting in contact with the farmers’ communities during the six workshops that were organised throughout the 3-year duration of the project. Contact to the farmers beyond the project duration was not possible, as money for financing any visits would not be available any more by then.

Thus the actor-network underlying the research project implied a specific social order linked to the distribution of responsibilities and corresponding scientific knowledge generation, and that would influence its implementation later on. The ILRI, Boku and ICARDA scientists were very much ‘in control’ of the research project, being the ones managing the disbursement of the funds and the corresponding realisation of activities, including those activities related to the generation of scientific knowledge as a result of the research. The farmers and DBRC scientists were at this stage basically contributing actors to these scientists’ research efforts.

7.2.6. Implementing Community-based Breeding

With the actor-network thus in place, the scientists were ready to begin implementing the breeding approach as such. Doing so would involve a number of steps, some of which ran in parallel while others followed a chronological order. Figure 39 gives an overview over these steps, and may serve as guideline while reading through the remainder of the small story. In the following description these steps will be conceptually grouped into the scientists’ attempt at mapping the farmers’ livelihoods, enacting the sheep population and finally the implementation of breeding as such.

[133] Note however that many of these visits were done by DBRC’s Technical Assistants, and not by the scientists themselves.
[134] Note that their shared nationality with the farmers does not imply familiarity with their culture. All three scientists were from Oromia and not from Amhara as were the farmers, and therefore did not share their cultural background or native language with the farmers.

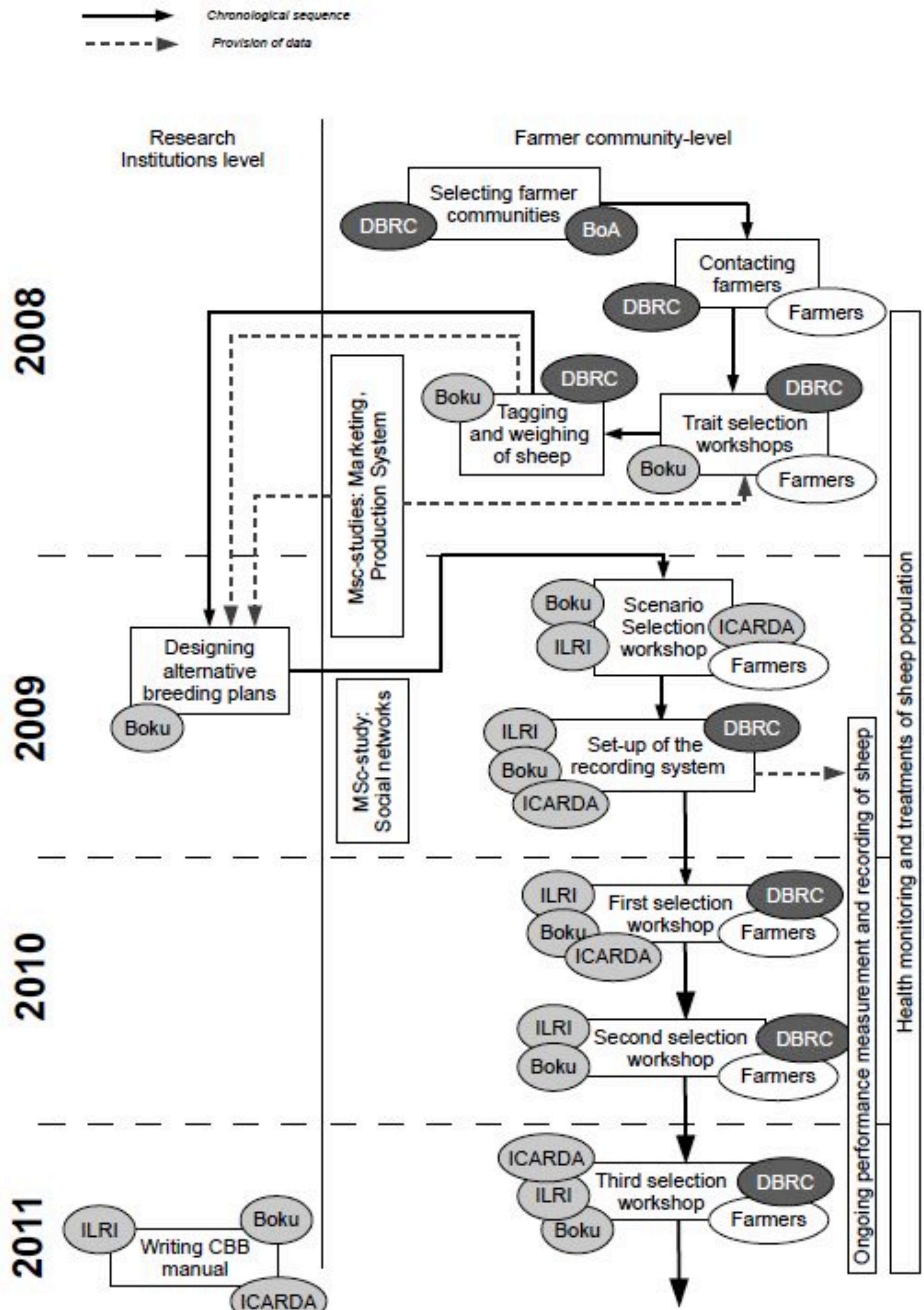

Figure 39 - Chronological overview of research project implementation

MSc-Studies: Mapping the Farmers' Livelihoods

One key distinction of community-based breeding over previous breeding approaches was its emphasis on acknowledging the importance of the farmers' livelihood and context and integrating it into the approach. The first step in the implementation of community-based breeding in the field was therefore to obtain information about the ways in which the farmers were living and farming. This information would eventually flow into the breeding plans to be developed.

The bulk of this work was done by Ethiopian MSc-students during the first year following the Planning Workshop. One student did an economic analysis of the price performance of Menz sheep along its marketing chain, another studied the economic valuation of Menz sheep, while a third one surveyed the farmers' livelihood and sheep production system.[135] Later during the project implementation a third - Austrian - MSc-student did an additional study on the farmers' social networks, to be used as a starting point in order to set up ram-sharing groups. For personal reasons however the analysis was delayed, and the thesis findings could not be used in the implementation of the community-based breeding approach.

Figure 40 – Scientists testing a questionnaire

All four theses had the same role in the project: they were a means to gather data that would be integrated into the PhD-students' work. The production system study for instance amongst others contributed to a list of sheep traits upon which the choice cards were developed, whereas the marketing study provided price information that enabled a simulation of the economic impact of the different breeding trajectories. This data was gathered using formal surveys (Figure 40), meaning that the farmers' livelihood was conceptualised as a source of - mostly quantitative - data which could be 'mined' by the MSc-students to ensure that the breeding plans to be developed using advanced computer software would correspond as far as possible to the context and preferences of the farmers. Which aspects were considered and which not was however decided by the scientists, shaped by the requirements of the breeding approach and the software, and limited to those elements that were needed to set up a breeding plan. The farmers were passive providers of information in this process, as were in a sense the MSc-students, being contributors to rather than co-creators of the breeding approach to be implemented. Since the approach had been described and set in the project proposal, there was no room for the farmers or MSc-students to discuss the approach as such or even question the suitability of such an approach in the first place.

Enacting the Sheep Population

[135] This student was a Technical Assistant from DBRC, who would eventually become the so-called Site Team Leader for the research project in Menz, i.e. main responsible at DBRC for implementing the research project.

While mapping the farmers' livelihood through MSc-studies provided the scientists with the data needed to set up their breeding plans, they also had to structure the participating farmers' individual flocks of sheep in such a way that they would 'function' as a single population that could be supervised and controlled by them from a distance.

As sheep are tied to their owners, this enactment of a larger sheep population meant that a first step was to select the farmers whose sheep were eventually to be included. While in principle joining the project was open to any farmer within the selected communities, the scientists eventually set a maximum of around 60 participating farmers in Mehal Meda and Molale respectively, as more would have become too difficult for them to handle. Furthermore, in addition to the criteria of the farmer being interested to join and having a minimum of 4 animals in his/her flock, the scientists also weeded out a few farmers based on the DBRC-scientists' previous experience in the communities. If a farmer for instance was known to be very difficult to work with, the scientists would ensure in a diplomatic way that s/he would not become part of the project. This was meant to ensure that those who eventually became enrolled into the network had the potential to function effectively within the system and would adhere to the breeding-script that the scientists were proposing. The scientists then organised the selected farmers into groups, each linked to a communal grazing area that its members were sharing. Up to this point these communal grazing areas were the place where all livestock came together and where uncontrolled mating between different farmers' sheep occurred. The scientists' intention was that from then on each group of farmers using the same communal grazing area would receive and share one or more of the selected 'good' rams, while all other rams within the group would have to be castrated. In this way only the selected ram(s) would mate with the group's ewes and transfer their genes to future generations.

Organising the farmers in this way was only one aspect in enacting the sheep population. The other was structuring the sheep themselves. Up to the arrival of the scientists, individual sheep could for the most part only be identified by their respective owners. As opposed to the Bahima, the Menzei have no practice of naming their sheep, and colour and shape are the main means through which they distinguish their animals from each other. For the highly structured and systematised approach that is selective breeding, this would obviously not suffice. Hence in the weeks following the scenario-selection workshop the scientists went around to each participating farmer together with an enumerator - a young farmer from the community hired for this purpose - and tagged every sheep of the population with a plastic ear-tag marked with a unique, 5-digit identifier. A total of 2411 animals - half of them in Mehal Meda and the other half in Molale - were tagged and identified in this way. Since some of these animals in Mehal Meda had already been part of DBRC's cross-breeding programme, it was not unusual to eventually have animals with two separate ear-tags in them, one for each programme. In addition, upon tagging the bodyweight of each animal was measured and written down. Whenever a lamb was born from a tagged ewe, the enumerators would then provide it with its own tag and numerical identifier. Coupled with performance measurements collected in written records, this system made it possible for anyone to distinguish the breeding population from surrounding flocks, tie individual animals to their performance recordings and thus select 'good' rams from a distance, without necessarily having any exposure to the animals as such.

The third and final aspect in the enactment of the population was the effort to keep it healthy. For an effective selection to take place, all animals would have to be in good shape and managed in a somewhat comparable way. This in order to ensure that any observable or measurable differences were the consequence of their genotype, and not of a disease or below/above-average management. Up to this point the health and performance of sheep could differ significantly, with e.g. sheep grazing close to streams being more affected by parasites, or growth rates differing due to variability in the quality of the farmers' private pastures and access to fodder crops. Several measures were thus undertaken in order to make the management of the sheep uniform and comparable.

First, the scientists provided the participating farmers with a series of trainings on a range of management practices. Giving such trainings was a practice that DBRC had already been doing with its previous project on cross-breeding on a yearly basis. Now, with the funds of the research project however up to three such trainings could be given every year. Topics included animal breeding and production, feeding and nutrition including the growing of forage crops, animal health, as well as marketing aspects. These topics were decided upon by the DBRC scientists, either based on what they thought was required, or on trainings they themselves had been receiving before elsewhere. These trainings were usually announced to the farmers through the Bureau of Agriculture. A team of scientists would then drive by car to the Bureau's offices where the farmers would be gathered, and would give the training in a classical manner. At the time of my field research and on the farmers' request they were however planning to move the trainings to the field, in order to be able to demonstrate some of the trainings in practice (e.g. urea molasses preparation and castration). In addition to the trainings, some farmers would often receive individual advice whenever the scientists or technical assistants were visiting them, and some would even be given seedlings and seeds of fodder crops in order to improve the fodder supply of their animals.[136] In the majority of cases these were the 'champions', i.e. those farmers who had shown a high receptiveness for the scientists' trainings and advice, with whom the scientists maintained good relations.

Such regular visits by DBRC-staff - done by technical assistants from DBRC every fortnight, sometimes together with the scientists - were a second measure to ensure the comparability of the animals. During these visits the technical assistants would inspect the animals' health and provide medical treatments whenever required. These included drenching each animal twice per year to prevent internal parasites, treating any sick animals brought to them by the farmers, strategic vaccinations against major endemic sheep diseases, as well as immediate vaccination in case an enumerator informed them about a disease outbreak.

All in all, the work of selecting and organising specific farmers, tagging and recording the performance of their animals as well as keeping the whole sheep population healthy through improved management trainings and health treatments ensured that the research project had at its disposal two populations of around 1200 sheep each[137] for selection purposes. They had additional, just as important functions as well, however. Since breeding is a long-term process, and genetic gains in the population would take several years to become clearly visible to the farmers, the trainings and treatments were a means to keep the farmers interested and motivated to stick with the project throughout its duration, that is to ensure the stability of the breeding network up to the point in which the farmers would clearly perceive its benefits. In addition, the trainings also had the purpose to provide the farmers with the knowledge and ability to take the lead in its activities on the long run. The long-term vision of the approach, after all, was that farmers would eventually take over and keep up the process of recording and uniform management without any major external support.

[136] There were not enough seedlings available to provide them to all participating farmers.
[137] 60 farmers per community having on average 20 sheep each.

Identifying Preferences

With the sheep population thus in place, the next step was to identify the objective breeding traits. Underlying any breeding programme is the choice of a number of traits which the breeder(s) want to strengthen or reduce in a given population through their targeted breeding efforts. Given the participatory approach of community-based breeding, these traits were to be determined by the farmers themselves. When they first began to work with the farmer communities, the scientists were faced with a total of around 120 sheep-owning households in two sites, each with their own, personal trait preferences. There was of course a large degree of overlap between them, with e.g. large animals being preferred by virtually all farmers, as DBRC's cross-breeding programme had already found out. Nevertheless, the diversity of preferred traits had to be reduced to a small number that was both manageable for selective breeding purposes and easily measurable under smallholder farming field conditions.

A first step towards the identification of breeding objectives had been made during one of the initial surveys by one MSc-student. This survey aimed at gaining a comprehensive understanding of the farmers' sheep production system. Data collection had been done by a number of trained enumerators using formal questionnaires to interrogate a total of 68 randomly selected heads of farmer households, as well as a group discussion with farmer elders. In addition to asking questions on the main sheep management practices the farmers were using, the survey had also included questions regarding the farmers' preferred sheep traits. These findings would form the basis of the subsequent trait determination exercises based on the scientists' tools described in the previous section.

These exercises - facilitated by the two PhD students with the support of DBRC-staff - involved more or less all households included in the research project. Choice cards were specifically developed for Menz, based on the baseline research done by the MSc-student. 24 different cards were made, each with 2 animals depicted on them that showed specific traits, and all households were asked to rank their preferences according to these cards. For the own flock ranking experiments the scientists visited each household early in the morning in order to make sure that the sheep were still in the homes and not out grazing. Eventually a total of 16 traits were identified in this way, with the scientists noting that through this method the farmers addressed relatively more often 'invisible' traits (e.g. size at birth, mothering ability, lamb survival…), as their continuous exposure to the animals had allowed them to get to know these for their individual animals. Finally, for the group animal ranking experiments the participating farmers within one community were subdivided into two groups and asked to rank each other's animals. This exercise allowed the scientists to identify over 20 morphological traits and their relation to the 'invisible' traits provided by the animals' life history. Overall, through the use of these tools the scientists obtained between 16 and 20 desirable sheep traits depending on the exercise, as well as their relative degree of preference. Through these exercises 120 diverse households were thus boiled down to a single community having a small set of shared trait preferences. By the nature of these exercises the farmers' part in this performance was that of relatively passive information providers to a pre-established data collection system. Once the preferences had thus been obtained, the next step was to translate these into a specific breeding plan which would guide the community's future breeding efforts.

Development and choice of breeding scenarios

To do so, the identified breeding traits had to be adapted to the requirements of the ZPlan breeding software and of the possibilities of on-farm data collection. As the breeding programme was to be based on the selection of rams, and in order to have a manageable number of traits to select for, the scientists trimmed the 16 to 20 traits they had obtained through the trait identification exercises down to three. These were the yearling weight,[138] the number of lambs weaned by the mother combined with lamb survival, as well as the weight of the yearling's greasy fleece. These were chosen based on a weighed statistical analysis of the outcomes of the different preference determination tools, choosing those traits that could be quantified and easily measured under smallholder farming conditions. Traits such as colour or tail size - while deemed important by the farmers - were not included in the simulation, as those could not be integrated into ZPlan. The economic valuation of the sheep turned out to be more difficult to integrate, however, given how 'cultural' traits play a determining role,[139] price is based on negotiation between buyer and seller, and prices are less stable than in the livestock markets for which ZPlan had initially been designed. Nevertheless, using a number of assumptions and approximations, and armed with the three traits and the population parameters, the PhD-students went about and used the software to generate a total of 18 breeding scenarios.

What these scenarios were meant to do was give the farmer community an orientation and a promise in time: if rams were selected according to the criteria set out in a given scenario, then after some time a certain effect would be achieved on the sheep population as a whole. However, in order to adhere to the tenets of participation and the active involvement of farmers, the choice of which scenario to aim for was again to be left up to the farmer community. Here, too, the idea of the workshops was that by giving farmers a choice on which breeding plan to implement, the scientists could ensure that this plan would fit their possibilities and limitations. An initial choice was made by the scientists, however. In order to not overburden the farmers with options, the PhD students chose four scenarios from the 18 which would be presented to them. These were based on two distinct criteria: a ram selection pressure of 10% or of 15%,[140] as well as 2 or 3 years of ram usage, with the combination of both criteria resulting in four alternatives. Overall, thus, the scientists and ZPlan were the actual architects of these scenarios, and the farmers were to be provided with simplified versions whose reliability from the point of view of the farmers was purely based on the trust they had in the scientists' capabilities.

The four alternatives were presented to the farmers during a subsequent field visit by the scientists to the communities. In both Mehal Meda and Molale the participating farmers were called together in a classroom at the Bureau of Agriculture (Figure 41), with the farmers sitting in the benches and the scientists standing/sitting in front. The project manager then held a presentation to the farmers in which he re-stated the purpose of the research project and explained the idea and underlying logic of the breeding scenarios to the farmers. Then the four alternatives were projected on a wall using PowerPoint, showing both the different criteria and their respective outcomes in terms of genetic gain of the three traits. After the explanations and the farmers' questions, one scenario was chosen by the farmers through a show of hands. In both Mehal Meda and Molale the choice fell unanimously on the option with a 10% selection pressure and the use of the rams for a duration of 2 years, as this meant

[138] Weight of the ram at one year of age.
[139] E.g. colour, with for instance black sheep fetching a much lower price than red-brown or white ones.
[140] Note that there was disagreement among the scientists as to whether this was a suitable criterion. Some argued that it would be better to have the selection pressure be based on the total number of rams needed to serve all ewes.

the highest selection pressure and thus also the fastest and highest genetic - and corresponding monetary - gain.[141] (Figure 42).

Figure 41 – Scientists arriving at the Bureau of Agriculture

A number of things happened during this scenario selection workshop that are worth describing in detail. First, underpinning this workshop and the subsequent selection workshops was the scientists' understanding that they should create an 'enabling environment' in which 'the community' could interact openly with them. The assumption was that such an open interaction and dialogue would create trust and commitment on behalf of the farmers, and ultimately result in the farmers taking over the ownership of the whole breeding process. This was later also highlighted in the guideline that the scientists wrote, where they emphasised the need for 'soft skills' among both the community and the technical staff supporting the breeding process. These workshops were, in other words, a key moment of 'selling' community-based breeding to the farmers, of enrolling them into the breeding network that the scientists wanted to set up. However, these workshops were the only occasion in which the farmer 'community' as such actually took a physical shape. Given how the selection of participating farmers was guided by criteria set beforehand by the scientists, this 'community' was not a reflection of the farmers' social networks and relations, but was constructed in response to the needs of community-based breeding. Outside of the workshops the group of farmers would never come together in this form. In addition, due to the classical format of this and subsequent workshops, in which agenda-setting and facilitation was the exclusive responsibility of the scientists, they positioned themselves as the keystone of the enactment of this community. While the future vision of community-based breeding was that the farmers were to lead the process, they were essentially being led.

Figure 42 – Selection of the scenario

Second, specific to the scenario-selection was the underlying assumption that through them the 'community' would understand, choose and accept a certain way of viewing and managing their sheep. Up to this point, while the chosen traits may have had an effect on an animal's price, they did not influence a farmer's breeding decisions, as most farmers didn't

[141] This option was actually chosen in all communities in 3 regions out of 4. Only the pastoralists of Afar chose an option whereby they kept the rams for 3 years instead of 2, as this was their usual management practice.

practice any breeding as such.[142] Now however through the scenarios and breeding plans specific traits were to become the main criteria according to which some rams were to be kept and others castrated, fattened and sold. Thus, the chosen scenario and corresponding breeding plan was to act as a kind of 'social/epistemic glue' (Sismondo, 1999) through which scientific breeding theory and farming practice were to be joined. A software-based document and its inherent promise became the element through which the farmers' diverse practices were to be held together and co-ordinated.


Figure 43 – Enumerator weighing an ewe

In this process the choice of the individual farmer was relatively limited. What the scientists did was provide an 'invited space' for farmer participation (Cornwall, 2008). During the workshop the farmers sat and listened while the scientists gave their presentation, followed by a session of questions (by the farmers) and answers (by the scientists). Then the choice the scientists gave to the farmers was to opt for a specific scenario through a show of hands. The approach as such was not put to question, or if it was[143], any farmer being unwilling to adhere to it would probably have as only option to leave the research project and any support that it might provide.

