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Beyond Technology: Micro Irrigation Systems and the Changing Livelihoods of a Community

A Case Study of the Iranian Village of Lamlang, Province of Gorgan

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1. Introduction

> *"The country [Iran] is increasingly facing a disastrous water shortage. This year the precipitation was only around 40 percent of last year's and this puts the whole country at risk. As around 80% of water is consumed for agricultural purposes in our country, water supply for irrigation would remain a significant risk at this sector. We need to monitor and manage our irrigation practices better, and this would not be possible without introducing and promoting irrigation technologies, which not only help wasting less water in irrigation, but also provide opportunities to save water. The challenge is how to convince the farmers to change to new approaches, how they will adapt to new technologies, and how far they would influence them…" (Hammond, 2014)*

The quote above is an excerpt from an interview with Deputy Energy Minister, Sattar Mahmoudi, at the World Cities Summit in Singapore, which was published on the premier international current affairs magazine for the Asia-Pacific region, and depicts how critical the issue of water scarcity is to Iran.

As my studies in Science, Technology and Society (STS) progressed, I became increasingly interested in how technologies are developed; how they become accepted or rejected; and how these technologies influence the dynamics of their surroundings. In the past decade science and technology scholars began to acknowledge the part water technologies play in framing social, political and cultural orders, from the very local (Barnes, 2012) to the national (De Laet & Mol, 2000) and even global (Alatout, 2007b, 2008a, as cited in Alatout, 2009). Inspired by the aforementioned studies, which discuss water and water technologies as well as the role they play in making changes in their surroundings, I focus on the Micro Irrigation System, as a water irrigation technology, which is used in some regions of Iran. The Micro Irrigation System is the technology that uses a dripping method to transfer water and nutrients to the root of plants through a set of pipes, valves, and emitters.

The main reason I chose to concentrate on an Iranian community for this study is due to the fact that in the recent years, the country and, thus, the specific community is undergoing an extreme water crisis. As a result, agriculture and farming are facing serious difficulties in the sourcing of water. In order to partly manage the crisis, while keeping the industry alive, Iran's government began projects to introduce and promote the Micro Irrigation System, as an alternative irrigation technology, which would consume less water in comparison to the traditional method of mass irrigation. This technology was proposed to aid in tackling the serious crisis on water shortage in the region. In my project, I attempt to investigate how through the establishment of the Micro Irrigation Systems in Lamlang village, the livelihoods of the individuals of the community and their relation to this technology have changed. My thesis

contributes to the concept that technologies make changes to their surroundings and are influenced in return. My case study shows the livelihoods of the community, which were about to shift to this new method of irrigation, underwent significant changes.

By using an Actor-Network Theory approach as the theoretical background, I focus on the Micro Irrigation System in order to study how it *acts as an actor* in the region where it is installed.

I decided on an ethnographic approach to this project in order to look deeper into the complexities of such a system. I use situational maps, interviews, as well as secondary research to compliment the main ethnographic approach, which consists primarily of field observations, in order to address my research questions. Using my field observations and notes, I analyse the agency of this irrigation device; its interaction with other actors in their wide network, creating new spaces of agricultural possibility; and the way in which the device influences and is influenced by the Lamlang society (Bijker, 2007).

The structure of the thesis is as follows:

In the second chapter, 'State of the Art', I outline the relevant STS literature, while positioning myself against how some authors in STS and other disciplines have addressed the issues similar to my field of research.

In the third chapter, 'Theoretical Framework', I discuss in depth the theoretical backbone of this project and the sensitizing concepts used while conducting the fieldwork and writing my analysis. This chapter depicts ANT as the main guide for my thought process and analysis in studying a technology in the context of its surrounding. Further on in the chapter, I reflect upon how ANT fits my choice of methodology.

In the fourth chapter entitled 'Research Questions and Methodology', I return to my main research question and related sub-questions, as well as the methods and approaches that I use in order to answer them. I elaborate why I chose these approaches and what issues I considered while applying them. Furthermore, I also explain the challenges and difficulties that I have faced while using any of my chosen methods.