The fact that the farmers' choice almost unanimously fell on the scenario promising the fastest and highest monetary gain may not necessarily have meant that the participating farmers truly understood the concept of selective breeding underpinning that scenario. Instead, it could also have been a reflection of their trust in the scientists and their interest in maximising their economic gain. Nevertheless, the scientists' understanding by the end of the workshop was that the farmers had committed themselves to implementing the breeding plan and where in principle willing to adhere to it. The next steps to be undertaken by them were to translate it into practice.

Setting up a Recording System by Turning Sheep Into Numbers

For the scientists, a successful implementation of the breeding plan largely relied on an accurate and efficient recording system as well as the ongoing motivation of the farmers. A few days after the scenarios had been chosen, the scientists from ILRI, Boku and ICARDA met at the ILRI campus in Addis Abeba and set up a so-called recording framework. Their aim was to make it into something that was easy to implement and use under smallholder conditions, and didn't require too much precision work. Based on the traits that had been selected, they decided for the recording system to include measuring rams' weight at birth, weaning and yearling age, the number of lambs born and weaned for their ewes and the rams' greasy fleece yields at yearling age.

142 According to the study done by the MSc-student for instance only about 20% of the farmers mentioned that they'd castrate a ram to prevent unnecessary mating. Most mating was uncontrolled, as flocks would intermingle e.g. during joing grazing on communal grazing land, making effective selection very difficult.
143 As there was no translator specifically available to me, I was not able to follow in detail the discussion that took place between the farmers and the (Ethiopian) scientists.

The measurements were to be done by the enumerators who had already been hired at the time of tagging, i.e. people from among the farmers of the communities (Figure 43). They were a key element of the recording system that the scientists set up. In Mehal Meda this was to become a 20 year old farmer's son who had already been performing the job for DBRC in their previous cross-breeding project. In Molale another 20 year old farmer's son was hired, together with two assistants due to the longer walking distances between farms. All enumerators had several years of formal education, and upon being appointed for the task received additional training through DBRC. Through the research project they were given a monthly salary, roughly equivalent to that of a daily labourer. In return they were to function as the linkage between the farmers and the scientists, informing the scientists by phone about any disease outbreaks,[144] and the farmers about any upcoming events and/or visits by the scientists. Their main task however was to monitor the sheep population on an ongoing basis. They would make a daily tour of their community, paying personal visits to the flocks of those households were lambs had been born. There (either at the home or in the pastures) they would weigh the lamb with a hand scale and provide it with a tag. Additional measurements of the rams (at 6 months and yearling age) were done in an enclosure that had been built for the purpose of the project in one of the communal grazing areas. The owners of these rams were asked to bring their animals there on specific measurement days in order to be weighed.

Figure 44 – Farmers waiting for the workshop to start

In each community, the measurements would be recorded in one 'big book' kept and managed by the enumerator(s), while each participating household would have a small booklet with information about the animals in their own flock. The idea behind the latter was that having their own recording book might help farmers in understanding the role and value of recording as a tool in animal selection, and thus further increase their commitment to the breeding approach. While many of the participating farmers were illiterate, the assumption was that their - usually literate - children would help them make sense out of the data. The records from the 'big book' were collected by scientists or technical assistants from DBRC who came to the communities on their fortnightly follow-up visits. Back at the centre the data was fed into an Excel-sheet and sent via e-mail to the scientists from Boku, ILRI and ICARDA. The sheep were thus condensed into numbers which were made mobile and through which the scientists could make an initial ram selection at a distance from a university in Austria. A key step in selection was in this way delegated to the recording system including the enumerators, their scales and record books as well as the scientists and their computers.

[144] As there was no mobile coverage yet during most of the duration of the CBBP, this had to be done via a landline in town.

Selecting Rams

Selecting the best rams from a distance based on numbers alone was however only a first step. The next step was to anchor this selection within the community. This was the role of the so-called Selection workshops. Throughout the lifetime of the project a total of three such workshops were held under the guidance of the scientists from Boku, ILRI and ICARDA. The long-term plan was that they should continue to be implemented by DBRC afterwards, on a basis of two workshops per year. During two of the three workshops[145] the scientists from Boku, ILRI and ICARDA were also present, the remaining one being implemented by the PhD students from Boku and scientists from DBRC.

A few days before the Selection workshop was to take place the farmers were usually informed about the arrival of the scientists via the enumerator(s)[146], and were asked to gather at the enclosure on a specific date and time for a 2-day workshop, together with a number of sheep from their flocks that had previously been identified by the scientists and the records as being among the best. The scientists from ICARDA, ILRI and Boku then first drove to the town of Mehal Meda on the afternoon of the day before the workshop to be held with the farmers there. They met up there with the scientists from DBRC in the hotel where they were staying. During dinner the last practical arrangements and discussions would then take place regarding the implementation of the workshop the next day.

Figure 45 – The farmers' selection committee at work

On the morning of the following day all scientists would drive by car to the meeting place at the enclosure, where most of the farmers would already be waiting for them (Figure 44). The farmers were expected to bring those sheep that had been designated by the scientists beforehand. After some additional waiting,[147] the scientists together with the enumerator would begin by finding and setting aside those rams that had been selected on the basis of their records. Two screenings would be performed, one for rams of 6 months age, and another - final - one at yearling age. Once all rams had been found and set aside, they would ask the so-called 'committee' to take over. Each community had been asked to designate such a committee, consisting of three farmers[148] selected by all farmers participating in the project, based on their reputation and experience. This committee was then tasked to make a final selection from among the rams selected through the written records (Figure 45). The idea behind this approach was that this

[145] Both of which I attended.
[146] On one occasion they were visited by one of the PhD students a few weeks before the workshop was to take place.
[147] While a specific time was usually fixed, neither the farmers nor the scientists fully adhered to it.
[148] In the three workshops that I observed these had always all been male, which may be a reflection of the men's authority among the Menzei. After all, the care of the sheep was mostly the responsibility of the women.

was the moment where the farmers' 'cultural', non-quantifiable aspects such as colour, tail type/size could come into play, which had not been captured by the recording system before, thus further anchoring the breeding system in the farmers' context. The committee would also be asked to select additional 'good' animals, which would then receive a prize the next day.

Figure 46 – Scientist discussing workshop results with the farmers

During the first part of the selection workshops the scientists mostly interacted with the enumerator and the farmer committee. Once the selections had been made the day would be closed by a discussion in a classical format (Figure 46). During this discussion all farmers sat and listened, while the project manager explained the different steps that had been taken, and facilitated any decision had to be taken or procedure that had to be approved by the farmers through a show of hands. This scientist eloquently described the procedures and on several occasions managed to raise the enthusiasm of the participating farmers and even regularly drawing some laughs. Ultimately however as with the scenario selection workshop control and facilitation of the workshop was in the scientists' hands. The agreements they obtained from the farmers were not anchored in an institution or social network that existed beyond the duration of the workshop, and it was eventually left to the individual farmer to see in how far s/he would (be able to) adhere to them.

Figure 47 – Sheep feeding on crop residues

Once the day was thus closed the farmers would go home, while the scientists returned to their hotel for a further evening of informal chatting, sharing of thoughts about the day and talks about the programme. The next day farmers and scientists would meet again at the enclosure, and prizes would be distributed to the farmers with the best animals (a process that will be described more in detail later). The team of scientists would then drive to the town of Molale, where the same workshop was repeated.

Controlling Farmers Through Contracts and Sheep Through Castration

The output of the selection workshop was a number of rams who were identified as breeding rams, and who were the only ones meant to mate with the ewes. Ensuring that this would indeed happen was made particularly difficult as mating was usually uncontrolled, with sheep from different flocks intermingling with each other during the period where they were allowed to feed on the stubbles of recently harvested fields (Figure 47), or when they were jointly grazing in the communal grazing areas. Castrating the deselected rams was the only option to ensure that their genotype would eventually be removed from the sheep population and that only the selected ones would procreate. The scientists themselves did not do this, however, instead asking those farmers whose animals had not been selected to castrate them after the two years agreed upon during the scenario selection workshop.

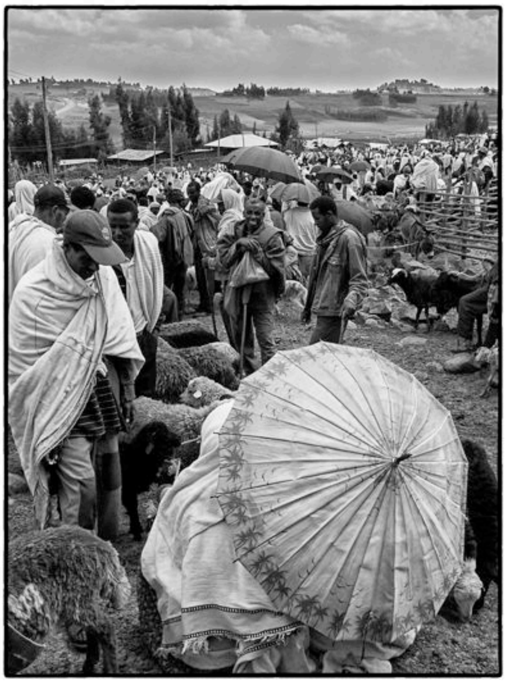

Figure 48 – Livestock market

These selected rams were to be shared among all participating farmers. The principle - developed during DBRC's previous cross-breeding programme - was that farmers using the same communal grazing area were formed into a group that would share one or more rams. These rams would be rotated among the groups' farmers. However, at any time one member of the group would be allowed to borrow a ram for a day or two from the member currently keeping it. At regular intervals - determined by the scientists from DBRC and co-ordinated by the enumerators - the rams would be exchanged between the groups in order to prevent the occurrence of inbreeding.

This meant however that the initial owner of the ram had to be willing to share it with the whole community. Based on the idea of one ICARDA scientist that came up in a discussion during the long car-drives, the scientists took the decision that the selected rams were to be bought by the programme and 'given' to the whole community. Once a ram had finished serving it would be sold on the market (Figure 48), and the money thus earned would become a so-called 'revolving fund' through which a new batch of breeding rams would be bought from their respective owners. Once these would be sold the money earned would fill-up the fund again for another round of purchasing and sale, and so on providing the community with a mechanism with which to maintain a population of breeding rams. For the duration of the project at least, this revolving fund was however to be managed by the scientists.

This idea was discussed in public with the community during the first selection workshop. In both Mehal Meda and Molale the participating farmers agreed, including with the suggestion that the price for the animals should be set by their respective committee, based on their estimate of current market prices.[149] The rams' owners later signed a contract with DBRC, stipulating that they handed over their rams to the community in return for the payment, and agreed to them being shared among all participants (Figure 49). Thus as with the planning and facilitation of the workshops, the scientists again positioned themselves - and in this case

[149] The scientists later told me that they actually added a bit to the price initially suggested by the committee.

their funds - as a keystone in the implementation of ram-sharing. Motivating the farmers to share their selected rams was not any more the task of the breeding plan and its promise of better animals in the future, but of the scientist-managed revolving fund through the sale of their ram in the here-and-now.

Motivating Farmers and Stabilising the Network

Figure 49 – Scientists signing a contract with the owner of a selected ram

By then all mechanisms for enacting selective breeding with a farmer community were in place: the farmers' livelihood had been mapped, traits and breeding plans had been determined, the sheep population was set up and selection and mating control mechanisms were in place. The scientists were still the main driving force behind this whole process, and their challenge now was to keep this network functioning over time by keeping both farmers and sheep enrolled, ideally even beyond the 4-year duration of their research project.

Figure 50 – Farmer inspecting his hay

To do so, the scientists viewed the mindset of the farmers as a crucial element. A key concept underpinning selective breeding - and accordingly also community-based breeding - is the 'breeding-mindset' as such. It refers to a farmer's active and systematic selection of animals and control of their mating behaviour in order to achieve pre-defined targets for their genetic improvement. Animal scientists differentiate farmers between users (using animals for purely exploitative reasons), keepers (applying basic husbandry practices), producers (supplying additional inputs to improve production) and breeders (carrying out integrated herd management focusing on disease control, feeding and reproduction) (Neidhardt, Grell, Schrecke, & Jakob, 1996). Within this framework, Menzei could arguably be viewed as users/keepers, as they were moving from a system where sheep were basically left to scavenge for themselves towards a system whereby basic health-care and additional fodder were provided for (Figure 50). The scientists' aim was to have them become 'breeders', however, by having them apply/helping them in applying more advanced animal husbandry practices in health and nutrition, but most of all by ensuring the controlled mating behaviour of their sheep. One Austrian scientist was especially keen on this issue, mentioning on several occasions how he was looking for signs - a kind of 'feel' - that the farmers were indeed beginning to think in terms of breeding objectives and on how to achieve these.

The team of scientists was aware that having the farmers become breeders was no easy endeavour. During the workshops they repeatedly emphasised to the farmers that breeding was a long-term endeavour, and that it might take years before results became visible. Accordingly, the trainings and treatments were not only seen as a means to keep the sheep population healthy and comparable. They were also a way to provide the farmers with short-term results and hence motivate them to stay involved in the process, as well as to provide them with the knowledge and practice required to manage their sheep in such a way that it remained possible to identify differences between the sheep in the population based on their genotype rather than on environmental conditions or differences in management. In addition to this, and as a result of the study on sheep marketing made by one of the MSc-students they also proposed the farmers to help them organise themselves into a sheep marketing co-operative. This was viewed as an important step towards organising the farmers into a structure that was more than a group of farmers held together by workshops and a breeding plan. However, ultimately this idea was not realised during the duration of the programme due to a lack of resources and time.

Nevertheless, this idea to not only focus on breeding, but also address issues of health, nutrition and marketing was understood by the scientists as community-based breeding's 'holistic' approach and a key element of motivating farmers and of anchoring the approach in their livelihood. The overall focus of the research project was however still strongly oriented towards breeding due to the set-up of the team of scientists who had both written the project proposal and were ensuring its implementation. The team consisted exclusively of animal breeders, with scientists from other disciplines only being tasked to contribute with some aspects of the training or the supervision of some of the MSc-students. This might have had institutional reasons: in DBRC for instance one scientist told that it was unusual for scientists in the centre to work across disciplines. As a a result however their community-based breeding approach was 'holistic' only in the sense that other disciplines and dimensions of the farmers' livelihood were enrolled to support the breeding effort. They did however not have an equally shaping and transformative role. For institutional reasons the knowledge and practices performed through the research project - its underlying ways of knowing - were thus focused on a relatively small - albeit arguably increasingly important - aspect of the farmers' livelihood.

Maintaining contact with the farmers over time was also viewed as a key element in keeping up the farmers' motivation. Every 14 days technical assistants from DBRC - on occasion together with one of the DBRC scientists - would drive to both Mehal Meda and Molale to follow up on the breeding activities and check the health of the flocks. In these cases they mostly interacted with the 'champions', i.e. those farmers who had either been identified by the Bureau of Agriculture or by the scientists themselves as being most interested in and responsive to new technologies introduced to them[150]. The scientists' hope was that by providing them with ad hoc advice and making sure that they implemented all the techniques

[150] The choice of 'champions' was partly also the result of the personal preference and affinity of the scientists for such people, given the interest that these farmers showed in what the scientists were doing. Last but not least, practical considerations also played a role, in that most of these farmers usually lived close to roads, and were as such easier to reach. For farmers that lived further away it was more difficult to establish such closer ties and interact directly with the scientists.

Figure 51 – Prize-winning ram

advocated by the trainings these were to become the 'model' to which other farmers would aspire.[151]

An additional attempt at motivating farmers and thus stabilising the breeding network was based on the idea of one Austrian scientist. Drawing inspiration from the livestock competitions and shows that are common practice in Austria and the industrialised world, he suggested to have a similar competition for the participating farmers. The best rams and ewes would thus be offered a prize - basically a small rosette - handed out during a ceremony following the ram selection (Figure 51). The idea underpinning this measure was that in this way a 'spirit of competition' could be instilled in the participating farmers, as - in the words of one of the scientists - 'breeding *is* about competition'. An additional signal that the scientists hoped to send was that highly performing animals were more valuable if used for breeding than if they were directly sold on the market. The animals themselves were chosen during the workshop by the farmer committee, with the best 3 rams and ewes in different age ranges being awarded a prize. The rosettes were then handed over to the respective animals' owners, with one farmer from the committee explaining the reasons for their choice. In addition, all participating farmers nominated one farmer who was seen as being the best farmer among them, and this farmer, too, would be handed over an in-kind prize. The first time this prize even had a pedagogical function: it was a metal castration pincher, meant to highlight the importance of castrating the unselected rams.[152]

Overall thus by their discipline and the focus of their research project, as well as through their trainings, competitions and promises of a future co-operative the scientists aimed for a long-term change of minds of the farmers by having them become breeders rather than mere users of sheep. This would require more from the farmers than just adopting a number of tricks and practices, instead demanding a whole new way of enacting sheep and of organising their livelihood around them. How this eventually worked out in the course of the research project is the subject of the next section.

7.2.7. The Farmers' Perspective

Thus far the focus of the description had been on the scientists' efforts in setting up and trying to stabilise a network through which to 'test' community-based breeding in a rural Ethiopian setting. This network carried the inscriptions of specific values regarding animal management and breeding, as well as of specific roles that scientists and especially farmers - the imagined, final 'users' of community-based breeding - were supposed to take up in it. As Akrich points out (Akrich, 1992), the inscriptions of a given technology are by default always de-scribed by its intended users. While these de-scriptions might at times fit the template of the inscriptions and thus the expectations of the designers - in this case the scientists - more

[151] The use of 'model farmers' is common practice in the Ethiopian agricultural extension service.
[152] The traditional castration practice of the Menzei is to crush a ram's testicles by using stones.

often than not there are discrepancies. The latter was also the case in the research project, as the farmers did not fully adhere to the role intended for them. In order to understand the rationale behind this, some additional information on the farmers' livelihood will first be required.

Farmers Stabilising Their Livelihood

As was described earlier the Menzei are to a large extent subsistence farmers, i.e. the majority of their farm produce is used for home consumption. They have a mixed crop-livestock system, growing cereals and vegetables and keeping livestock such as cattle, sheep and poultry for home consumption, traction power and sale. While their farming system as such had been relatively stable and productive for centuries (McCann, 1995), the recent decades have brought with them a change in the rainfall patterns that has upset their crop production. The Belg rains in February and March used to be the time when their main crop would grow, but in recent years these have become increasingly erratic. Many crops were lost due to drought. Even a shift to the Mehal rainy season in July-August often did not help, as the crops thus sown were often destroyed by the frosts that regularly occur in October. Their sheep, too, are not protected from natural disasters. Disease outbreaks do occur regularly, as on one occasion where the mother of a key informant lost a large number of her sheep in a sudden outbreak. While their indigenous breed is well adapted to living under scarce resources, increased population pressure has led to a decreased amount of pastures available for feeding. Thus, overall many Menzei are not any more able to sustain themselves from their production alone, and are dependent on external food aid for their survival.

Figure 52 – Farmers helping each-other with house-building

The political context, too, has a history of sudden shifts and changing fortunes. Many of the farmers from middle- to older age still remember the Villagisation Programme under the Derg regime. Using the 1983-1985 famine as a pretext, many Menzei were forcibly relocated to the south in order to live in socialism-inspired collective villages. They were only able to return to their homeland after the Derg's overthrow in 1991. Even today however the political climate is tense. This is most vividly exemplified by the crackdown on the government opposition in 2005, and the generally strict policy of the ruling party against all critical voices. For farmers, staying on good terms with the ruling party-structures at municipality-level is therefore a necessity.

In order to eke out a living in such a relatively volatile and uncertain environment, the Menzei draw on a range of assets that they have at their disposal. To begin with, they are known for their strong cultural identity, drawing pride from their strict religious faith which helps them endure and give meaning to their predicaments (Levine, 1965). They are also all embedded in a range of social networks such as Iddir,[153] Debo[154] and Wenfel,[155] through which they provide and obtain mutual support (Figure 52). Their production, too, is not dependent on one asset alone, but is characterised by a diversity of sources of production and income. In addition to growing cereals such as barley and wheat, the Menzei will keep either permanent or seasonal plots of land on which they grow vegetables.[156] All farmers will keep either a few trees or a whole grove of eucalyptus, cutting them after a few years either to be used for construction material or fuelwood or to be sold (Figure 53). Those farmers with dairy cows will produce butter that they will sell to traders on the market. Some farmers told of buying grain on one market and reselling it at another market further away at a profit. Others would collect the wool from their sheep and weave cloths out of it, or sell it on the market. One farmer told of his ambitions to become a part-time tailor, while another household had both husband and wife working part-time as clerks at the Bureau of Agriculture. Last but not least, a majority of farmers[157] would participate in food-for-work programmes, building erosion protection structures in return for food aid.


Figure 53 – Transporting eucalyptus trunks to the market

Thus, if one views a farmer's livelihood as an actor-network that the farmer strives to stabilise, then the aspects mentioned above illustrate how this is a matter of balancing a large number of actors and corresponding linkages and associations. How a farmer choses to do this varies from individual to individual. In the words of some of the farmers interviewed, they told how some farmers were 'strong' and others 'weak'. The former were known to actively strive to improve or stabilise their production, and/or had sufficient resources (land, livestock…) to fall back upon. Others were either very poor, in some cases even landless, or were - according to some of their neighbours - made 'lazy' by their dependency on food aid. A general trend that could be seen, however - and one that is overall quite widespread among smallholder farmers (Dixon, Gulliver, & Gibbon, 2001) - was to diversify their sources of income in order to reduce the risks they were exposed to within their volatile environment.

[153] A form of network found throughout rural and urban Ethiopia. Members support each other in e.g. organising and financing important family events or lending members money in times of need. In Mehal Meda it was also told to be a platform to resolve disputes between members.
[154] A working arrangement by which farmers help each other with labour intensive tasks e.g. while ploughing, weeding, harvesting or home construction in return for food and drinks.
[155] Similar to Debo, however for less time-intensive tasks.
[156] Only farmers with a year-round supply of water are able to grow vegetables on a permanent basis.
[157] More in Mehal Meda than in Molale, due to the former's more erratic rains and hence lower average crop yield.

Sheep as Cash Reserve

Figure 54 – Farmer having his ram treated at the veterinary station

One important part of their livelihood-network are sheep. In the past - still close enough in time for some of the older farmers that were interviewed to remember - sheep were an important source of meat and wool (see also Levine, 1965). At the same time they were - and still are today for many smallholder farmers - an important form of savings, in that by selling one or more on the market they could quickly obtain cash whenever there was a need for it. In other words, they were used as multifunctional animals (Bayer, Lossau, & Feldmann, 2001) fulfilling a number of roles in the maintenance of the Menzei's livelihood. However, according to these same farmers, up to recently not much effort was put in managing them. Sheep were left to graze and scavenge on pastures or crop residues, without any particular effort being put in improving their fodder-supply. Nor was much effort put in treating sick animals. What mattered was to have large flocks, probably as a means to have safety in numbers, so that even if some died or were lost, there were still enough to fall back upon.

Figure 55 – Bush used as fodder-crop for the sheep

With erratic rains and decreasing crop yields things changed, however, and sheep became an increasingly important source of income. Consequently farmers are generally trying to improve their animal husbandry practices in order to maintain their flock alive and healthy. Some farmers for instance highlighted how they would now bring even small lambs that became sick to the veterinary station in town, when before they might just have let them die (Figure 54). And while knowledge about the functioning of drugs is generally limited,[158] their importance is acknowledged. Several farmers also expressed a growing interest in e.g. fodder crops, in some cases to be grown on their fields, in others kept as bushes close to their homes (Figure 55).

[158] A deworming drug is for instance known as 'fertiliser' among the farmers, due to the animals significantly gaining weight again once the parasites have been killed. Another illustration (from Ambo Ber close to Gondar) was when a farmer asked the wife of a Development Agent (DA) to provide her with drugs for her chicken. The DA's wife didn't have any drugs for chicken at hand, and so took a drug meant for cattle, crushed it and gave a small portion to the farmer. On my question whether the drugs might turn out not to be suited for poultry she replied 'Why not? Drugs are drugs…'

This growing importance of sheep notwithstanding, they are still predominantly seen by the Menzei as a means of production - in contrast to e.g. the Bahima's view of cattle as contributing to their cultural identity. This is reflected in the farmers' knowledge of their animals. For instance, as opposed to the Bahima's complex system of naming cattle, sheep are not given individual names. Instead, they are identified by their colour, a method that - according to some farmers - may lead to some confusion if two sheep look almost identical. Similarly, while some farmers have been exposed to 'foreign'[159] breeds - such as the Awassi-Menz cross-breeds brought by DBRC to Mehal Meda, or sheep from Afar or Wollo that are sometimes traded in the towns' markets - there is no clear distinction between breeds or ability to estimate degrees of crossing[160] as could be found among the Bahima. One DBRC scientist for instance told of one farmer visiting the research centre, where he was shown the centre's well-fed Menz-sheep. To the scientist's surprise the farmer assumed that this sheep was of a 'foreign' breed, and asked whether he could be given a ram.

In addition there is no tradition of targeted breeding. Rams will for instance only be castrated after they have reached sexual maturity, meaning that even rams with undesired traits can mate with ewes. Similarly, for many farmers inbreeding is not seen as a problem (as one farmer said: 'Why not? They're animals…'). Last but not least, many of the interviewed farmers said that they would usually sell off their best animals first in order to obtain the highest possible price on the market. While some farmers did e.g. keep a ram with desirable traits for a longer period of time, these were in the minority. A contributing factor to their lack of interest in breeding is their system of keeping animals on communal grazing areas and watering points, and of letting them scavenge crop residues. While such a system takes advantage of the limited fodder resources available, it does not enable any control of the animals' mating behaviour.

The Menzei's relatively limited knowledge about their sheep and their generally low effort in controlling the mating behaviour of their animals can to a large extent be explained by the role attributed to sheep in their livelihood. As Owen highlights (Owen, 2005), smallholder farmers in developing countries usually use sheep as a kind of *cash reserve*, enabling them to quickly obtain money when needed. They require only small investments both in terms of labour - in most cases the sheep will be guarded by small children - and inputs, have short production cycles and are usually well adapted to the environment they live in. Due to this, keeping them entails a relatively low risk (as opposed to e.g. keeping dairy cattle), and provides an excellent asset to face emergencies and thus stabilise one's livelihood.[161] Most animals will eventually be sold in return for cash, with which the farmers can cover expenses such as school fees, taxes and the purchase of appliances or food. Shearing and the sale of wool provides an additional source of income. The home slaughter and consumption of sheep however occurs only on rare and special occasions, such as religious festivities.

With this role of sheep in mind, it becomes clear that the adoption of community-based breeding would require a different enactment of sheep on behalf of the farmers, including a different approach to their management. From being relatively easy-to-maintain 'cash dispensers' that can be sold in case of need, specific sheep would have to become breeding assets that have to be kept over much longer periods of time, and a significant amount of

[159] A term used by some farmers to designate animals that were not 'their own', i.e. Menz-sheep.
[160] Farmers are however able to estimate to some extent the heritability of certain traits.
[161] 'In case of an emergency' - e.g. disease of a relative, purchase of food as a result of crop failure - was usually one of the first reasons given by farmers on the question why they would sell one of their sheep.

effort would have to be put in managing and caring for them. This would entail a lowering of the farmers' flexibility to respond to emergencies by selling a sheep: selected rams would have to be kept, unselected ones would have to be castrated and sold. From the perspective of the individual farmer, the potential future gain through better animals thus has to be contrasted with a potential decrease in flexibility in being able to respond to cash-needs and emergencies, and thus a corresponding increase in vulnerability. While this may not be such a problem for farmers with large flocks, it may be for farmers with smaller numbers. It is such considerations that may help in understanding the farmers' response to the project.

The Farmers' Actual Project Participation

Before describing the farmers' response to the project, it should be highlighted again that as opposed to the Bahima, where in-depth insight into their ways of knowing regarding cattle and their interactions with the researchers was possible, the data obtained in Ethiopia was less detailed. Most farmers that I interacted with perceived me as being part of the scientists' team, which may have coloured their responses. Nevertheless, through observation and interaction I could obtain a general impression of the farmers' perception of the project and of its benefits for them.

For most farmers, the most frequent exposure to the research project was through the work of the enumerator. Whenever a lamb was born they would inform him and he (or one of his assistants in the case of Molale) would come and measure the newborn and its mother. They would also bring their tagged animals to the sheep enclosure at regular intervals for further weighing. The farmers' interest in these activities was however very limited. Most of them mentioned that they never looked at the little booklet given to them in which these measurements were kept.[162] Some couldn't, as they were illiterate,[163] but others apparently saw no benefit in doing so. Thus, in general measurements and recording were seen by most farmers as something that the scientists wanted to have done, and which they were willing to put up with.

While recording was easy enough for the farmers to accept, the selection of rams was the moment in which the different enactments - breeding asset vs. cash dispenser - clashed. As a consequence, while the first workshops went relatively well,[164] the outcome of the third was below expectations from the scientists' point of view. The first apparent sign for this was in the participation of the farmers. In Mehal Meda they were unusually late in turning up. In Molale they initially didn't turn up at all, as they were attending a government meeting to which they had been called, and for which they had paid a fee in return for a lunch which they didn't want to miss. When it came to selection, the scientists had selected 30 rams in Mehal Meda based on the records from which the future breeding rams were to be chosen. Only 6 of them were brought to the workshop, however. The owners of the missing ones replied that their animals had either been sold or died. The situation was similar in Molale, where out of 60 sheep that had been selected by the scientists only 18 were provided by the

[162] Those who did mention looking at it may have said so because they perceived me as part of the team of scientists.

[163] While schooling has become compulsory for all children, conditions in rural areas are far from ensuring that actual education does indeed take place. The curricula are made for urban conditions, in which children are able to attend school morning and afternoon throughout the week. As rural children are needed for a range of farming tasks - including guarding sheep - they usually only attend morning or afternoon classes on some days of the week. Consequently one may find children who even after several years of schooling are not able to read or write.

[164] Of these I was only able to attend the first in February 2010. According to the PhD students, the second in June 2010 also went as planned.

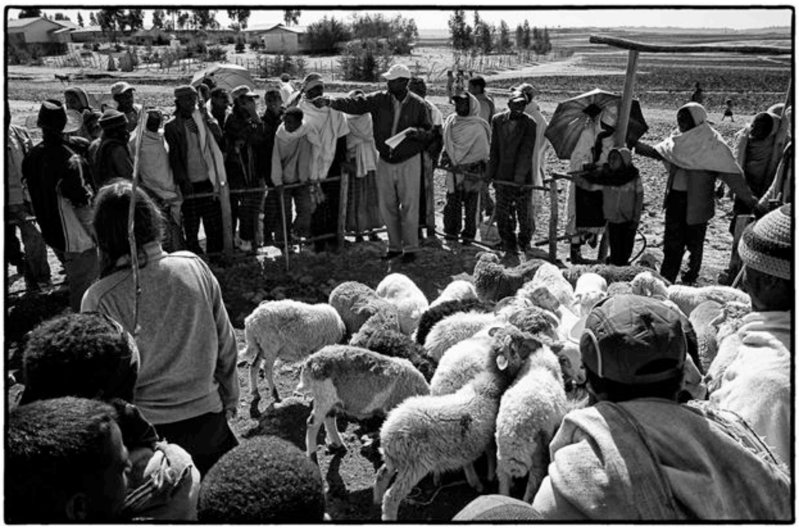
Figure 56 – Only relatively few of the selected rams were brought to the project's final workshop

farmers (Figure 56). But even the selection itself caused problems. For instance, one ram that had been selected turned out not to belong to the farmer who had brought it to the workshop. Instead, it was part of a ribi-scheme[165], and he was unwilling to commit it to the project without consulting with its owner. Similarly, during the discussion afterward one farmer voiced his displeasure with the previous selection, saying that the rams that had been selected were not good enough. He had consequently refused to castrate his rams as was requested. Others complained that the prices paid for the selected rams during the previous workshop had been too low. Yet others finally were also not willing to commit their animals, as they had been sent as deputies to the workshops while the animals' owners were selling goods on the market that day. All in all, the general impression was that the project farmers were not displaying the commitment and discipline that was needed to effectively implement a breeding scheme as envisioned by the scientists.

A Positive Perception

This behaviour stood in stark contrast to their overall attitude towards the project as they told during the interviews. Without any exception they all were very positive about their participation in it. The scientists were equally seen in a positive light, as - in the words of one farmer - 'they are here to help us'.[166] This help was however not so much understood as bringing the benefits of selective breeding to the farmers. The reason for their positive response were instead the free treatments of the animals as well as the training and advice that the scientists provided. Project farmers knew that when there would be a disease outbreak they could to a large extent rely on the technical advisors from DBRC to quickly intervene in order to stop it. Similarly, the trainings were seen by many farmers as a valuable asset in helping them improve their sheep management practice and thus strengthening and stabilising their sheep production. Those farmers with whom the scientists had regular contact also appreciated the informal advice given to them whenever they met, or the fodder grains or crops that they received for free. Similarly many farmers were looking forward to getting help in improving their sheep marketing channels that the scientists had talked about. Up to then most farmers sold their sheep to traders in the markets in Mehal Meda or Molale. As part of their proposal of setting up a breeders' co-operative the scientists had mentioned that the farmers would be able to sell directly to the terminal markets in Addis Abeba, and thus earn a larger share of the transaction. While this idea was not followed up on during the

[165] A scheme whereby one farmer may take care of another farmer's flock, receiving any offspring of this flock in return for his care.
[166] The fact that most of the interviewees perceived me - the interviewer - as being part of the team of scientists may have influenced their assessment of the project. It however also further strengthens the point that they saw it as an asset worth conserving.

lifetime of the project due to a lack of resources, on several occasions farmers would ask me when the scientists would come and help them with this issue.

Another element of the farmers' understanding of the project was ram distribution. In Mehal Meda the farmers had been working previously with DBRC, a collaboration in which they had been given free, cross-bred starter rams that they shared among themselves following a rotation system set up and facilitated by the DBRC-scientists. Based on their experience with DBRC's cross-breeding programme, many participating farmers were still hoping to get new rams, the scientists' frequent claims to the contrary notwithstanding. Interestingly, the situation was no different in Molale. There - probably due to a misunderstanding that the scientists themselves didn't remember - the issue of distributing free seeder rams had been mentioned to the farmers during the very first meeting when the research project was introduced. Years later - and despite the scientists' repeated explanations that rams would have to come from within the community - some farmers were still expecting to be given free rams at some stage, even asking me why the scientists' initial promise had not been kept.

Last but not least, per diems may also have been a contributing factor to some farmers' interest in being part of the project. Introduced in the region by NGOs, these are payments made to farmers in return for their attendance of training activities, as a compensation for their time lost working in the fields. Their payment was a highly controversial issue among the scientists, as they feared that by disbursing them they would send the wrong signals and maintain a certain dependency of the farmers on donations. Nevertheless, out of a fear that many farmers would not attend the trainings they were handed out during those. In the selection workshops however they were replaced by a soda drink and a free lunch.

All in all, the project farmers' main interest in their collaboration with the scientists was to secure training, access to markets and tangible support in the form of free treatments, rams and per diems (for some). The benefits of such support did not go unnoticed by neighbouring farmers not involved in the project. Almost all non-project farmers that were interviewed expressed their interest in joining. In Molale some non-project farmers even attended the selection workshops, using them as a platform to voice their interest in becoming part of it. A non-project farmer was also the only one I met who expressed interest in the enumerators' weighing of the animals. In his words a weighing scale was a better judge of the condition of an animal than his own eyes were, as - in his words - 'the scale never lies'. This interest in the information provided by the scale was however not tied to the possibility for selective breeding. Instead, he hoped that by observing minute changes in weight the scientists would able to assess his health and nutrition practices, and provide him with advice on how to improve them.

Participation in the Project as Securing Patronage

To better understand this discrepancy between the farmers' positive stance towards the project and the unwillingness of many to adhere to its selection process, one should take a look at the way in which the farmers' livestock system had evolved, and how it fits in their wider livelihood. As was described above, most farmers aim to stabilise their livelihood and reduce risk by diversifying their sources of income. A shift to breeding and subjugating themselves to the requirements and discipline of a breeding network would impact their ability to do so, however. Under community-based breeding sheep would have to have a different way of being enacted - i.e. of being viewed and managed - that differed strongly from the way they were traditionally viewed. For the farmers, their primary function was to serve as form of savings with which they could obtain cash, either to respond to emergencies

Figure 57 – The Bureau of Agriculture also occasionally provides health-services; here: government-funded spraying of sheep against parasites

or increasingly as an additional source of income with which to buy e.g. food. Community-based breeding however would require the owners of selected rams to forfeit some of their ability to respond to emergencies, since some of their animals were now to be viewed as *breeding assets* that had to be kept, irrespective of any emergencies or cash-needs of the household. The fact that only a small fraction of the selected rams were actually brought to the last selection workshop may be an indication that for many farmers the discrepancy between the way they used to use their sheep and the requirements of community-based breeding were resolved in favour of the former. Even the contracts they had signed apparently were not a strong enough incentive to do as they had been told.

In addition, saying that the farmers liked the benefit they obtained from ‘the project’ is somewhat misleading. When asked what the word ‘project’ meant, farmers said that it was the term that the scientists used to refer to their work. They themselves did not know what the term exactly implied, however. For the farmers in Mehal Meda - and also for the enumerator - the research project was basically a continuation of DBRC’s cross-breeding programme, with the occasional new scientists - some of them ‘ferenjis’[167] - turning up. Some would refer to the project as the work of ‘Sheno’, the old name for DBRC when it was still located in the town of Sheno. Others would see it as work of the Bureau of Agriculture, i.e. the government (Figure 57). In other words, their collaboration with the scientists was not about participating in the assessment of the performance of cross-breeds or the introduction of a new breeding approach, under a pre-defined timeframe and with specific objectives. Their aim was the establishment or maintenance of a *linkage* with the scientists, a relationship of *patronage* through which they would obtain tangible support, access to networks (as with the access to urban markets through the promised co-operative) and management advice.[168] They accepted the measurement and recording of their animals as well as the participation in the selection workshops as a token to the scientists in order to maintain this relationship with them. In doing so they secured what they were most interested in, namely the treatments, training and management advice. This approach fitted well in their effort to stabilise their livelihood and reduce risk in a volatile environment. After all, by participating in the project they were able to secure and stabilise one of their key assets: their flock of sheep.

The idea of breeding was not lost on all of them. Some farmers did tell how they - as a result of what they had been told by the scientists - tended to sell off the lesser animals first,

[167] Amharic for ‘foreigner’. A term used to refer to whites and Chinese.
[168] Note that for some farmers it may also have been a general deference to the government that may have led them to accept participating in the project. As one scientist from DBRC recalled, he once asked one farmer what his interest was in working with them. The farmer’s reply was ‘Why would I refuse something given to me by the government?’

keeping the better performing ones for breeding purposes. Others however stayed the course and told me how they always sold those animals that would guarantee the highest return. The poor performance during the last selection workshop may be an indication that the latter may have been in the majority.[169]

7.2.8. Small Story Reflections: Constrained Interactions and Limited Room for Manoeuvre

Summing it up, this small story has shown how the translation of community-based breeding into an Ethiopian context in essence boiled down to a process of mutual enrolment by the farmers and the scientists. For the scientists, the aim was to achieve academic success by demonstrating the value of community-based breeding and turning their experiences in implementing it into a manual and a number of scientific publications. To do so they had to enrol a number of actors - from the Austrian Development Agency via Ethiopian ministries and national agricultural research services to the farmers themselves - into the actor-network that was needed to translate the breeding approach into practice. While their initial target was the realisation of a 4-year project, their overall ambitions went beyond this. The idea was to have the farmers become guardians of their local breed, increasing their income while maintaining the breed as genetic resource for future generations on a global scale. The idea of the breeders' co-operative went in this direction, the hope being that this would become the permanent structure through which this guardianship would be maintained.[170] Thus ultimately they viewed breeding as a starting point for a whole business model of which the participating farmers could become a part. One scientist from DBRC - bearing in mind the constraints to crop production in Menz - even envisioned that under government guidance the region could become a 'breeding area' for Menz-rams that could serve to supply other areas with rams for (re)production. The overall idea of the scientists was thus for the farmers to become part of wider breeding and resource-management networks, with all the opportunities and constraints this would entail for them.

In contrast, the farmers' aim was to stabilise and ideally even improve their livelihood in an inherently volatile environment. For the farmers in Mehal Meda, linkages to scientists had existed previously, while for those in Molale they were relatively new. Nevertheless, their corresponding benefits in the form of treatments and trainings - and their results on the participating farmers' sheep - were clear and visible enough for all of them to be interested in making sure that these linkages stayed. The fact that breeding as such did not work as the scientists had intended draws attention to the potential of breeding in the livelihood of subsistence farmers. As one of the scientists pointed out - not considering pastoralist societies such as the Bahima - only a minority of farmers in any given society are 'breeders' in the true sense of the word. They are the ones who have both the interest and the resources to put a targeted effort in realising specific breeding objectives and create premium breeding stock. For the majority - while may consider issues of mating and heritability - instead focus on improving their overall production, improving their herd/flock by introducing premium stock from outside sources. The same may have been the case with the research project. There may have been a few farmers who had both the resources and interest to implement selective breeding as the scientists had intended. Most however were hoping to obtain 'free rams' and keep up their relationship of patronage with the scientists in order to maintain and even

[169] This workshop took place during a short follow-up visit in February 2011. By then I was not able to stay longer in the country to follow up with the farmers on the outcome of the workshop.
[170] The inspiration may have come from DBRC, whose scientists had managed to set up such a co-operative with a group of farmers in South Wollo within the scope of their cross-breeding programme.

improve their flock. Some may have understood the long-term vision that the scientists were aiming for, but its potential apparently did not weigh up against their short-term necessity to stabilise their livelihood in a volatile environment.[171]

The scientists blamed the farmers' unwillingness to fully participate in breeding on their 'lack of awareness'. The previous analysis has shown however that it was rather due to a mismatch between what the scientists imagined the project could achieve and what the farmers were hoping to get out of it. 'Participation', community-based breeding's key ingredient to ensure that the approach would fit into the farmers' context was clearly not sufficient to bring this mismatch to the fore. Reasons for this can be found in the structure and enactment of the actor-network underpinning the research project.