In the fifth chapter, 'Empirical Analysis', I reflect on my main observations and link them to my theoretical framework and methodology, which led me to these stories. I show how the Micro Irrigation System can be shaped and adjusted by the surrounding settings and how it could make differences in its environment.

Lastly, in the sixth chapter, 'Discussion and Conclusion', I elaborate on my most important findings, and develop some conclusions, which I drew from my empirical case study. I have shown how this technology could serve the community in terms of giving them the opportunity to consume fewer resources for irrigation while gaining more trust and social credibility among customers. I demonstrate how such technology could act as a fluid artifact, which is not strictly

linked to any borders or boundaries, but instead can be changed and customized. Furthermore, I depict that a technology could be admirable in how responsive it can be in relation to its new environment and how it could influence its surroundings.

2. State of the Art

2.1. Introduction and Transfer of Technology

> *"…there is no such thing as technology transfer. That technologies don't originate at a point and spread out. But instead that they are passed. Passed from hand to hand. And that as they pass they are changed. Become less and less recognizable." (Law, 1999, p.2)*

This quote from John Law's essay 'Traduction/Trahison: Notes on ANT' (1999) draws attention to the concept of *technology transfer* by challenging the notion of technologies as originating from a single source and then spreading out to another. Instead, he suggests passing the technology from one place to another involves changes in the technology, as well as changes in the surrounding, the social and technical orders. Drawing from Actor-Network Theory, Law argues that technologies and the things around them change in the transfer, as new actors gradually come in to play. As an example, Law uses the story of transferring a machine, which compacted forest waste into briquettes and was implemented in Sweden and Nicaragua, as shown by Madeleine Akrich (1993). In this transfer, the machine must change, as new actors, such as geography, deforestation, and civil war are influential to the functioning of this machine in Nicaragua. In Nicaragua, the machine plays a different role than in Sweden. Moreover, different actors in Nicaraguan network play different roles than analogous actors in Sweden. There are, in general, different networks around this machine in Nicaragua and Sweden. In Sweden, the forest waste is compacted to briquettes and those briquettes are, in turn, burnt and combusted for industrial use. In Nicaragua, however, this machine is used to convert cotton waste into briquettes, which are then burnt for use in bakeries. These examples are just a few differences in these two networks; yet, the networks differ in almost every social, technical, and natural aspect. Therefore, when a technology transfer is taking place, not only a change in the new place is occurring, but also a change in the technology itself in order to fit the situation of the new region.

Comparably, John Law in his review of the book 'Technology on Trial: The Introduction of Steam Power Technology into Sweden' (1987) reminds us that technology is a system or a network, which encompasses artifacts, human capabilities, natural resources, social arrangements, economic considerations, and both cultural and regional preferences. Law argues, technology transfer is not just the easy task of transporting a new tool into a novel

context; rather, it, more importantly, entails that the context is to be rebuilt accordingly or replicated.

In the two pieces by Law mentioned above, technology transfer is explained as a process, which not only leads to changes and impacts in the orders of their surroundings, but also leads to the technology itself to be respectively manipulated and adapted to the new local environment. I find John Law's view of technology transfer quite useful, as his context-driven description of technology transfer shows how important it is in my own research to adequately address this and, as Kulkarni (2003) puts it, to explore the local context to which the technology is being applied.

As mentioned in the latter review, Law refers to transfer of technologies as networks, which are composed of many elements. The idea that within each technology transfer there exist different networks, consisting of various actors, is also reflected in Rogers' (2002) study of the nature of technology transfer. Rogers describes technology transfer as a communication process among networks through which the results of scientific research of one source are received and put into use by a receptor. Instead of the actors, he refers to different participants in each network, each of which have their own interests and needs. All the participants must cooperate well in order to achieve a successful transfer. Rogers defines the term technology transfer as a potentially difficult process of applying information into use (Rogers, 2002). Referring to a similar frustrating procedure, Williams and Gibson (1990, p. 10, as cited in Rogers, 2002) argue that technology transfer is not an easy process, because individuals who participate in the transfer "use different vocabularies, have different motives, and represent organizations of widely differing cultures". In addition, Rogers (2002) confirms Williams and Gibson's argument by stating that participants in every technology transfer are various and diverse; thus, those who receive the technology speak a different language than those who have invented it. There seems to be consensus among analysts that technology transfer, by far, is not a straightforward process as it always necessitates changes and adaptations, while involving various actors, which play a role in different networks.