To begin with, the keystone to enabling the project in the first place was ensuring the support of the Austrian Development Agency which eventually funded all activities. Before the funding could be disbursed, the scientists from Boku, ICARDA and ILRI had to submit a complete project proposal delimiting what would be done under which conditions and in which period of time, which had to be adhered to as far as possible during implementation. Geographical distances, differences in Internet access, language barriers and operating procedures meant that discussions were held, ideas developed and key decisions taken predominantly by the scientists from Boku, ILRI and ICARDA. By the time the farmers got involved the technological trajectory of the research project was thus basically 'closed down' (Stirling, 2005), with no real room left for the farmers to shape the approach beyond the limited options that the scientists provided them with.

The actual interaction between farmers and scientists during the different workshops, too, had characteristics that prevented any open discussion. During these, farmers with different assets and abilities were joined into one 'community'. However, as Cornwall highlights, '[l]umped together in a group, the particularities of the interests of 'the poor' become submerged' (Cornwall, 2008). For the 'stronger' farmers with large flocks of sheep it may indeed not have caused too much trouble to share a ram with other farmers, as there would be enough animals left to sell when needed. For farmers with smaller flocks however this might have been more limiting. Selling an ewe instead would have meant losing the ability for the flock to reproduce, after all, whereas there would always be the neighbour's rams on communal pastures to inseminate their ewes. The workshops in which the 'community' took shape and where decisions were discussed and taken may not have been a suitable platform for such weaker farmers to voice their concerns. For cultural[172] and peer pressure reasons they may have rather acquiesced in order to ensure the ongoing support by the scientists, and sticking to their established ways once the scientists had left. In other words, the 'community' as a homogeneous entity and as main interface with the scientists didn't bring differences among the farmers to the fore. It were these differences however that may ultimately have impacted the breeding network to such an extent that it didn't perform as the scientists had hoped.

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[171] I should point out here that I have not been able to follow up this issue with the farmers themselves, as I was unable to go back in the field after the last selection workshop. It might also have been difficult for me to discuss the issue with them, as for many I was perceived as being part of the scientists' team (see also Chapter 4 - Methodology and Analysis).

[172] Levine (1965) describes the Amhara tradition of 'Wax and Gold', i.e. the the use in language and poetry of a 'superficial' meaning (the wax), which however conceals the true meaning ('the gold'), thus enabling things such as humour, polite insult, protection of privacy and others. He then contrasts this cultural trait with modernisation's requirement for openness and accuracy, a requirement that is also found in CBB. Similarly, some DBRC scientists said how working with the Menzei was difficult, as many would be reluctant to openly discuss some aspects of their livelihood with them, in stark contrast to e.g. farmers in South Wollo with whom they were also working.

Overall, thus, the situation was one of inhibited and constrained farmer-scientist interactions combined with a pre-defined and limited room of manoeuvre for project implementation. This meant that both the 'community' of the farmers and that of the scientists stuck to their own, respective 'practice', and worked towards achieving their own respective aims: maintaining linkages and obtaining support for the former, as well as implementing the project according to plan and generating the promised scientific outputs for the latter.

7.3. Closing Thoughts: From Diffusion to Interessement

Going back to the initial premise of this case study, the aim of the scientists had been to 'try out' community-based breeding within an Ethiopian context. They viewed it as an approach that can basically be applied in any smallholder setting throughout the world, its inherent farmer participation ensuring that it can be adapted to each specific setting. The first small story then analysed community-based breeding as such. It showed how the breeding approach can be viewed as an enrolment of smallholder farmers into a global, technoscientific breeding network. By becoming part of this network they are both expected to increase their income and to contribute to the conservation of animal genetic resources by becoming the guardians of their indigenous livestock breeds. The farmers may thus benefit from it, but they will also have to adhere to the specific requirements and discipline of the approach. Furthermore, given the pre-set agenda and approach needs, their 'participation' is limited to very specific 'invited spaces' (Cornwall, 2008). The second small story then looked at the translation of this breeding approach into practice. It showed how in the case of Menz there was a difference between the requirements of the approach and the volatile reality the farmers had to deal with in order to secure their livelihood. The limited interaction between farmers and scientists and the constrained room of manoeuvre of the research project meant that both 'parties' stuck to their own and worked to achieve their own, respective objectives, enrolling each other into their respective actor-networks in order to do so.

The limited success that the scientists achieved by the end of the project puts into perspective the innovation model underlying their understanding of community-based breeding. For them, introducing the approach in Menz was a matter of training the farmers and actively involving them in breeding activities in order to 'raise their awareness' about its benefits and have them change their mindset by moving from being 'keepers' of livestock to being 'breeders'. The assumption was that as a consequence and on the long run the farmers would 'adopt' the approach and implement it independently of the scientists' presence. The latter in turn would distil their experiences of 'trying it out' in Ethiopia into a manual. Other development organisations - NGO's, extension services etc. - would then be able to implement the approach elsewhere by following the manual's guidelines. The key elements of these guidelines - i.e. of implementing selective breeding in a smallholder farmer setting - came down to a simplification of the technical aspects, involving farmers through participation in a limited set of processes and decisions, as well as the 'soft skills' of all parties involved, that is their abilities to interact and communicate openly with each other.

In other words, the scientists' understanding was underpinned by the 'diffusion' model of innovation: they had an 'innovation' - selective breeding - that originated from industrialised countries and had been refined through scientific research, and that bore promise even for smallholder farmers in developing countries. Through their research project and the inclusion of the concept of 'participation' they aimed to adapt it to the needs of a specific 'market', in this case smallholder farmers. All this basically loosely following the maxim of the 1933

Universal Exhibition in Chicago. ‘Science discovers, industry applies and man follows.’ (Akrich et al., 2002a). The failure of the farmers to adhere to the prescriptions of the approach by not bringing in the selected rams was blamed on their ‘lack of awareness’ of the long-term benefits of the approach. We saw however that a different dynamic might have been at play. It may not have been so much a lack of awareness of the farmers, but the incompatibility of these prescriptions with the farmers’ livelihood combined with a limited scope of dialogue and interaction within the research project.

Akrich et al. propose conceptual building blocks for alternative understanding that might better capture this alternative dynamic, summed up in what they call the ‘model of interessement’ (Akrich et al., 2002a). Rather than viewing an innovation like selective/community-based breeding ‘as is’ and its transfer into a specific setting as either a success or a failure, they acknowledge that the whole process is rather more complex. To capture enough of this complexity one would need to make a socio-technical analysis of the process, disassembling the innovation into its parts and looking at these parts’ ability to ‘interest’ the different allies needed to such an extent that they are willing to go along with it. For the case study here this would require to take a ‘step back’ and not conceptualise what happened as the scientists transferring a specific way of knowing and doing into the minds and practices of the farmers, but instead as net-‘working’ by the farmers and scientists. The latter had the objective of realising a research project with specific objectives in mind - from securing their own livelihood and academic standing to trying out their idea. This involved gaining the support and involvement - the ‘interest’ - of a number of actors - the Austrian Development Agency (ADA) via Ethiopian ministries and research institutions to the farmers themselves - in a set of activities - funding, approving, recording, selection, trainings, treatments etc. While this was relatively straightforward with ADA, the ministries and research institutions, things became somewhat more complicated when it came to the farmers. For these were involved in net-‘working’ activities of their own in their attempt to stabilise their livelihood in a volatile environment. This meant that they were interested in specific aspects of the scientists’ activities such as the treatments and trainings, but refrained from participating when these activities came in conflict with their established ways of knowing and doing, more specifically when the understanding and enactment of sheep as breeding asset conflicted with their role as emergency savings. The ‘pull’ of key aspects of community-based breeding away from their established ways of knowing and doing to new forms of organising their livelihood was not strong and rational enough, i.e. there was no strong enough interessement.

If the scientists would have left the sites by the end of the research project, they would have collected enough data to publish papers and write a manual, but the breeding activities among the farmers would most likely have ceased to take place. After all, the farmer ‘community’ existed only during the workshops and trainings, and was kept in place through the ‘interessement devices’ of treatments, trainings and per diems as well as the farmers’ overall wish to maintain their linkage to and support from the scientists. The interessement device of participating in the other, more breeding-specific activities - e.g. recordings, the co-ordination of ram-sharing - was the farmers’ anticipation to get access to trainings and free treatments as a result. This whole network was kept in place through project funding and the active involvement of the scientists. By the end of the research project, if funding would have ended and the scientists have left there would probably not have been any linkages in place that would have kept the breeding activities going.

The scientists were fully aware that more time would be needed for the benefits of community-based breeding to become visible and the farmers to become ‘aware’ of the approach’s benefits for them. As a consequence they worked to secure funding for subsequent projects and continued involvement with the farmers. While I was not able to follow-up on these, as of 2015 ILRI’s online-blog showed that they were still involved in Molale, and according to this blog the farmers now clearly favoured their ‘new’ Menz sheep to the formerly more attractive Awassi cross-breeds. Nevertheless, the scientists still seem to be directly involved with them, and the question remains whether it is the activities resulting in their presence that keep the farmers interested, or whether there are by now alternative processes and linkages - such as linkages to markets and alternative supporting structures - that are strong enough to stay in place without the scientists’ presence and funding. Put differently, the question is not so much one of seeing whether the farmers ‘have become aware’. Instead, the model of interessement highlights how ways of knowing are not merely a matter of the mind, but are heterogeneous, enacted and stabilised through actor-networks involving people (and their minds), funds, sheep, drug treatments etc. It draws attention to the materiality and linkages underlying ways of knowing and ensuring their stability over time, which must be understood and acknowledged in order to fully capture the complexity and pitfalls of innovation ‘transfer’.

Chapter 8 - Discussion and Conclusions

"No matter how it looks at first, it's always a people problem." ***Gerald M. Weinberg***

The case studies in the previous two chapters offered an analysis of how farmers and scientists met and interacted with each other in two different livestock research projects. In both cases the scientists came with specific objectives that they wanted to reach through their research projects. In the Ugandan case study their topic of the research project was to generate scientific understanding of a complex and dynamic process of change within the Ugandan dairy sector. In the Ethiopian case study, on the other hand, the research was 'applied' in that it was about the testing of a breeding approach in (farming) practice. The farmers, too, had their own objectives regarding their participation in the research projects. The participating Bahima farmers had an active interest in modernising their farming practice and becoming part of a growing dairy market and - in prolongation - the global, technoscientific dairy production network with its high-yielding breeds, advanced milk production technologies and new marketing opportunities. Their hope was that through their involvement with the scientists they would learn more about how to better manage their relatively new cross-breed cattle. The main interest of the Menzei farmers joining the research project, on the other hand, was to stabilise their livelihood in the face of changing climatic conditions and a generally rather volatile socio-political environment. Their involvement with the scientists came out of an interest of gaining support and patronage in the management of their sheep.

The research projects were however more than the meeting of individuals or groups with their own respective objectives. They inserted themselves within the wider process of the 'travel' of technoscience, being attempts by the scientists to include the targeted farmers into its global, technoscientific networks. In Uganda, they wanted to translate the Bahima's farming system into scientific formats - publications, theses and a software-based model - that would form the basis for further scientific engagement with them in the future. In Ethiopia, their aim was to transfer an adapted form of selective breeding to smallholder farmers in order for the latter to become the guardians of their local breed. It was a process that involved not only the people, but also livestock, computers, surveys, cars and all other material elements that were required to implement the research projects as intended. Nor did the destination of this travel occur in a 'knowledge vacuum', but instead implied multiple encounters and articulations of different ways of knowing within the scope of the research projects.

Both case studies showed that these meetings and interactions did not occur without friction, with the farmers in both cases resisting the scientists' attempts at enrolment. In Uganda there was an almost open conflict between farmers and scientists when the former did not perceive any direct benefits from the scientists' research; and in Ethiopia many of the participating farmers eventually did not act according to the community-based breeding procedures that the scientists had been aiming for. The key argument of this thesis - which will be elaborated upon in the first part of this chapter - is that these frictions were caused by a dialogue between farmers and scientists in which both 'parties' remained caught within their pre-existing knowledge orders. As a consequence, key aspects of the farmers' and scientists' ways of knowing - most notably their underlying materialities and social orders - were left unaddressed and thus could not be easily negotiated and eventually integrated into the solutions being developed.

It is here that the quote from Gerald Weinberg - a software scientist - comes in. With this quote he wanted to draw attention to a key deficiency among many software engineers: having designed a specific software and knowing exactly how it is supposed to operate, these engineers often do not know or understand the lived reality of the people who are eventually supposed to use it. What he therefore calls ‘people-problems’ should in the scope of this thesis be expanded to all tacit elements of farmers’ and scientists’ ways of knowing, most notably the implications of their underlying materiality, social orders, values and even their respective time-horizons or ‘timescapes’ (Adam, 2008). The claim that will be made in the second part of this chapter is that difficulties in farmer-scientist interactions can be partly overcome by bringing such tacit orders and aspects to light, both by addressing the social orders and materiality of ways of knowing and by striving for more open-ended and interactive approaches to agricultural research. The argument builds on Powell’s assertion that ‘[t]he issue for anyone working on development issues cannot be simply how to deal with ‘knowledge’, but how to act effectively in an environment of multiple ‘knowledges.’ (Powell, 2006, p.521). The second part of this chapter is therefore aimed to provide some avenues for a better understanding of these multiple knowledges.

If thus far the stance of the thesis has been analytically-descriptive, this chapter has an agenda that is explicitly targeted at improving the implementation of agricultural research for development. Since the main audience of this thesis is academic[173], such a stance seems justified. Its contribution to agricultural research will however not so much take the shape of practical ‘How to do…’-recommendations related to implementation. The difficulties that arise when ways of knowing meet cannot be solved through ‘technical’ fixes. Rather, they require a re-framing of the understanding of knowledge and of agricultural research for development by the people involved in it. Such a re-framed view can then serve as starting point for research design and implementation that allows for a meeting of scientists and farmers as ‘interactional experts’ (H. Collins & Evans, 2007) in their respective ways of knowing. Accordingly, some avenues for such a re-framing will be offered in this chapter.

8.1. Of Limited Perceptions and Interactions

To begin with, the materiality, social orders and timeframes underlying the scientists’ and farmers’ respective ways of knowing will be looked at, showing how these limited the interaction and exchange between the two ‘parties’.

8.1.1. The Locality and Limitations of Scientific Ways of Knowing

Underlying the scientists’ interventions was their understanding that the knowledge they wanted to generate about or transfer to the farmers was ‘universal’. The tools they used to analyse the participating farms were seen as capable of giving an objective and universally valid representation of these farms and the farming practices applied on them. The practices of recording and selective breeding, in turn, were understood as being transferable to almost any setting. There was of course the awareness that the farmers’ context of living and working is a crucial element to consider in both understanding their farming and in introducing them to a new breeding approach. The scientists’ assumption was that through careful analysis of said context using a variety of tools as well as through participatory

[173] If anyone beyond the reviewers will read it, that is…

approaches this contextuality could be captured and integrated into their established, scientific ways of knowing, thus achieving the universality implicit in the solutions promoted through the research projects.

However, this thesis argues that notwithstanding these claims of universality of scientific ways of knowing, the scientists' knowledge, too, was 'local', having emerged in a specific, industrialised setting and enacting specific ontologies of livestock that cannot be seen as separate from this setting. As Briggs (2005) writes:

'[I]t is ironic that although the charge is frequently made that indigenous knowledge is too place- and culturally-specific to be universal and transferable, and therefore to be of much value in a broader sense, such doubts are rarely expressed about western science (…)' (p.11)

The assumed universality of the scientists' ways of knowing was not due to qualities inherent to scientific knowledge as such. Rather, it was the result of the enrolment of African and 'international' research institutions in the research projects. Through this process, the idea of an individual Austrian professor based on his own knowledge and preferences acquired in the countries he had previously worked in became an 'international' effort of like-minded scientists. It was through these scientists' willingness to apply this idea in new settings that scientific universality was 'enacted'. It should be noted that this 'enactment of universality' was not achieved through the research projects alone. Rather, they were the continuation of the much wider process of the travel of technoscience that had started with the establishment of the first institutions of research and higher learning on African soil following industrialised models.

Once this locality of science is acknowledged, a number of aspects are put in perspective that were analysed in depth in the previous chapters. First comes the heterogeneity - including the materiality - of the research projects, starting with the way they were initiated. In both cases the origin of the research projects was a small team of scientists based in Boku in Vienna and in 'international' research institutes such as ICARDA in Aleppo and/or ILRI in Nairobi and Addis Ababa, linked through personal acquaintance, functioning communication infrastructure (mostly Internet) and a common interest in securing funding in order to further their academic careers. Given the Boku-scientists' physical location in Austria these teams had access to funding from the Austrian Development Agency. This meant that through their physical location and means of communication they were in a unique position to set the research agenda, choosing topic and content of the projects based on their personal preferences, interests and abilities and on what they saw as being of interest to the - distant - setting they would be researching in, a setting that some of them had never seen before. African research institutions such as NAGRC and DBRC were eventually also involved, but their role was predominantly limited to providing logistical support and anchoring as well as legitimacy.

The implementation of the research projects thus being limited to a specific group of people with a distinct background in a given institutional setting, they were strongly shaped by these people's academic discipline: animal breeding. While during implementation the research projects did to some extent also involve technical staff or even researchers in the fields of animal nutrition and health, the core team of scientists consisted of animal breeding scientists, and their perceptions and understanding as well as the tools they used would accordingly be the predominant building blocks of the projects to be implemented. Most notably, this disciplinary focus brought a number of (predominantly quantitative) tools and approaches into action, which provided the scientists with a specific view of the farmers' context, drawing attention to some aspects while overlooking others. Software such as ZPlan in Ethiopia, or Stella or MISTRO in Uganda were used for modelling and analysis purposes, questionnaire surveys and statistical analyses were used to 'map' the environments in which they were operating, choice cards and other approaches were used to 'see how the farmers think'. All these tools translated a complex and heterogeneous 'hinterland' of farming livelihoods and practices into a format that could be seen, understood and used by the scientists in their work (Law, 2008). Given their origins in industrialised countries, these tools enacted a specific ontology of the livestock the farmers were managing, being viewed as genetic resources and productive assets to be bred for maximal economic gain.

Another aspect brought to the fore is that the use of these tools also resulted in a specific social order in the generation of knowledge. Especially the software-based analytical tools and modelling software were physically linked to the scientists' institutions in that it took university-based academic training for the PhD students to learn how to operate them, and the bulk of the calculating work was done in Boku's and ILRI's computer rooms. In so doing these tools positioned the scientists as the primary 'knowledge-generators', whereas in both cases the farmers were passive data-providers. The knowledge generated in this way and translated into publications and models thus became part of the scientists' actor-network, being specialist expertise in the form of publications and models that was as much - if not more - a reflection of their perceptions and priorities as it was of the farmers' realities.

Last but not least, the case studies also highlighted the temporal setting in which the scientists were operating. In both cases they had a long-term vision of the development of the farmers, considering futures such as the introduction of animal recording to Uganda, the possibility to set up breeder co-operatives in Ethiopia and the need to conserve animal genetic resources in both cases. At the same time they were constrained by the 4-year duration of their research projects, being bound to written research proposals, the limited funds tied to them and the predetermined objectives that they were required to achieve. This meant that exposure to and interaction with the farmers was limited in space and time. They were under pressure to produce research outputs and had limited time and funds for travel and data collection. Combined with long distances to farmers, weak infrastructure and means of communication, this meant that the direct exposure to and interaction of the core team of scientists with the farmers was usually very restricted. The relatively short duration of the research projects and the inability to guarantee follow-up funding meant that while scientific outputs were generated, there was no room for the establishment of long-term farmer-scientist linkages as well as mutual openness and trust. Communication between farmers and scientists was therefore mostly classical and one-way, with feedback, discussions and the exchange of ideas being predominantly limited to within the scientists' own team. There was no room to be exposed to the farmers' livelihood, acquire their tacit specialist knowledge and thus achieve the interactional expertise required for them to have peer-to-peer communication with the farmers that would enable them to put their scientific findings in context.

8.1.2. The Materiality, Orders and Timeframes of Farmers' Ways of Knowing

Similar considerations of materiality, social orders and timeframes can be applied to the farmers' ways of knowing. Contrary to the scientists, neither in Uganda nor in Ethiopia did they form a 'team' as such. In both cases a number of farmers were brought together within the scope of a research project. In Uganda they were chosen for practical considerations, i.e.

their ownership of herds of both pure-bred Ankole and cross-breeds, their expressed interest in participating in the project and their accessibility by road. While some knew each other and may even have given each other cattle in a few cases, their farming was predominantly individualistic and they were usually separated by long distances. The same applied to some extent to the Ethiopian case study. Here distances were shorter, the farmers lived in the same villages, shared communal pastures and were members in the same social structures such as Iddir and Wenfel. Nevertheless, practical considerations prevailed in the construction of 'the community' - the farmers' expressed interest and ability to cooperate, the size of their herd - and it was only bound together by a breeding plan, the scientists' enactment of the sheep population through tags and records and its physical coming together during trainings and selection workshops.

However, the farmers did share the same livelihood and corresponding ways of knowing in relation to their livestock. The Bahima were part of the same ethnic identity and farming system (including the wish to improve their dairy business), and, to a greater or lesser degree, all were moving towards market-integrated dairy farming as the main basis of their livelihood. As with the scientists, their ways of knowing were heterogeneous in that they tied together people, cattle and the physical elements of their farms. The farmers themselves were the main repositories of knowledge about the animals, and experience about their livestock was acquired through daily interaction with them, 'writing' their findings and ideas into the cattle they bred, the land they managed and the social networks they maintained through their animals. The Menzei too shared a similar livelihood and precarious environment, their sheep playing a similar stabilising role in their survival strategies. While in this thesis they were not explored as in-depth as the Bahima's were, the Menzei's ways of knowing too consisted of the farmers' daily interaction with their farms and any ideas they had or approaches they wanted to try out were inscribed into their animals and farms rather than in publications and papers.

For both, shifts in their wider context 'forced' them to use new tools and practices that had their origin in industrialised countries. For the Bahima it was their settling down and the emergence of a dairy market, including the introduction of exotic Holstein Friesians into their farms, that led them to reshape their approach to livestock management, moving from Ankole-based pastoral practices to territorially constrained dairy farming using breeds and inputs obtained from as well as value-chains based on industrialised systems. For the Menzei, it were climatic shifts that turned sheep into a much more important resource for their livelihood, and they were accordingly obtaining support wherever they could, bringing even lambs that were sick to the woreda's veterinary service in order to be treated. There was thus an assimilation taking place, with the farmers integrating 'modern' tools and practices whenever it suited their concept and objectives. Contrary to the scientists, the farmers knew of no discipline-based structure to their ways of knowing, however. There was no differentiation between 'social' or 'technical' aspects, as everything they did and perceived was part of the same attempt at maintaining and improving their livelihood and personal networks. This was especially the case for their livestock, which had ontologies that differed from the ones enacted by the scientists through the research projects. For the Bahima, the cattle represented as much a productive asset as they were embodiments of their social relations and part of the performance of their ethnic identity. For the Menzei in turn, rather than genetic resources and breeding assets they were the savings they could fall back upon in case they for instance had to urgently pay for medical treatment or a funeral.

Underlying both ways of knowing was a relatively individualistic social order, with each farmer being responsible for his/her own farm. While social support networks did play a crucial role - and were embodied in and maintained through cattle in the case of the Bahima - the farmers themselves took key decisions regarding livestock. This does not mean that they were not interested in allies, however. For both the Bahima and the Menzei the arrival of the scientists brought with it the hope for new knowledge and tangible support. Whereas for the Bahima farmers of the research project, their own standing was secure enough to threaten the scientists with eviction when problems arose, the patronage that the Menzei secured through the research project had a much greater importance for the stability of their livelihood.

This last aspect points to the issue of the temporalities in which the farmers were operating. None of them were truly interested in - and in the case of the Menzei not even aware of - the time-horizon of the research projects in which the scientists were operating. The scientists were operating according to a temporality that was 'out of time' (Scoones & Thompson, 1994) in that their work was part of a global effort at guiding and shaping agricultural development. From the scientists' perspective research projects like those described in the case studies were relatively short and more or less controlled 'experiments' with specific, pre-set objectives. These were meant to contribute to a much larger and more long-term 'picture' of the situation of agriculture and of its most pressing global challenges such as the Livestock Revolution and the potential loss of animal genetic resources. The farmers on the other hand were living 'in time'(ibid.), having to manage their farm in the here-and-now, secure its production and productivity on a permanent basis and make sure that their families were fed and clothed at the end of the day. Theirs was a day-to-day management, seizing opportunities where they arose and acquiring new knowledge along the way.

8.1.3. Non-overlapping Specialist Expertises

In the meeting of ways of knowing that occurred through the research a number of difficulties were observed. In the case of the Bahima it was the underlying social order of knowledge-generation - the scientists as knowledge-creators and the farmers as passive data-providers - that led to the dissatisfaction of the farmers, with the latter perceiving the work of the farmers and the knowledge they were being given as inadequate to their perceived farming needs. For the Menzei it was the enactment of sheep as breeding assets that clashed with their own vital enactment of sheep as savings that led them to be unwilling to commit their animals to the breeding programme facilitated by the scientists. The argument forwarded here is that these difficulties were in large part caused by the scientists not having adequate concepts, tools and processes to capture and acknowledge such aspects and consider them in their research.

Regarding their concepts and tools, it is worth repeating that the scientists did view the farmers' knowledge and context as important aspects to be considered. However, in this attempt the scientists 'compartmentalised' the farmers' ways of knowing by assuming that there were 'social' and 'technical' aspects to it that could be viewed separately and that could be captured through questionnaires and surveys. Given their disciplinary background in animal breeding, the scientists' main focus was on the latter, i.e. on aspects directly related to breeds and breeding. 'Social' aspects were seen as data input to their technical tools and analyses. In the Ankole II project, for instance, this took the shape of 'social' studies of the farmers' breeding practices. In this study the farmers served as data-mines from whom the scientists extracted information with the help of a formal questionnaire. These findings in turn were translated into a probability-function in a software-based farming system model, as well as into scientific publications making a case for subsequent breeding programmes without problematising the differences in ontologies of cattle. In the community-based breeding Programme the scientists also undertook a number of questionnaire-based studies on the 'social' and 'economic' dimensions of the farmers' livelihood in order to have sufficient data to set up their breeding plans. In both cases the scientists also did some research into what they called the farmers' 'indigenous' knowledge, be it on the Bahima's knowledge of pastures or the Menzei's ability to predict the heritability of traits. In doing so, the farmers' knowledge was compared with the measurements and calculations obtained through scientific means, and thus 'scientifically validated'. The exception to the rule were the selection workshops in Ethiopia: here the farmers were given an 'invited space' (Cornwall, 2008) to integrate their knowledge in the approach by having a selection committee elected by the farmers choose the best animals among the pre-selected ones in order to also consider non-quantifiable traits.

Overall however, while the scientists acknowledged the farmers' so-called 'indigenous' knowledge and strived to address and even integrate the 'social' aspects of their breeding efforts - in Menz to some extent also their livelihood as a whole - in their research, they never strayed very far from their academic discipline and the tools that they were used to. Everything they studied was translated into a format suitable for and fed into a technological trajectory that was pre-defined by them. This trajectory had ontologies of cattle and perceptions of farming that have their roots in industrialised settings and that co-produced social orders that were not necessarily wished or possible to adhere to by the farmers they work with. They remained, in other words, within their own specialist expertise, using tools and approaches that quantified the farmers' livelihood, with all the enactments and imaginations that this implies. This view is echoed by van Asten, who argues that scientists often have insufficient insight into the complexity of the system that farmers operate in, and look at it through their own frame of reference without considering those of the farmers (van Asten et al., 2009).

In addition to having a biased view of the farmers' livelihood shaped by their discipline and tools, they did not critically reflect on the contextuality of their own ways of knowing and their underlying materiality, social orders and timeframes. Science was viewed as standing above and beyond the context in which the farmers' ways of knowing were enmeshed, providing a 'view from nowhere' (Nagel, 1986) on the farmers' perceptions and farming practices. However, in doing so their analytical glance captured only half of the picture that was unfolding, the farmers' half. The underlying imaginaries of development; the roles of the different actors - including those of farmers and scientists - within the actor-network that they were trying to set up; the changes required from the farmers in order to adhere to the scripts that they were expected to enact; the enrolment of the farmers into the global, technoscientific network and the delegation of decision-power to external actors (including computer-software) that this would imply; the view of livestock as genetic resources and production- and breeding-assets: all were for the most part neither addressed nor reflected upon. The assumption was instead that the solutions being promoted and the knowledge being generated was inherently beneficial for smallholder farmer development, since they were 'scientific' and had already proven their value elsewhere.

It can be argued that the situation was similar for the farmers. Their ways of knowing had no claims of universality the way science has, being rather focused on the individual farms and contributing to making sure that the farmers' livelihoods could be maintained and their objectives achieved. Contrary to the scientists, their work did not 'feed' into a wider network through publications and presentations. Instead, their 'written records' were their farms as such, and anything they did had somehow to have visible repercussions on its performance, had to be 'written into the farm', so to speak. They therefore viewed the engagement with the research projects as opportunities to advance their own aims and achieve tangible benefits for their farming practice. In Uganda, while the access they gave to their farms was partly out of courtesy vis-à-vis the scientists, they also hoped to learn something new about the management of their high-yielding cross-bred cattle from them. When this was not forthcoming, they opted for a confrontational course in the hope of obtaining material assistance from the scientists. In the Ethiopian case study this material assistance and learning were there from the start, and were the main motivating factors for the farmers to be part of the research project. In both cases the farmers had an established strategy for managing their farms, and used the research projects as contributions to the realisation of this strategy.

Both the farmers and the scientists thus acted and viewed the other 'side' through their own, respective 'view from somewhere'. They were enacting their own ways of knowing through their respective actor-networks, following a logic that made sense within their own context and aimed at achieving their own, respective objectives. The 'others' - farmers for the scientists and vice versa - were viewed as actors to be enrolled into these actor-networks without significantly altering their structure and inherent logic.

Obstacles to Interactional Expertise

It is here that we should come back to Collins' and Evans' Periodic Table of Expertise (H. Collins & Evans, 2007):

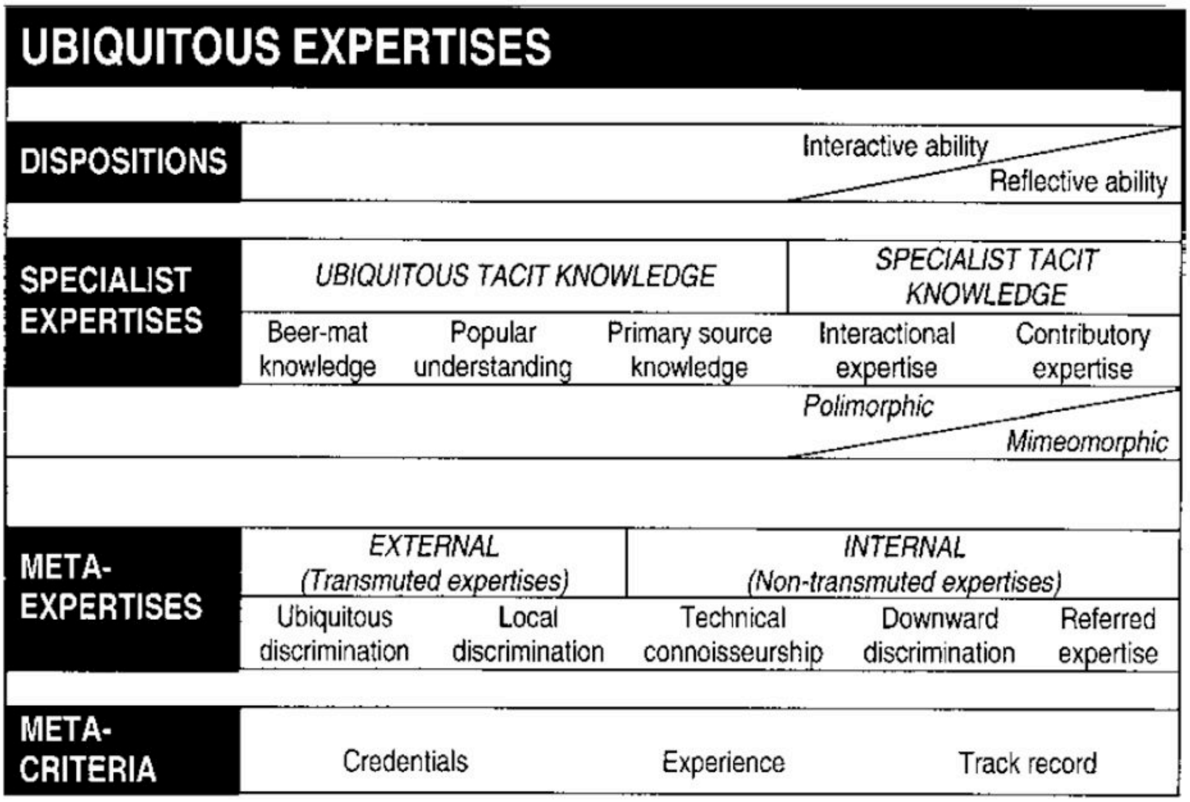

Figure 58: The Periodic Table of Expertise

Drawing on this table one can first of all view farmers and scientists as having to some extent separate ubiquitous expertises, with the latter having a predominantly urban - in some cases also non-African - background and livelihood with its underlying tacit perceptions and practices, and the latter living in a rural context with customs and traditions that differ significantly from the scientists'. A certain degree of overlap may exist, especially for those African scientists having grown up in rural areas themselves. Nevertheless, at this level there are already tacit discrepancies that affect the way they view and interact with each other. The difference becomes more distinct when it comes to ways of knowing related to animal husbandry, where farmers and scientists can be viewed as having two separate specialist expertises, each with its own, underlying materialities, social orders and temporalities. Whereas the scientists did have exposure to the farmers' livelihood, this exposure was never prolonged enough for them to acquire more than beer-mat or at best primary knowledge about it, by for instance knowing about the use of sheep as savings, but not being aware of the numerous ramifications this has and the difficulties it may cause when committing to a community-based breeding programme. The Bahima in their attempt at modernising their dairy farming may already have had collected practical experience with the management of dairy cattle. Here too, however, this can be viewed as primary knowledge of science-based animal husbandry at best, in that they may be familiar with the application of oxitetracycline as allround-antibiotic, but they may apply it following a 'more is better' approach without for instance considering the necessary withdrawal period for milk after a cow has been treated. The Menzei, finally, are probably only beginning to grasp the underlying logic of modern sheep management tools and methods, as their reference to deworming drugs as 'fertiliser' due to the better growth of treated sheep may imply.

The point being made here is that at no stage did the scientists or the farmers reach a level of interactional expertise in the others' ways of knowing that would have allowed for a peer-to-peer communication about the research procedures and the meaning of its results within the farmers' context. Of course, on the short- to medium-term interactional expertise in science-based breeding might be difficult to achieve, especially for the Menzei given their limited access to formal schooling and the many more pressing constraints of their livelihood. Even for scientists this expertise might be impossible to reach; it for instance takes a lifetime with cattle to become a Muhima farmer, after all. However, for the scientists the mere attempt to strive towards interactional expertise of the farmers' ways of knowing would be a valuable step towards increasing the value of their research for these farmers. A lot of the aspects of farming consist of tacit specialist expertise, after all, and thus need to be 'lived' in order to be put in their right perspective.

The structure and procedures of research projects are however currently not conducive to the creation of such expertises among their participants. The research projects in both cases were 'fixed' in research proposals that gave them a 4-year time-horizon and clearly defined deliverables that had been decided upon from afar, at times without any previous direct exposure to - let alone contribution by - the farmers. Their course was thus set, and did not allow for changes - and thus learning - in case a given approach was not suitable to a given context in this specific form. Research was thus enacted as 'packages of pre-determined scientist-led activities in time' rather than long-term processes of mutual learning and exchange. The limited funds were constraining as well, which combined with the large distances and weak infrastructure to allow only for short visits by the scientists with only limited exposure to or interaction with the farmers. Combined with the general pressure on the scientists to deliver on the expected results, having only short visits for data-collection, co-ordination and feedback - combined with the use of advanced, software-based analytical tools - enacted them as knowledge-creators whose role was to gather data, teach farmers in workshops using classical training formats, or lead the farmers in a pre-determined breeding approach in which the latter could contribute in specific 'invited spaces' (Cornwall, 2008).

As a consequence - especially in the case of the Menzei - the deference to the authority that scientists represented prevailed, as there was no time or space to create familiarity and collegiality and have interactional expertise emerge.

8.2. New Perspectives on Agricultural Research for Development

While both case studies did not provide platforms for an open interaction and exchange between farmers and scientists, doing so would be crucial for science to benefit farmers in developing countries. The farmers in Ethiopia and Uganda differ in that the former have just started to integrate science-based technologies in their sheep farming, whereas the latter are already actively involved in production and marketing practices inspired by industrialised models. In both cases, however, the integration of their livelihoods into cash-based economies, the limited availability of natural resources such as pastures and the increasing access to 'modern' inputs, breeds and services makes it necessary for them to incorporate science-based ways of knowing into their established farming practices. At the same time, climate change - visible both in Menz through the erratic nature of the Belg rains and in western Uganda through the occurrence of prolonged droughts - requires adaptation measures that may go beyond the options available to the farmers in their existing ways of knowing. In other words, science-based breeding has much to offer to the farmers for them to address their most pressing problems, but needs to overcome some of its own inherent biases in order to do so.

The main challenge that scientists face when working with farmers is to translate - used here in the ANT-sense - their own ways of knowing in such a way that farmers are both willing and able to integrate them into their farming. 'To adopt is to adapt' (Akrich et al., 2002b), which means here that this process cannot be viewed as the mere transfer of established understandings and practices from one context to another. A transformation and adaptation has to take place that takes into account the opportunities and limitations of the people meant to adopt these understandings and practices. This section suggests two avenues for scientists engaging with farmers to facilitate such a process, inspired by the theories applied throughout this thesis. The first has to do with the understanding of technologies and ways of knowing, which has to move from the current, rather 'rigid' understanding to one that is more 'fluid' (de Laet & Mol, 2000) and that acknowledges the situatedness and underlying materialities of the respective ways of knowing of farmers and scientists. The second draws on the model of interessement (Akrich et al., 2002a) and interactional expertise (H. Collins & Evans, 2007) to argue for an approach that is more open and interactive to mutual transformation and adaptation.

8.2.1. Of Symmetry and Fluidity

The first avenue suggests new ways for scientists to reflect about and understand technologies and ways of knowing, drawing on the notions of symmetry and fluidity introduced in Actor-Network Theory.

A Symmetric View of Technologies and Ways of Knowing

The notion of symmetry draws attention to the need to approach technologies and ways of knowing *symmetrically*, i.e. considering both farmers' and scientists' ways of knowing and practices as being similar and comparable, and by acknowledging their underlying materiality, i.e. the need to equally consider both the human and non-human actants through which they are enacted.

Regarding the symmetry of farmers' and scientists' ways of knowing, it shows how for *anyone* involved in knowledge generation and use in agriculture a variety of aspects and actants may become relevant and have to be integrated with each other. For the Bahima, for instance, livestock closely intertwines production objectives and the securing of ethnic identity and social support. The Menzei in turn use their sheep as emergency cash dispensers, forming a keystone in their risk reduction strategy that cannot be ignored. Even science-based practices such as animal recording are the enactment of a productivist paradigm driven as much by economic considerations as by scientific ones, and made possible through extensive technoscientific networks involving people, laws and tools. The same applies to scientific assessments of 'social' aspects through questionnaires and surveys, which can more accurately be viewed as translations of the realities of the farmers' actor-networks into those of, say, simulation software with its quantitative requirements rather than an 'objective' representation of these farmers' realities. By paying attention to such aspects for both farmers' and scientists' ways of knowing rather than 'black-boxing' and reifying them through arbitrary distinctions - e.g. 'scientific' vs. 'traditional', 'social' vs. 'technical', 'theory' vs. 'practice' that conceal more than that they explain - it becomes easier to address, describe and integrate elements that are crucial in agricultural research for development, but that might be overlooked otherwise.

In doing so, the underlying materiality of technologies and ways of knowing has to be acknowledged. As was illustrated throughout this dissertation, knowledge is as much about the minds of people as it is about the tools they use and the environment in which they act and with which they interact. One example from the case studies is the Holstein Friesian cow, which originates from industrialised farming, is linked to imaginations of industrial, high-yielding modes of production, is usually viewed as a 'milk production machine' and thus 'forces' the Muhima farmer to ensure appropriate fodder- and drug-supplies - including linkages to drug-suppliers - in order to have it function as expected. Community-based breeding, too, originates from a global livestock breeding network, enacting a social order whereby farmers are expected to become 'breeders' and 'guardians' of their local breed, requires a shift of specific sheep from being 'savings' to being 'breeding assets' and requires a certain management- and breeding-discipline from its participating farmers. And even a seemingly innocuous practice like animal recording 'forces' the user to focus on quantifiable livestock performance to the detriment of aesthetic beauty or the maintenance of social linkages, and requires more or less extensive heterogeneous actor-networks involving people, tools and standards in order to be implemented as intended.[174]

Using such a symmetric perspective also draws attention to the notion of contingency (Noe & Alrøe, 2003a), i.e. the realisation that a given actor-network - say, a specific approach in managing animal breeding - is only one possible configuration out of an infinite multitude that could have been developed in a given setting. That it does take the form it has is then often the result of a choice that is not acknowledged as such, and only in retrospective presented as 'fact'. A good example here is selective breeding, with its origin in Bakewell's idea in response to the Industrial Revolution and now widely presented by scientists as *the* way of breeding livestock. However, as thousands of years of livestock domestication imply and as the case studies showed, there can be a multitude of other ways of managing and breeding livestock that are well-adapted to a given socio-economical and environmental

[174] Note here for instance how even the 'simplified' recording system in community-based breeding required sheep, consenting farmers, enumerators, scales, enclosures, books, phones, computers and software as well as the people trained in using them for a selection to become possible in the first place.

setting. Realising this multiplicity of ways of doing things may lead people to change their approach from being prescriptive ('There is only one right way of doing things') to them looking for opportunities for the effective translation and adaptation of a given technology into a new context.

Overall, such a symmetric perspective may prevent analysts from the pitfall of blaming e.g. farmers' 'lack of awareness' for not adopting a certain technology or practice. Instead, it encourages them to analyse the materiality of specific ways of knowing and trace the translation processes that occur when a technology is introduced in a new setting, drawing attention to the actor-networks required for it to function effectively and maintain stability over time. In this way it may become much easier to become aware of aspects in the farmers' perceptions and practices that would otherwise remain implicit, such as the strategic considerations of the Menzei in 'playing along' in order to secure free drug treatments or the Bahima's numerous valid reasons for not taking up animal recording. Once such awareness is there, the next step - the adaptation of technologies and ways of knowing - can take place.

From 'Rigid' to 'Fluid' Technologies and Ways of Knowing

Actor-Network Theory literature has a number of cases describing how transfers of a technology from one setting to the other did not work out as expected (e.g. Akrich, 1992, 1993; Law, 1999; Shepherd & Gibbs, 2006). The Ugandan case study, too, showed how the transfer of animal recording to the Bahima by 'convincing' them of its benefits and distributing software-based binders did not yield any lasting results. The Ethiopian case study in turn pointed to how the introduction of community-based breeding in Menz ended up not so much being a transfer of a breeding approach as the scientists intended, but turned instead into a process of mutual enrolment for the purpose of obtaining research results and linkages of patronage respectively. All cases are similar in that they were attempts in which a given technology was understood as being relatively 'rigid' - requiring specific, pre-defined understandings and practices - and was expected to be adopted as such.

Rather than viewing technologies as pre-defined ways of knowing and doing to be adopted 'as is', they should be envisioned as 'fluid' entities whose premises, structure and borders should not be exactly defined beforehand. Put differently, they should not so much be imposed on a given actor-network requiring its radical reorganisation in the process - as the Ethiopian example of a shift of sheep from 'savings' to 'breeding assets' - but should rather be open to re-negotiation and adaptation, 'serving' the needs of its users rather than the other way round. The origin of this concept of 'fluidity' and a good example of its use in practice is DeLaet and Mol's description of the so-called Zimbabwe bush pump, a water-pump widely adopted throughout the country mostly due to its extreme adaptability to different requirements and settings (de Laet & Mol, 2000). This 'fluidity' manifested itself amongst others in the choice of the site and drilling of the bore-hole. Rather than using hydrological expertise to identify the site and advanced mechanical tools to drill the hole, the community water diviner was consulted and hand operated drilling was used, turning the installation of the pump into a village feast. This guaranteed full ownership of the pump by 'its' village, something that could not have been achieved if external experts had imposed *their* imagination of what constitutes a 'proper', science-based installation on the process. Similarly, 'opening up' technologies like animal recording or community-based breeding to negotiation with and change by the farmers might have led to their adoption in a way that may not have resembled what the scientists had initially in mind, but that would have matched more closely the needs and possibilities of the farmers. With community-based breeding this might have led to the realisation that not everyone wants or has the means to become a ‘breeder’[175] and as a consequence perhaps to a form of collaboration that combines the farmers’ wishes for support with the scientists’ aim for improved breeding e.g. by limiting the actual selection to a more limited number of farmers. Similarly, the farmers’ keen interest in improved sheep marketing might have formed a basis for collaboration that might have been in a better position to stabilise joint breeding efforts than the contracts for selected rams eventually proved to be.[176]

The same notion of fluidity should be applied to ways of knowing in general, i.e. on the ways of understanding and acting upon the world on which given technologies are based. In his work, Turnbull illustrated how there has been and is a multiplicity of ‘indigenous’ knowledge and of which science is but one (Turnbull, 1997; Watson-Verran & Turnbull, 1995). Jasanoff echoes a similar view when she highlights how a specific way of knowing and representing the world is closely intertwined with a specific way of living in it (Jasanoff, 2004). It is, in other words, not possible to draw a clear line between ‘agricultural science’ and ‘farmer livelihoods’ since each type of knowledge - including the scientific one - makes sense in relation to the setting in which is located. As soon as scientists get in contact with farmers these settings overlap, with for instance the 4-year limit of a research project having as much an influence on the outcome as the number of sheep available to the farmers involved. By reflecting on *all* aspects that have a bearing on how ways of knowing are enacted, the scientists would not view the Menzei’s attempts at creating and maintaining linkages of patronage as an aberration of farmers unwilling to ‘play along’, but as a strategy that makes sense within the farmers’ context and ways of knowing and that has to be acknowledged and addressed. While this does add complexity and even a certain degree of relativism to agricultural research, it does also offer new possibilities. Turnbull writes:

The ultimate reason for embracing relativism and reflexivity is that they make clear the necessity for criticising and changing our understanding of the world by recognising the messy and complex diversity of the multiple ways of knowing. (…) *It is in the revelation of these hidden messy and actively constructed components that the possibility lies of working together with people in other spaces. (Turnbull, 2000, p. 232)*

Put differently, such a ‘relative’ or ‘fluid’ understanding of ways of knowing is a prerequisite for effective farmer-scientist dialogue to occur in the first place. Rather than having scientists approach farmers with an implicit hierarchy of understandings and corresponding values - most importantly an understanding that theirs is a ‘universal’ knowledge that has to be ‘transferred’ to the farmers’ context - it encourages them to critically review the background, rationale and materiality of both their own and the farmers’ ways of knowing, and in this way have a better chance to identify the most promising avenues for development. Taking the example of animal recording, while it does provide a proven approach to achieve quick genetic gains, its functioning is dependent on a host of factors, processes and structures, from a setting in which livestock can be kept as breeding assets, the availability of tools to measure and record and the people able to measure them, institutions to guide and control the process, to the mutual trust and willingness of all actors to participate in the system. Acknowledging how a specific approach and understanding is interlinked with a specific context prevents a scientist from aiming for its straightforward transfer (arguably with a certain degree of adaptation, be it through simplification or ‘participation’) to a dialogue with the farmers in

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[175] According to an Austrian farmer/breeder I talked to, the same applies to European farmers, with only a relatively small number being actively interested in breeding as such.

[176] Interestingly this might have become the case with the scientists’ current (as of 2015) efforts at combining breeding with integrating the farmers in a sheep value chain. While I was not able to follow-up on this beyond reading about their progress on the Internet, breeding-network stability through marketing would be an interesting topic for ANT-based follow-up research.

which different ways of knowing are 'opened up', explored and questioned, and flexible avenues for combination and integration are found.

8.2.2. Opening-up Social Orders: A New Understanding of Farmer-scientist Interactions

Upon reflection, the second avenue proposed for approaching agricultural research for development differently has to do with action, or more specifically with the way in which farmers and scientists interact. While Actor-Network Theory in itself does not give any practical recommendations, its use in the analyses and reflections of the case studies does provide some starting points for improving farmer-scientist interactions. In essence this comes down to reframing some of its key assumptions in relation to the purpose of research and on how to approach farmer-scientist interactions.

The Selfish and Selfless Motivations of Doing Agricultural Research

First comes the purpose of research. The basic assumption underlying agricultural research for development is that its purpose is the generation of new scientific knowledge that will eventually contribute to the modernisation of agriculture in a given context. The case studies however brought to the fore how research projects are also a means for the scientists to secure their livelihood and the institutional stability of their home institutions through funding. This draws attention to the fact that agricultural research is not merely an issue of bringing the benefits of science to the farmers, as the modernist development narrative may imply. While the intentions of the researchers - the author of this dissertation included - are usually guided by the willingness to contribute to some greater good, there are also usually more 'selfish' motives at play. In the two case studies the scientists were even arguably the ones benefiting most from the research, having been able to achieve their stated objectives, collect data, write scientific publications, obtain academic degrees and generally secure or even improve their standing within the scientific community. Any findings that were generated by the research projects were, thus far, too fragile to be of any direct benefit to the farmers involved, if they were to benefit them at all. Instead, any advantage they may have obtained through their involvement with the scientists - free drug treatments, trainings, the occasional advice by the enumerator/veterinarian - was directly tied to the funding and networks provided by the research projects and was likely to end once these projects were over.

In other words, the scientists did not act as knowledge-driven altruists, but - just like the farmers - as actors aiming to achieve their own objectives and secure their own stakes and interests within their own, socio-economic context. Explicitly acknowledging this can be viewed as an important step towards improved farmer-scientist linkages. From a unilateral view of scientists transferring 'universal' knowledge 'down' to the farmer-level and helping farmers 'develop' and 'modernise', on-farm agricultural research should instead be reframed as a 'deal' in which the stakes and needs of both parties have to be identified and acknowledged from the onset. While this does not necessarily question any wider benefit of scientific research for improving agriculture on the long run, it does introduce a certain degree of humility in the research endeavour. This in turn is a valuable precondition for scientists to acknowledge the symmetry that Actor-Network Theory requires to achieve its more accurate description of the scientists' and the farmers' respective ways of knowing.

The Limits of Participation - Clarity Through Specificity

This in turn brings us to the ongoing debate on farmer participation, which is often viewed as a prime way of having farmers become equal partners in agricultural research. As the review of the debate on farmer participation in Chapter 2 showed, it does however not always live up to this promise. The Ethiopian case study, too, illustrated how 'participation' did not put the farmers in a position in which they were able to significantly shape the approach being implemented, being constrained instead to making choices in specific 'moments' pre-defined by the scientists.

A number of authors introduced previously have already reflected on the limits and opportunities of farmer participation, offering a number of frameworks and concepts to help better understand its mechanisms, potentials and limitations (Cornwall, 2008; Neef & Neubert, 2010). These authors contribute to overcoming a certain degree of 'vagueness' in the participation debate, aiming instead for what Cohen and Uphoff call 'clarity through specificity' (Cohen & Uphoff, 1980; in Cornwall, 2008), paraphrased by Cornwall as 'spelling out what exactly people are being enjoined to participate in, for what purpose, who is involved and who is absent' (p.281).

Here, too, Actor-Network Theory can contribute to such clarity by providing a more detailed understanding of the process and practice of farmer participatory research. By opening up the technological approaches that are promoted and tracing their underlying, heterogeneous actor-networks, and by looking at farmers and scientists symmetrically it helps to identify and understand the processes and networks in which farmers are expected to participate, and the implications this has. This in turn brings to the fore the scope of participation that is there in the first place. The Ethiopian case showed how community-based breeding hinged on the exact control of the mating behaviour and management of a large number of sheep owned by a diverse group of individual farmers. The control itself in turn involved the use of complex calculations and tools that required the involvement of people with advanced academic training. In other words, by the very definition and set-up of community-based breeding there was only a very limited scope for farmer participation. This in itself is not to be understood in a negative sense, however. 'Full' farmer participation is only suitable for specific cases or technologies. Biggs for instance - reflecting on his typology ranging from 'consultative' to 'collegiate' participation - writes:

> *I remember that some of the more populist advocates of participatory approaches took my collegiate mode and promoted it as a goal or as a natural progression leading on from the other types. This had not been the reason for creating this typology – in fact the article had argued that different modes were relevant to different situations.* (Biggs, 2008)

Nevertheless, it does question the assumption that a given technology can be adapted to a specific context or setting through farmer participation. Using the model of interessement (Akrich et al., 2002a) to analyse the Ethiopian case study showed that what took place wasn't so much the transfer of community-based breeding to the Menzei that the scientists had aimed for, but a process of mutual enrolment of farmers and scientists into each-other's actor-networks. The farmers did not 'adopt' community-based breeding, but used the scientists as patrons to secure and further stabilise their livelihood, whereas the scientists used the farms in Mehal Meda and Molale as key element of their data collection and generation of scientific findings. Such a perspective brings crucial underlying power-dynamics to the fore, which may get obscured by a participation rhetoric: the scientists had control over the project resources and had a limited amount of time in order to achieve their pre-defined objectives.

The farmers on the other hand had reasons to participate in the project that may have had little to do with the original intentions of the scientists. What was thus achieved was an association between farmers and scientists that was not stable enough to enact co-ordinated breeding already during the lifetime of the project, let alone beyond its duration.

Such an analysis is crucial if a given technology is to be sustainably introduced in a given setting. By drawing attention to the motivations and enrolment efforts of the actors involved as well as to the underlying materiality of the technology being introduced, it helps to see in how far a certain degree of stability of the technology has been or can be achieved. As it was then, community-based breeding could only be maintained through the external involvement and support of scientists, their tools and the funds of the research project, and would have required additional efforts and stabilising actants in order to ensure its ongoing implementation over time.

Re-thinking Knowledge Generation and Farmer-Scientist Interactions

The above directly leads to the question how these avenues are found, which is linked to the third key assumption of agricultural research that is questioned through ANT, namely how farmer-scientist interactions should be understood and approached.

In both case studies the scientists were in control, given how the research projects were set up, structured and implemented. They were the ones designing the projects in the first place, based on their personal interests and existing institutional networks. The farmers were enrolled when all was in place, as contributors in a pre-set, 'closed down' technological trajectory (Stirling, 2005). The scientists' relation to what they referred to as 'indigenous knowledge' fit in this approach, with e.g. the Bahima's knowledge of pastures or the Menzei's preferences and experience with the heritability of traits being captured through questionnaires and scientifically 'validated' through their subsequent analysis. In addition to being data-providers, the farmers were involved as pupils during trainings and workshops, or were asked to take specific decisions in pre-defined 'invited spaces' (Cornwall, 2008). Despite the scientists' expressed wish to have farmers participate in the case of Menz, theirs was a top-down approach. The implicit assumption was that they as scientists had an innovation that had to be applied in the farmers' setting. While adaptation was to take place by having farmers decide regarding specific aspects of implementation, the whole process of adaptation as such was to be controlled and guided by the scientists themselves.

The logic described above is captured by the model of 'diffusion of innovations' (Akrich et al., 2002a). According to this model, the researcher is understood as the 'inventor', i.e. someone who mobilises resources and uses his/her intellectual capacity in order to develop a new approach or technical solution to a given problem. If needed, the adaptation of this approach or solution to the setting in which it is to be applied is ensured through a careful study of 'the market' or the intended end-user. Once diffusion takes place the innovation either sinks or swims, and any failure to succeed is blamed either on its insufficient suitability or on failures by the end users.

To some extent the research projects of both case studies operated according to this logic. Both were agricultural research for development, meaning that their implicit agenda was to bring science and modern technologies to bear on African agriculture in order to contribute to its development. In Uganda, the aim was to understand the economic and ecological sustainability of a specific farming system undergoing a dynamic process of change, using on-farm data collection, software-based modelling as well as statistical and survey-based analyses. As a side-activity, the research project was also used as a platform for the scientists to teach the farmers about animal recording and convince them of its benefits. From a long-term perspective, the research project was understood as a first step to enrol the farmers into a global, technoscientific network on animal breeding, both in order to ensure the survival of Ankole cattle as animal genetic resource and to have the farmers benefit from state-of-the-art livestock breeding practices. In Ethiopia, the purpose of the research project was to transfer selective breeding to a smallholder setting, both by simplifying the approach and by setting up a 'community' of farmers who would be given the opportunity to take specific decisions regarding its implementation. In both cases the scientists were the ones 'owning' innovative approaches and generating new (scientific) knowledge, which was ultimately to be used on and/or by the farmers for the latter's benefit. Any failure of the farmers to 'adopt' these approaches - be it animal recording by the Bahima or participation in the breeding scheme by the Menzei - was usually blamed on their 'lack of awareness' of the approaches' advantages and benefits.

Here Akrich et. al's alternative model of interessement may be of use again as an alternative and arguably more accurate view on how innovation takes place (Akrich et al., 2002a). They write:

The model of diffusion restricts the work of elaboration to the limited circle of the designers responsible for the project; the model of interessement underlines the collective dimension of innovation. (Akrich et al., 2002b, p.209)

Drawing on a number of examples, they highlight how any innovation that is successfully integrated into a given setting - and ideally even widely diffused - is not the result of the inherent qualities of this innovation, but to its ability to 'interess' what they call 'allies'. This interessement is at times even only linked to parts of the innovation and not to the innovation as a whole, and may be due to reasons that are as much 'social' as they are 'technical'. Taking their example of the introduction of frozen food as an illustration, they argue how it was not invented once and then adopted 'as is'. Rather, the introduction of frozen food in contemporary livelihoods was the result of a decades-long process of negotiation with a large number of very diverse actors, which slowly went about building an economy that was able to sustain it. During this process 'technical' aspects - e.g. which foods to freeze and how - were closely intertwined with 'social' and even 'political' ones - e.g. the relocation of processing factories (and the jobs linked to them) closer to the producers, convincing retailers and consumers to invest in new storage facilities such as freezers and fridges, and the introduction of new regulations for freezing and transport. It was thus a process that was not limited to the inventors of frozen food, but entailed a complex and interactive process through which the whole of society was partially reshaped in order to accommodate this new food storage system. Akrich et.al. (Akrich et al., 2002b) add:

The social "material" and the technical "material" are both relatively malleable and the successful innovation is the one which stabilises an acceptable arrangement between the human actors (…) and the non-human actors (…) at the same time. The particular strength of the innovator is to permanently play with both registers, to treat nature and society symmetrically. Why speak of technical feasibility and social acceptance? Why change the vocabulary? Acceptance, like feasibility, is just as social as it is technical. (p. 210).

Such a symmetrical treatment of social and technical aspects was however not found in the research projects described in the case studies. Rather, their approaches were strongly shaped by the academic disciplines of animal sciences and animal breeding. Accordingly, any 'social' aspects of the farmers' livelihoods that they considered - trait preferences, socio-economic aspects, breeding approaches - were viewed as input to the 'technical' approaches that they were elaborating and that were the main focus of their work. A symmetrical approach would require a radical revision of the understanding of how scientific knowledge is generated. From having scientists as the main knowledge-generators and limiting the contribution of farmers to data-provision and participation in pre-defined invited spaces, it should involve a much more active listening to and engagement with the farmers by the scientists. Most importantly, such an engagement should come paired with an 'opening up' of the ways of knowing of farmers and of scientists, tracing the underlying heterogeneous networks and critically assessing their materiality and underlying social orders and timeframes. From a scientific standpoint this may at times require the abandonment of certain key understandings and practices in favour of those more adapted to a given context. Akrich et al. write:

We must be ready at all times to burn that which we used to worship. (…) this research, the only one which deserves the name, is the most difficult and painful that there is (p.214)

Recommendations on how exactly scientists should do so and go about playing both registers would go beyond the scope of this thesis. Nevertheless, some avenues of reflection can be offered. To begin with, doing so would require individual scientists to interact more intensively and at peer-to-peer level with farmers, combined with their openness and willingness to learn and to question their own core assumptions and even the methods of inquiry through which these assumptions were obtained. In other words, they should strive towards achieving interactional expertise about the farmers' ways of knowing, livelihood and farming practices (H. Collins & Evans, 2007). In addition, rather than being focused on a specific academic discipline, agricultural research for development in which farmers are involved would require truly multidisciplinary teams, involving also sociologists and/or anthropologists in design and implementation (see also Biggs, 2008; van Asten et al., 2009). These could act as 'facilitators' between the ways of knowing of farmers and of scientists, and make the navigation of the 'social registers' easier for those people not trained in doing so. Last but not least, research should be implemented in such a way that it is flexible enough to adapt itself to the unexpected directions and moments of interessement that might be found when attempting to integrate the farmers' and the scientists' ways of knowing. Akrich et al. propose what they call the 'whirlwind model of innovation' in which '*innovation continuously transforms itself according to the trials to which it is submitted i.e. of the "interessements" tried out.*' (Akrich et al., 2002b, p.213). Put differently, rather than starting with a pre-set objective regarding the set-up and shape of a given technology to be transferred, the approach is iterative and interactional, with technologies being tested and discussed between farmers and scientists in order to identify and improve on the points that provide enough interessement to the farmers for them to adopt them while modifying or even discarding the others. To do so, more open-ended action research approaches might be more suitable than the pre-defined technological trajectories that were found in the case studies. Research projects with pre-defined objectives and 4-year time-horizons place scientists in a position of both responsibility and power that is not as conducive to interaction and innovation as would be required for this innovation model.

Creating Spaces for Interactional Expertise

This last point leads to the issue of the wider context in which agricultural research for development takes place. Judging by the way in which the research projects of the case studies were planned and implemented, this context is not yet fully conducive to the more open-ended and flexible research approaches as argued for above. These projects were designed by scientists in industrialised countries or based in international research institutions, expected outputs were defined beforehand and the time to achieve them was limited in duration to four years with no guarantee for follow-up funding. The decision on whether to continue funding was constrained to the funding agency and based on written reports, with no involvement of people in the targeted countries in the decision-making - least of all the farmers themselves. In other words, the wider research context did not provide the means for a closer and more open-ended interaction between farmers and scientists.

While Actor-Network Theory might provide some avenues for re-thinking agricultural research for development structures and procedures in order to bring them closer to the farmers' context and needs, such reflections are not warranted given the analytical scope of this thesis. For the time being one can safely assume that the system outlined above is unlikely to change, meaning that it is up to the scientists to 'play it' in order to make sure that spaces for engagement between farmers and scientists are created within the research projects that they design, allowing them to engage with farmers on a long-term basis, acquire the interactional expertise required to understand the farmers' ways of knowing and integrate them in the solutions that they propose. One way of doing so could already be observed among the case studies' team of scientists. While obtaining funding was not always straightforward, they nevertheless always attempted to aim for long-term engagement with both the national research institutions and the farmers they had been working with. They did so mostly by providing opportunities for academic training and research for the national research institutions' staff in these follow-up projects, and targeting the same farmers they had been working with before. Given the limited time I spent in the field I was not able to see the impact of this long-term engagement. Nevertheless, it is likely that it did offer a starting point for the establishment of trust between farmers and scientists, breaking away from the restricting timeframe of a short-term research project to one of a long-term process of engagement.

8.3. Concluding Remarks

Agricultural science has much to offer to smallholder farmers in developing countries to help them cope with the challenges they are faced with, ranging from climate change via the ubiquity of 'modern' technologies and breeds to increasingly global, cash-based markets. Scientists therefore owe it to the farmers they work for and with to make sure that they mobilise science's full potential in helping farmers face these challenges. In doing so, understanding and explicitly addressing the respective ways of knowing of farmers and of scientists plays a key role.

This thesis has argued that these ways of knowing should be understood as heterogeneous actor-networks that are not limited to the minds of individual people, but involve a number of human and non-human actants including scientists, farmers and their networks, livestock, records, computers, etc. This underlying materiality implies that they are geographically bound, with the introduction of science-based approaches and technologies in African settings being viewed as the 'travel' of technoscience to new geographic locations. The livestock breeding research projects described in the case studies were seen as part of this process of the 'travel' of science, being an attempt of the scientists to enrol the farmers they work with into the global, technoscientific network of science-based livestock breeding. This was to be achieved through publications translating farming systems into a scientific format as well as through the introduction of science-based breeding approaches such as animal recording and selective breeding, aiming to have the farmers become the 'guardians' of their respective 'indigenous' breed.

The case studies then showed how difficulties arose within these projects, ranging from the conflicts between Bahima and scientists regarding the purpose and benefit of the research to the Menzei's unwillingness to adhere to the procedures of community-based breeding. These were explained as being the outcome of social orders and materialities underlying these ways of knowing that were neither explicitly acknowledged nor addressed. Most notably they showed how the way the research projects were set up and the tools that they involved positioned the scientists in a position of power vis-à-vis the farmers, further compounded by the implicit assumption of the 'universality' of science and the understanding of scientists as knowledge-generators whose technical solutions should be transferred to and adopted by the farmers. These structures and orders did not sufficiently acknowledge how the scientists' and the farmers' respective ways of knowing had each emerged within - or been co-produced by - a particular context with its own specific orders and requirements. It were these differences in origins and corresponding orders and materialities - the ethnic identity of the Bahima as exemplified by their intimate, people-based knowledge of their livestock and its role in stabilising linkages, or the Menzei's use of sheep as cash-reserves to stabilise their livelihood in a volatile environment and their attempt at securing linkages to scientists as source of support - that led to difficulties in implementation and mismatches in understanding and implementation. Nor did the orders and timeframes implicit in the research projects provide spaces in which such differences could be identified and addressed, and interactional expertise be acquired that would have allowed for a more open dialogue between farmers and scientists and ultimately a better fit of the scientific knowledge being generated and the technological solutions being proposed.

The argument that was raised in this final chapter is that for agricultural research to generate knowledge and provide solutions that do reflect the context and meet the needs of the farmers, the ways of knowing of both farmers and scientists should be viewed symmetrically and on a level field, rather than viewing scientific knowledge as universal and farmer knowledge as context-specific. Their underlying actor-networks, orders and materialities should be traced, understood and integrated, thus helping agricultural science get out of the 'modernist box' in which concepts like farmer 'context' are black-boxed and reified (Busch & Juska, 1997), obscuring aspects that significantly influence the relevance and impact of its findings. It might also encourage scientists to see themselves not as teachers out to raise the awareness of farmers for the benefits of science and a specific technology, but as learners who are aware of the limitations and biases of their own ways of knowing, who are able to question their own most entrenched assumptions and frameworks and who strive for interactional expertise of the farmers' ways of knowing, allowing them to better understand and take into consideration the latter's objectives, limitations and needs in their work. Ultimately this would lead to what Appadurai describes as 'dialogue rather than dominion' (Appadurai, 2012 p.30), jointly searching for solutions and new trajectories of development that combine elements of farmer knowledge and of science. While such an approach is likely to add an additional degree of complexity to the scientific endeavour, this is probably a good thing. Farmer reality is often described as 'complex' in scientific literature, and as this thesis hopefully demonstrated the same applies to agricultural science. It is time for both to be treated as such.

References

Adam, B. (2008). The Timescapes Challenge: Engagement with the Invisible Temporal. In *Timescapes. ESRC Longitudinal Study Project Launch* (p. 6).

Agrawal, A. (1995). Dismantling the Divide Between Indigenous and Scientific Knowledge. *Development and Change*, *26*(3), 413–439.

Agrawal, A. (2005). Environmentality - Community, Intimate Government, and the Making of Environmental Subjects in Kumaon, India. *Current Anthropology*, *46*(2), 161–190.

Akrich, M. (1992). The De-scription of Technical Objects. In W. Bijker & J. Law (Eds.), *Shaping Technology/Building Society: Studies in Sociotechnical Change* (pp. 205–224). Cambridge/Massachusets/London: MIT Press.

Akrich, M. (1993). A Gazogene in Africa. In P. Lemonnier (Ed.), *Technological Choices: transformation in material cultures since the neolithic* (pp. 289–337). London & New York: Routledge.

Akrich, M., Callon, M., & Latour, B. (2002a). The Key to Success in Innovation Part I: The Art of Interessement. *International Journal of Innovation Management*, *6*(2), 187–206.

Akrich, M., Callon, M., & Latour, B. (2002b). The Key to Success in Innovation Part II: To Adopt is to Adapt. *International Journal of Innovation Management*, *6*(2), 207–225.

Anderson, W. (2002). Introduction - Postcolonial Technoscience. *Social Studies of Science*, *32*(5-6), 643–658.

Anderson, W., & Adams, V. (2008). Pramoedya's Chickens: Postcolonial Studies of Technoscience. In E. Hackett, O. Amsterdamska, M. Lynch, & J. Wajcman (Eds.), *The Handbook of Science and Technology Studies* (Third Edit., pp. 181–204). MIT Press.

Appadurai, A. (2012). Thinking beyond Trajectorism. In M. Heinlein, C. Kropp, J. Neumer, A. Poferl, & R. Römhild (Eds.), *Futures of Modernity. Challenges for Cosmopolitical Thought and Practice* (pp. 25–32). Bielefeld: Transcript Verlag.

Bayer, W., Lossau, A. von, & Feldmann, A. (2001). Smallholders and Community-Based Management of Farm Animal Genetic Resources. In *Community-based Management of Animal Genetic Resources* (pp. 1–12). Mbabane.

Bernard, H. R. (2006). *Research Methods in Anthropology: Qualitative and Quantitative Approaches* (4th ed.). Oxfort: Altamira Press.

Biggs, S. (2008). The lost 1990s? Personal reflections on a history of participatory technology development. *Development in Practice*, *18*(4-5), 489–505.

Blumer, H. (1969). *Symbolic Interactionism: Perspective and Method*. (Prentice-Hall, Ed.)*The British Journal of Sociology* (Vol. 39, p. 208). University of California Press.

Bowker, G., & Star, S. L. (1999). *Sorting Things Out. Classification and Its Consequences*. Cambridge, Mass: MIT Press.

Briggs, J. (2005). The use of indigenous knowledge in development: problems and challenges. *Progress in Development Studies*, *5*(2), 99–114.

Brodt, S. (2001). A Systems Perspective on the Conservation and Erosion of Indigenous Agricultural Knowledge in Central India. *Human Ecology*, *29*(1), 99–120.

Bryman, A. (2008). *Social Research Methods* (3rd ed., p. 748). Oxford: Oxford University Press.

Busch, L., & Juska, A. (1997). Actor Networks and the Globalization of Agriculture. *Review of International Political Economy*, *4*(4), 688–708.

Callon, M. (1986). Some elements of a sociology of translation: domestication of the scallops and the fishermen of St Brieuc Bay. *Sociological Review*, *32*, 196–233.

Chambers, D. W., & Gillespie, R. (2000). Locality in the History of Science: Colonial Science, Technoscience and Indigenous Knowledge. In R. McLeod (Ed.), *Osiris, Volume 15: Nature and Empire: Science and the Colonial Enterprise* (Vol. 15, pp. 221–240). Chicago: University of Chicago Press.

Chambers, R. (1983). *Rural Development: Putting the last first* (p. 256). Routledge.

Chambers, R. (1997). *Whose Reality Counts? Putting the first last* (p. 297). London: Intermediate Technology Development Group.

Charmaz, K. (2006). *Constructing Grounded Theory: A Practical Guide Through Qualitative Analysis* (p. 208). London: Sage Publications Ltd.

Cleaver, F. (1999). Paradoxes of participation: questioning participatory approaches to development. *Journal of International Development*, (11), 597–612.

Cohen, J., & Uphoff, N. (1980). Participation's place in rural development: seeking clarity through specificity. *World Development*, (8), 213–235.

Collins, H., & Evans, R. (2007). *Rethinking Expertise* (p. 176). Chicago: University of Chicago Press.

Collins, H. M. (2001). Tacit Knowledge, Trust and the Q of Sapphire. *Social Studies of Science*, *31*(1), 71–85.

Cooke, B., & Kothari, U. (2001). *Participation, the new tyranny?* (p. XII, 207 p). London: Zed.

Cornwall, A. (2008). Unpacking "Participation": models, meanings and practices. *Community Development Journal*, *43*(3), 269–283.

Cox, A. M. (2005). What are communities of practice? A comparative review of four seminal works. *Journal of Information Science*, *31*(6), 527–540.

Davis, K., Swanson, B., Amudavi, D., Mekonnen, D. A., Flohrs, A., Riese, J., … Zerfu, E. (2010). In-Depth Assessment of the Public Agricultural Extension System of Ethiopia and Recommendations for Improvement. Washington D.C.

De Laet, M., & Mol, A. (2000). The Zimbabwe Bush Pump: Mechanics of a Fluid Technology. *Social Studies of Science*, *30*(2), 225–263.

Delgado, C., Rosegrant, M., Steinfeld, H., Ehui, S., & Courbois, C. (1999). Livestock to 2020 - The Next Food Revolution. Washington D.C.

Desai, V., & Potter, R. B. (2006). *Doing Development Research*. (V. Desai & R. B. Potter, Eds.)*Methods* (Vol. 00, p. 340). Sage Publications.

Diao, X., Hazell, P. B. R., Resnick, D., & Thurlow, J. (2007). *The role of agriculture in development - Implications for Sub-Saharan Africa*. (I. F. P. R. Institute, Ed.)*IFPRI Research Reports* (Vol. 153). Washington.

Dixon, J., Gulliver, A., & Gibbon, D. (2001). *Summary - Farming Systems and Poverty: Improving Farmers' Livelihoods in a Changing World*. (M. Hall, Ed.) (p. 41).

Drori, G. S., Meyer, J. W., Ramirez, F. O., & Schofer, E. (2003). *Science in the Modern World Polity: Institutionalization and Globalization*. Standford University Press.

Easterly, W. (2006). *The White Man's Burden: Why the West's Efforts to Aid the Rest Have Done So Much Ill and So Little Good* (p. 448). Penguin Press.

Ebner, M. (2010). Breeding Development? The making-of of Animal Breeding Policies in Uganda. Vienna: University of Vienna.

Ellen, R., & Harris, H. (2000). Introduction. In R. Ellen, P. Parkes, & A. Bicker (Eds.), *Indigenous environmental knowledge and its transformations* (pp. 1–33). Amsterdam: Harwood Academic Publishers.

FAO. (2015). Animal Genetic Resources - A Safety Net for the Future. Retrieved September 04, 2015, from http://www.fao.org/nr/cgrfa/cthemes/animals/en/

Farrington, J., & Bebbington, A. (1993). *Reluctant Partners: Non-governmental Organisations, the State and Sustainable Agricultural Development*. London: Routledge.

Flick, U. (2009). *An Introduction to Qualitative Research* (p. 528). Sage Publications Ltd.

Foote, R. H. (2002). The history of artificial insemination : Selected notes and notables. *Journal of Animal Science*, (80), 1–10.

Frankema, E. (2014). Africa and the Green Revolution A Global Historical Perspective. *NJAS - Wageningen Journal of Life Sciences*, *70-71*, 17–24.

Gayon, J., & Burian, R. M. (2000). France in the era of mendelism (1900-1930). *C.R.Acad.Sci.Paris*, (323), 1097–1106.

Gilbert, R. (2008a). From Bakewell to BLUP. *The Shepherd*, 10–15.

Gilbert, R. (2008b). From Bakewell to BLUP: A History of Livestock Breeding (Part II). *The Katahdin Hairald*, 4–8.

Glaser. (2002). Constructivist grounded theory? *Forum Qualitative Sozialforschung/Forum: Qualitative Social Research*.

Glaser, B., & Strauss, A. (1999). *The Discovery of Grounded Theory: Strategies for Qualitative Research* (p. 271). Aldine Transaction.

Godin, B. (2006). The Linear Model of Innovation: The Historical Construction of an Analytical Framework. *Science, Technology & Human Values*, *31*(6), 639–667.

Gold, R. L. (1958). Roles in Sociological Field Observations. *Social Forces*, *36*(3), 217–223.

Haraway, D. (1988). Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective. *Feminist Studies*, *14*(3), 575–599.

Heeks, R., & Stanforth, C. (2013). Technological Change in Developing Countries: Opening the Black Box of Process using Actor-Network Theory. Manchester.

Henke, C. R. (2000). Making a Place for Science : The Field Trial. *Social Studies of Science*, *30*(4), 483–511.

Holloway, L., & Morris, C. (2008). Boosted bodies: genetic techniques, domestic livestock bodies and complex representations of life. *Geoforum*, *39*, 1709–1720.

Holloway, L., Morris, C., Gilna, B., & Gibbs, D. (2009). Biopower, genetics and livestock breeding: (re)constituting animal populations and heterogeneous biosocial collectivities. *Transactions of the Institute of British Geographers*, *34*, 394–407.

Holloway, L., Morris, C., Gilna, B., & Gibbs, D. (2010). Choosing and rejecting cattle and sheep: changing discourses and practices of (de)selection in pedigree livestock breeding. *Agriculture and Human Values*, 1–15.

Infield, M., Rubagyema, P., & Muchunguzi, C. (2003). *The Names of Ankole Cows*. Kampala: Fountain Publishers.

Jacob, F. (1970). *La logique du vivant*. Paris: Gallimard.

James, K. (2006). A History of Ethnic Relations in Ankole, Uganda, during the Colonial Period, 1898-1962. Retrieved August 26, 2015, from http://www.researchgate.net/publication/239328946_A_History_of_Ethnic_Relations_in_Ankole_Uganda_during_the_Colonial_Period_1898-1962

Jarret, F. G. (1985). Sources and models of agricultural innovation in developed and developing countries. *Agricultural Administration*, (18), 217–234.

Jasanoff, S. (2004). Ordering Knowledge, Ordering Society. In S. Jasanoff (Ed.), *States of Knowledge: The Co-production of Science and Social Order* (pp. 13–45). Routledge.

Juma, C. (2011). *The New Harvest - Agricultural Innovation in Africa*. Oxford: Oxford University Press.

Karras, K., Kominakis, A. P., & Spandonidis, T. (n.d.). ZPlan-online - optimization of breeding programs. Retrieved September 02, 2015, from http://www.zplan-online.eu

Klerkx, L., van Mierlo, B., & Leeuwis, C. (2012). Evolution of systems approaches to agricultural innovation: concepts, analysis and interventions. In I. Darnhofer, D. Gibbon, & B. Dedieu (Eds.), *Farming Systems Research into the 21st Century: The New Dynamic* (pp. 457–482). Dordrecht: Springer Netherlands.

Kosgey, I. S., & Okeyo, A. M. (2007). Genetic improvement of small ruminants in low-input, smallholder production systems: Technical and infrastructural issues. *Small Ruminant Research*, (70), 76–88.

Lamers, J. P. A., & Feil, P. R. (1995). Farmers' knowledge and management of spatial soil and crop growth variability in Niger, West Africa. *Netherlands Journal of Agricultural Science*, (43), 375–389.

Latour, B. (1983). Give Me a Laboratory and I will Raise the World. In K. Knorr-Cetina & M. Mulkay (Eds.), *Science Observed: Perspectives on the Social Study of Science*. London: Sage Publications Ltd.

Latour, B. (1986). Visualization and Cognition: Thinking With Eyes and Hands. *Knowledge and Society: Studies in the Sociology of Culture Past and Present*, *6*, 1–40.

Latour, B. (1988). *Science in Action: How to Follow Scientists and Engineers through Society* (p. 288). Harvard University Press.

Latour, B. (1991). Technology is Society Made Durable. In J. Law (Ed.), *A Sociology of Monsters: Essays on Power, Technology and Domination* (pp. 103–131). London & New York: Routledge.

Latour, B. (1992). Where Are the Missing Masses? The Sociology of a Few Mundane Artifacts. In W. Bijker & J. Law (Eds.), *Shaping Technology/Building Society* (pp. 225–258). London/Cambridge: MIT Press.

Latour, B. (1993). *We Have Never Been Modern*. Hemel Hempstead: Harvester Wheatsheaf.

Latour, B. (2004). Why Has Critique Run out of Steam? From Matters of Fact to Matters of Concern. *Critical Inquiry*, (30 (Winter 2004)), 225–248.

Latour, B. (2005). *Reassembling the social : an introduction to actor-network-theory*. *Clarendon lectures in management studies* (p. X, 301 p). Oxford: Oxford University Press.

Latour, B., & Woolgar, S. (1979). *Laboratory Life: The Construction of Scientific Facts*. Princeton University Press.

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. (R. Pea & J. S. Brown, Eds.)*Learning in doing* (Vol. 95, p. 138). Cambridge University Press.

Law, J. (1986). On the Methods of Long Distance Control: Vessels, Navigation, and the Portuguese Route to India. In J. Law (Ed.), *Power, Action and Belief: A New Sociology of Knowledge? Sociological Review Monograph 32* (pp. 234–262). Henley: Routledge.

Law, J. (1992). Notes on the Theory of the Actor Network: Ordering, Strategy and Heterogeneity. Centre of Science Studies, Lancaster University. Retrieved from http://www.lancs.ac.uk/fass/sociology/papers/law-notes-on-ant.pdf

Law, J. (1999). Traduction/Trahison: Notes on ANT. Centre for Science Studies, Lancaster University. Retrieved from http://www.lancs.ac.uk/fass/sociology/papers/law-traduction-trahison.pdf

Law, J. (2008). Seeing Like a Survey. Retrieved September 04, 2015 from http://heterogeneities.net/publications/Law2008SeeingLikeASurvey.pdf

Leach, M., Scoones, I., & Wynne, B. (2005). *Science and Citizens: Globalization and the Challenge of Engagement* (p. 295). Zed Books Ltd.

Leach, M., Sumner, A., & Waldman, L. (2008). Discourses, dynamics and disquiet: multiple knowledges in science, society and development. *Journal of International Development*, (20), 727–738.

Levine, D. N. (1964). On the history and culture of Manz. *Journal of Semitic Studies*, *1*(9), 204–211.

Levine, D. N. (1965). *Wax and Gold - Tradition and innovation in Ethiopian culture*. Chicago and London: The University of Chicago Press.

Levine, D. N. (1968). The Flexibility of Traditional Culture. *Journal of Social Issues*, *XXIV*(4).

Lewins, A., & Silver, C. (2007). *Using Software in Qualitative Research: A Step-by-Step Guide*. London: Sage Publications.

Livingstone, D. N. (2003). *Putting Science in its Place: Geographies of Scientific Knowledge*. Chicago and London: The University of Chicago Press.

Lush, J. L. (1951). The impact of genetics on animal breeding. *Journal of Animal Science*, (10), 311–321.

Mackenzie, F. (1995). Selective silence: a feminist encounter with environmental discourse in colonial Africa. In J. Crush (Ed.), *Power of development* (pp. 100–112). London: Routledge.

Mbabazi, P. (2005). *Supply Chain and Liberalization of the Milk Industry in Uganda*. Kampala: Fountain Publishers.

McCann, J. (1995). *People of the plow: an agricultural history of Ethiopia*. Madison: The University of Wisconsin Press.

McNeil, M. (2005). Introduction: Postcolonial Technoscience. *Science as Culture*, *14*(2), 105–112.

Mikkelsen, B. (1995). *Methods for Development Work and Research: A Guide for Practitioners*. London: Sage Publications.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative Data Analysis: An Expanded Sourcebook*. London: Sage Publications.

Mol, A. (1998). Ontological Politics. A word and some questions. *The Sociological Review*, *46*(S), 74–89.

Mol, A. (2002). *The Body Multiple: Ontology in Medical Practice*. Durham and London: Duke University Press Books.

Morgan, G. (1997). *Images of Organization* (p. 496). Sage Publications.

Mosse, D. (2001). “People”s Knowledge’, Participation and Patronage: Operations and Representations in Rural Development. In B. Cooke & U. Kothari (Eds.), *Participation: The New Tyranny?* (pp. 16–35). London ; New York: Zed Books Ltd.

Mosse, D. (2005). *Cultivating development : an ethnography of aid policy and practice*. *Anthropology, culture, and society* (p. xvii, 315 p.). London ; Ann Arbor, MI: Pluto Press.

Mosse, D., & Lewis, D. (2006). Theoretical Approaches to Brokerage and Translation in Development. In D. Mosse & D. Lewis (Eds.), *Development Brokers and Translators: the Ethnography of Aid Agencies* (pp. 1–26). West Hartford: Kumarian Press Inc.

Moyo, D. (2010). *Dead Aid: Why Aid Is Not Working and How There Is a Better Way for Africa* (p. 208). Farrar, Straus and Giroux.

Nagel, T. (1986). *The View from Nowhere*. New York: Oxford University Press.

Neef, A., & Neubert, D. (2010). Stakeholder participation in agricultural research projects: a conceptual framework for reflection and decision-making. *Agriculture and Human Values*, *28*(2), 179–194.

Neidhardt, R., Grell, G., Schrecke, W., & Jakob, H. (1996). Sustainable livestock farming in eastern Africa. *Animal Research and Development*, (43/44), 44 – 52.

Neuman, W. L. (1997). *Social Research Methods - Qualitative and Quantitative Approaches* (3rd ed., p. 560). Needham Heights: Allyn & Bacon.

Noe, E., & Alrøe, H. F. (2003a). Combining Luhmann and Actor-Network Theory to see Farm Enterprises as Self-organizing Systems. *Systems Theory*. Copenhagen.

Noe, E., & Alrøe, H. F. (2003b). Farm Enterprises as Self-organizing Systems: A New Transdisciplinary Framework for Studying Farm Enterprises? *International Journal of Sociology of Agriculture and Food*, *11*(1), 3–14.

Oberthür, F. (2002). *Survival of the Fitting: The Social Construction of NGO-NARS Relations in Agricultural Technology Development for Family Farming in Southern Brazil*. Wageningen University.

Okali, C., Sumberg, J., & Farrington, J. (1994). *Farmer participatory research : rhetoric and reality* (p. 159 p.). London: Intermediate Technology Publications.

Ollivier, L. (1999). Scientific challenges to animal breeding and genetics. In J. C. M. Dekkers, S. J. Lamont, & M. F. Rothschild (Eds.), *From Jay L. Lush to genomics: visions for animal breeding and genetics* (pp. 24–34). Ames, Iowa: Iowa University Press.

Ollivier, L. (2008). Jay Lush: Reflections on the Past. *Lohmann Information*, *43*(2), 3–12.

Oudshoorn, N., & Pinch, T. (Eds.). (2003). *How Users Matter: The Co-construction of Users and Technology* (p. 340). Cambridge, Mass: The MIT Press.

Owen, E. (2005). *Livestock and wealth creation* (p. XII, 601 S.). Nottingham: Nottingham Univ. Press.

Ploeg, J. D. van der, & Long, A. (1994). *Born from within : practice and perspectives of endogenous rural development*. *European perspectives on rural development* (p. 296 p.). Assen: Van Gorcum.

Polanyi, M. (1966). *The Tacit Dimension* (p. 128). Garden City: Doubleday & Company Inc.

Porter, T. (1995). *Trust in Numbers* (p. 310). Princeton, NJ: Princeton University Press.

Porter, T. (1996). Making things quantitative. In M. Power (Ed.), *Accounting and science : natural inquiry and commercial reason / edited by Michael Power* (pp. 36–56). Cambridge ; New York :

Powell, M. (2006). Which knowledge? Whose reality? An overview of knowledge used in the development sector. *Development in Practice*, *16*(6), 518–532.

Preston, P. W. (1996). *Development Theory* (p. xv, 368 p.). Oxford ; Cambridge, Mass.: Blackwell Publishers.

Pretty, J. N. (1995). Participatory Learning for Sustainable Agriculture. *World Development*, *23*(8), 1247–1263.

Rabinow, P. (1999). Artificiality and enlightenment: from sociobiology to biosociality. In M. Biagioli (Ed.), *The science studies reader* (pp. 407–416). London: Routledge.

Reckwitz, A. (2002). Toward a Theory of Social Practices: A Development in Culturalist Theorizing. *European Journal of Social Theory*, *5*(2), 243–263.

Rege, J. E. O., Marshall, K., Notenbaert, A., Ojango, J. M. K., & Okeyo, A. M. (2011). Pro-poor animal improvement and breeding - What can science do? *Livestock Science*, *136*, 15–28.

Reijntjes, C., Haverkort, B., & Waters-Bayer, A. (1992). *Farming for the Future: An introduction to low-external input and sustainable agriculture*. Leusden: ILEIA.

Richards, P. (1985). *Indigenous agricultural revolution : ecology and food production in West Africa* (p. 192 p.). London etc.: Hutchinson etc.

Roscoe, J. (1923). *The Banyankole*. Cambridge: Cambridge University Press.

Rottenburg, R. (2009). *Far-fetched Facts - A Parable of Development Aid*. Cambridge, Mass.: The MIT Press.

Schroeder, R. A. (1999a). Community, forestry and conditionality in the Gambia. *Africa*, (69), 1–21.

Schroeder, R. A. (1999b). Geographies of environmental intervention in Africa. *Progress in Human Geography*, (23), 359–378.

Scoones, I., Leach, M., Smith, A., Stagl, S., Stirling, A., Thompson, J., & Centre, S. (2007). Dynamic Systems and the Challenge of Sustainability. (S. Centre, Ed.)*STEPS Working Paper 1*. Brighton: STEPS Centre.

Scoones, I., & Thompson, J. (1994). Knowledge, power and agriculture - towards a theoretical understanding . In I. Scoones & J. Thompson (Eds.), *Beyond Farmer First:*

rural people's knowledge, agricultural research and extension practice (pp. 16–32). London: Intermediate Technology Development Group.

Shapin, S., & Schaffer, S. (1985). *Leviathan and the Air-Pump: Hobbes, Boyle, and the Experimental Life* (p. 448). Princeton, NJ: Princeton University Press.

Shepherd, C. J., & Gibbs, M. R. (2006). "Stretching the Friendship" - On the Politics of Replicating a Dairy in East Timor. *Science, Technology and Human Values*, *31*(6), 668–701.

Sikana, P., & Mwanbazi, T. (1996). Environmental change and livelihood responses: shifting agricultural practices in the lakes depression zone of northern Zambia. In C. Reij, I. Scoones, & C. Toulmin (Eds.), *Sustaining the soil: indigenous soil and water conservation in Africa* (pp. 107–116). London: Earthscan Publications.

Sismondo, S. (1999). Models, Simulations, and Their Objects. *Science in Context*, *12*(02), 247–260.

Smith, B. D. (1998). *The Emergence of Agriculture*. *Scientific American Library Paperbacks* (p. 231). New York: Scientific American Library.

Spradley, J. P. (1979). *The Ethnographic Interview* (p. 256). Cengage Learning, Inc.

Stirling, A. (2005). Opening up or closing down? Analysis, participation and power in the social appraisal of technology. In M. Leach, I. Scoones, & B. Wynne (Eds.), *Science and Citizens - Globalization & The Challenge of Engagement* (pp. 218–231). London & New York: Zed Books Ltd.

Strauss, A., & Corbin, J. (1990). *Basics of qualitative research: Grounded theory procedures and techniques*. (A. Strauss & J. Corbin, Eds.)*Basics of Qualitative Research Techniques and Procedures for Developing Grounded Theory* (Vol. 2nd, p. 270). Sage.

Thompson, J., & Scoones, I. (2009). Addressing the dynamics of agri-food systems: an emerging agenda for social science research. *Environmental Science and Policy*, *12*, 386–397.

Tibbo, M. (2006). *Productivity and Health of Indigenous Sheep Breeds and Crossbreds in the Central Ethiopian Highlands*. Swedish University of Agricultural Sciences.

Turnbull, D. (1997). Reframing Science and Other Local Knowledge Traditions. *Futures*, *29*(6), 551–562.

Turnbull, D. (2000). *Masons, Tricksters and Cartographers*. London & New York: Routledge.

Turnbull, D. (2006). The Function of Maps. In P. Rothenberg (Ed.), *Beyond Borders* (pp. 7–15). Worth.

Van Asten, P. J. A., Kaaria, S., Fermont, A. M., & Delve, R. J. (2009). Challenges and lessons when using farmer knowledge in agricultural research and development projects in Africa. *Experimental Agriculture*, *45*, 1–14.

Watson-Verran, H., & Turnbull, D. (1995). Science and Other Indigenous Knowledge Systems. In S. Jasanoff, G. E. Markle, T. Pinch, & J. C. Petersen (Eds.), *Handbook of Science and Technology Studies* (pp. 115–139). Thousand Oaks: Sage Publications.

Wenger, E. (1998). *Communities of Practice: learning, meaning and identity*. Cambridge: Cambridge University Press.

Wenger, E., McDermott, R., & Snyder, W. M. (2002). *Cultivating Communities of Practice* (p. 284). Boston, Mass.: Harvard Business School Press.

Wolcott, H. F. (2004). *The Art of Fieldwork* (2nd ed., p. 298). Altamira Press.

Wood, R. J., & Orel, V. (2001). *Genetic prehistory in selective breeding : a prelude to Mendel* (p. XVII, 323 p). Oxford: Oxford University Press.

World Bank. (1998). Indigenous Knowledge for Development - A Framework for Action. Washington D.C.

Wurzinger, M., Okeyo, A. M., Semambo, D., & Sölkner, J. (2009). The Sedentarisation Process of the Bahima in Uganda: An emic view. *African Journal of Agricultural Research*, *4*(10), 1154–1158.

All pictures were taken and figures made by the author, unless indicated otherwise.

Annexes

1. List of Abbreviations

ADA	Austrian Development Agency (Austria)
AGRA	Alliance for a Green Revolution in Africa
AI	Artificial Insemination
ANT	Actor-network Theory
Boku	Universität für Bodenkultur (Austria)
CGIAR	Consultative Group for International Agricultural Research
DBRC	Debre Birhan (Agricultural) Research Centre (Ethiopia)
FAO	Food and Agriculture Organisation of the United Nations
ICAR	International Committee on Animal Recording
ICARDA	International Centre for the Research in Dry Areas (CGIAR)
ILRI	International Livestock Research Institute (CGIAR)
NAGRC	National Animal Genetic Resource Centre (Uganda)
NARO	National Agricultural Research Organisation (Uganda)
UN	United Nations

2. English Abstract

The narrative underlying agricultural research for development is that its task is to transfer its 'universal' scientific principles and science-based technologies to the 'local' settings of smallholder farmers in developing countries, adapting and implementing them in the hope of empowering these farmers to overcome their poverty and to 'develop'. In animal science this narrative further includes an ongoing 'Livestock Revolution', with growing global demand for livestock products requiring farmers to increase their productivity. Animal science's role then is to provide them with the means to do so without endangering available natural and genetic resources. Critics question its underlying modernist, linear thinking and call for approaches that acknowledge the complexity and power-dimensions in agricultural development and knowledge-generation.

This dissertation takes up this call by conceptualising the ways of knowing of farmers and scientists as heterogeneous actor-networks that have emerged as response to and in interaction with specific contexts. They have an underlying materiality - i.e. they are embodied not only through people but also through non-human elements such as livestock, localities and tools - as well as implicit social orders that shape the way in which they interact with and integrate other ways of knowing. Agricultural research for development is accordingly envisioned as a 'travel' of scientific processes and the heterogeneous elements of which they consist to the localities of the farmers that they are meant to address. On-farm research projects are understood as part of this travel, with scientists applying their methods and tools to have farmers become part of a global, technoscientific network making knowledge about these farmers available for the wider community of scientists and policy-makers, and providing the farmers with science-based technologies and approaches to breeding. It is this process of enrolment of farmers into science-based animal breeding through research projects that is the subject of this dissertation.

The empirical basis of the dissertation is the ethnographic study of two animal breeding research projects in Ethiopia and Uganda respectively. In the Ugandan case study the farmers belong to a tribe of pastoralists who settled down and are in the process of becoming market-based dairy farmers. A team of scientists who intended to analyse their farming system and identify avenues for development approached them. While the scientists' translation of the farmers' livelihood into scientific outputs provided a basis for future engagement by researchers and policy-makers, the project's timeframe and the tools and approaches that the scientists used did not provide room for the farmers to challenge the values and imaginations underlying animal breeding science and technology. Furthermore, the project's enactment of farmers as data-providers and passive receivers of feedback ultimately led to tensions that jeopardised project implementation. The Ethiopian case study describes the attempt of a team of scientists at having smallholder farmers in Menz region of the Ethiopian Highlands adopt community-based breeding. While the 'participation' of farmers was a key element of this approach to breeding, it only occurred in specific spaces pre-determined by the requirements of the approach. Furthermore, community-based breeding required the farmers to maintain their sheep as breeding assets, as opposed to their typical use of them as emergency cash reserves. This conflicting enactment of sheep ultimately led to many farmers not following the scientists' instructions, their main interest being instead the relation of patronage and support with the scientists that the research project provided.

Both case studies illustrate how the ways of knowing of animal breeding science entail specific orders and values and impose certain ontologies of livestock that can be traced back to their origins in industrialised countries. The same applies for the farmers' ways of knowing, which are also a product of their respective setting. The tools and approaches of animal breeding science - including the limitations of working through projects - however do as yet not provide any room to address and integrate differences in underlying orders and values. Doing so would require a symmetric view on ways of knowing, considering farmers' and scientists' knowledge as comparable and addressing their underlying materiality. Similarly, technologies should be viewed as fluid entities that are open to adaptation and reinterpretation. Research, finally, should aim for long-term engagement between farmers and scientists, providing spaces and places in which they can openly interact and challenge each other, and thus acquire a deeper understanding for each other's respective ways of knowing.

3. German Abstract

Forschung in der landwirtschaftlichen Entwicklung basiert auf dem Verständnis, dass es deren Aufgabe ist, 'universelle' wissenschaftliche Prinzipien und auf Wissenschaft basierte Technologien in das ‘lokale’ Umfeld von Kleinbauern in Entwicklungsländern zu bringen, und diese anzupassen und zu anzuwenden damit Kleinbauern ihre Armut überwinden und sich ‘entwickeln’ können. In den Nutztierwissenschaften wird dieses Verständnis weiter ergänzt durch eine sich gegenwärtig vollziehende ‘Livestock Revolution’, in der die wachsende, globale Nachfrage nach tierischen Produkten Bauern dazu antreibt, ihre Produktivität zu erhöhen. Die Rolle der Nutztierwissenschaften ist es daher, dies Bauern zu ermöglichen, ohne die verfügbaren natürlichen und genetischen Ressourcen zu gefährden. Kritiker hinterfragen die unterliegende modernistische, lineare Denkweise und fordern Herangehensweisen, die die Komplexität und die Machtverhältnisse in der landwirtschaftlichen Entwicklung und Wissensgenerierung berücksichtigen.

Diese Dissertation nimmt diese Forderungen auf, indem sie die Formen des Wissens von Bauern und Wissenschaftlern als heterogene Akteur-netzwerke versteht. Diese Netzwerke sind als Antwort auf und im Zusammenwirken mit spezifischen Kontexten entstanden und basieren auf einer eigenen Materialität, d.h. sie werden sowohl durch Menschen als auch durch nichtmenschliche Elemente wie z.B. Vieh, Orte und Werkzeuge verkörpert. Auch beinhalten sie implizite soziale Ordnungen, die deren Interaktion mit und Integration von anderen Formen des Wissens beeinflussen. Diesem Verständnis entsprechend wird landwirtschaftliche Entwicklungsforschung verstanden als eine ‘Reise’ von wissenschaftlichen Prozessen und den heterogenen Elementen aus denen sie bestehen, hin zu den Bauern. On-farm Forschungsprojekte werden als Teil dieser Reise verstanden, in der Wissenschaftler ihre Methoden und Werkzeuge anwenden, damit die Bauern Teil eines globalen, technowissenschaftlichen Netzwerkes werden. In diesem Netzwerk wird Wissen über diese Bauern für die breitere wissenschaftliche Gemeinschaft von Wissenschaftlern und politischen Entscheidungsträgern verfügbar gemacht, und die Bauern bekommen Zugang zu auf Wissenschaft basierenden Technologien und Zuchtmethoden. Diese Dissertation behandelt diesen Prozess der Integration von Bauern in der auf Wissenschaft basierenden Tierzucht durch Forschungsprojekte.

Die empirische Basis der Dissertation ist die ethnografische Untersuchung von zwei Forschungsprojekten in der Tierzucht in Äthiopien und Uganda. In der ugandischen Fallstudie sind die entsprechenden Bauern Mitglieder eines Stammes von ehemaligen Hirten, die sesshaft geworden sind und zunehmend marktintegrierte Milchbauern werden. Sie wurden von einem Team von Wissenschaftlern kontaktiert, deren Absicht es war, ihr Produktionssystem zu analysieren und Wege zu dessen Entwicklung zu identifizieren. Zwar konnten die Wissenschaftler die Lebensweisen der Bauern in wissenschaftliche Ergebnisse übersetzen, die eine Grundlage bilden für ein zukünftiges Engagement durch andere Wissenschaftler sowie politische Entscheidungsträger. Der Zeithorizont des Projekts und die Werkzeuge und Herangehensweisen, die die Wissenschaftler hierbei verwendet haben, boten jedoch den Bauern nicht den Raum, die den Nutztierwissenschaften und Technologien zugrunde liegenden Werte und Imaginationen anzufechten. Zudem führte die Inszenierung der Bauern als Datenquellen und passive Empfänger von Feedback im Rahmen des Forschungsprojekts zu Spannungen die den Ausgang des Projektes gefährdeten. Die äthiopische Fallstudie beschreibt den Versuch eines Teams von Wissenschaftlern, einen sog. ‘community-based breeding’-Ansatz unter Kleinbauern in der Menz Region in den äthiopischen Hochländern einzuführen. Während hierbei die ‘Partizipation’ der Bauern ein

Kernelement dieses Tierzuchtansatzes war, fand diese jedoch nur in spezifischen Momenten statt, die durch die Erfordernisse des Ansatzes vorbestimmt worden waren. Zudem ist es im Rahmen von ‘community-based breeding’ erforderlich, dass die Bauern ihre Schafe fortan als Zuchtanlage erhalten, im Gegensatz zu ihrer üblichen Herangehensweise, in der Schafe als Geldquellen für Notfälle genutzt werden können. Diese konfliktierenden Inszenierungen von Schafen führten letztendlich dazu, dass viele teilnehmende Bauern die Anweisungen der Wissenschaftler nicht mehr folgten. Ihr Hauptinteresse lag stattdessen in der ‘Schirmherrschaft’ und der Unterstützung, die ihnen die Wissenschaftler im Rahmen des Forschungsprojekts boten.

Beide Fallstudien beschreiben, wie die Formen des Wissens der Nutztierwissenschaften spezifische Ordnungen und Werte beinhalten und bestimmte Ontologien von Nutztieren auferlegen, die auf ihren Ursprung in industrialisierten Ländern zurückgeführt werden können. Dasselbe gilt für die Formen des Wissens der Bauern, die auch das Ergebnis ihres jeweiligen spezifischen Kontexts sind. Die Werkzeuge und Herangehensweisen der Nutztierwissenschaften – inklusive deren Einschränkungen aufgrund der Arbeit im Rahmen von Forschungsprojekten – bieten jedoch noch nicht den Raum, um diese Unterschiede in den unterschwelligen Ordnungen und Werten zu berücksichtigen und zu integrieren. Dies zu tun würde eine symmetrische Sichtweise von Formen des Wissens erfordern, die die Formen des Wissens von Bauern und Wissenschaftlern als gleichwertig und vergleichbar ansieht und deren zugrundeliegende Materialität beachtet. Auch sollten Technologien als fluide Instanzen gesehen werden, die angepasst und reinterpretiert werden können. Wissenschaftliche Forschung sollte langfristiges Engagement zwischen Bauern und Wissenschaftlern anvisieren, wodurch Räume und Orte geschaffen werden können, in denen sie offen miteinander umgehen und einander infrage stellen können. Hierdurch würden sie ein tieferes Verständnis füreinander und für ihre jeweiligen Formen des Wissens erhalten können.

4. Curriculum Vitae

Personal Data

Name: Frederik Winfried Oberthür, MSc
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Educational Background

2008-2015	Doctoral Studies in Sociology (Dr.phil) at the Dept. of Social Studies of science/University of Vienna (Austria)
1994-2002	Studies of Crop Science (free orientation) at Wageningen University and Research Centre (Netherlands); Master thesis: *Survival of the Fitting; The Social Construction of NGO-NARS Relations in Agricultural Technology Development for Family Farming in Southern Brazil*

Collaboration in Research Projects

'Ways of Knowing – When scientific and rural epistemologies meet in rural development'; Austria, Ethiopia, Uganda; University of Natural Resources and Live Sciences, Vienna, Austria (funded by the Austrian Science Fund)

'Natural Resource Management Revisited – Analysing ways of knowing in research projects in East Africa'; Austria, Ethiopia, Uganda; University of Natural Resources and Live Sciences, Vienna, Austria (funded by the Austrian Science Fund and the Commission for Development Research at the OeAD GmbH)

Publications/presentations

'Changing Perspectives on Sheep - The meeting of local and scientific epistemologies in community-based sheep-breeding in the Ethiopian Highlands'; presentation at the XVIII World Congress of Rural Sociology, Lisbon, 2012

'From Herding to Business: A Sociology of Translation of Dairy Farming in Western Uganda'; presentation at the international workshop 'Understanding Development Through Actor-network Theory', London School of Economics, UK, 2011

Oberthür, F. (2003). Learning and holographic organizations: NGOs versus NARS. *Biotechnology and Development Monitor, 50.*

Professional Experience Related to the Research

2013-ongoing	Planning Officer/Adviser at the Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH; thematic focus: agricultural education, training and extension
2003-2008	In-house consultant at NIRAS AB (Stockholm); short-term agricultural extension and communication expert in a range of development projects in Africa, Central Asia and Eastern Europe