The actor-network as well as intricacy aspects in technology transfer are also highlighted by Shepherd and Gibbs (2006), who discuss what a transfer involves by observing both how the actors experience the processes of translation and how this experience provides a level of complexity to the task. The authors argue the transfer includes both movement and transformation - what Callon (1986, as cited in Cressman, 2009) calls *translation*. In order to investigate how the transfer of a technology took place, one should attempt to interpret how the actors involved in a certain transformation and translation experienced the processes of translation and understood the processes' complexities. In order to make the notions of transformation and translation a bit clearer, I move back to the Madeleine Akrich's story of

waste convertor machine, mentioned by John Law (1999). As argued in the previous paragraph, the story is about two networks (Swedish and Nicaraguan) that are linked through the machine, which originated in Sweden; yet functions and succeeds in Nicaragua. However, these networks are different in almost every aspect. The material being converted; the customers of the briquettes; the need for storage as well as the period in each year in which the conversion could take place; the haciendas; the machinery for dealing with waste; and the habits of customers, are all different in the two places wherein the machine should work. These differences entail translation and transformation of the Swedish network for the machine, which needs to function in the Nicaraguan one. In brief, whenever there is transfer, there is indeed translation and transformation.

While Law's notions of translation and transformation are necessary elements within a technology transfer, I believe both terms fall short of describing the full story of a technology transfer. Translation, in a traditional sense, implies a linear one-to-one process of transferring, meaning without changing the technology, only using a different framework and different tools, but aiming for the exact same thing. Therefore, translation alone cannot represent technology transfer. Transformation, I find, is a stronger term and closer to the aim of technology transfer; yet, the term still does not manage to fully address the fact that a transferred technology gains a completely new and unique identity of its own, sometimes even losing all links to its origins.

From a more general STS perspective, one would see technology transfer as a story of transportation, rearrangement and reestablishment of a heterogeneous socio-technical assemblage from one place of origin to another destination. These processes of translation, to remain within Law's terminology, constitute all the natural, technical, cultural, social, economic, and political components (Latour, 1993; Pigg, 1997; as cited in Shepherd & Gibbs, 2006) - human and non-human, discursive-epistemic, and material. Escobar (1984, 1995), Latour (1993), Law and Hassard (1999) (all as cited in Shepherd & Gibbs 2006) also refer to a similar concept, but more from an experimental and political angle. They refer to the politics of interaction rather than its complexities. The authors argue that politics are distributed amongst the networks of socio-technical assemblages and negotiations are flowing among the different involved actors with their various interests and points of view.

The report on technology transfer by Intergovernmental Panel on Climate Change (IPCC) (2000) emphasizes the requirements for translation, transformation, customization, and negotiation while utilizing a technology in a new place. According to this report, other than the need to "adapt the technology to local conditions and integrate it with indigenous technologies" (p. 3), technology transfer should also encompass the procedures of ''learning to understand'' (p. 3). Here the aspect of learning is highlighted as an important component, offering that technology transfer is a social process where people are involved, whom should understand,

learn, replicate and apply different aspects of the new method or technology. A successful transfer, therefore, should take into account the local conditions of the receptor and adapt to them as much as possible. Furthermore, the new technology should be integrated with the locally existing knowledge and methods. This point raised by IPCC further strengthens my view that technology transfer is not just a process of making the technology understandable in a different context, but it is also about technology gaining a new identity. Technology does not merely change to suit a new purpose, rather the technology evolves into something completely new, potentially serving a new purpose and losing material links to its origins.

De Laet and Mol (2000), in their discussion of the fluidity of a certain water pumping technology, emphasize the importance of integrating local knowledge and making the technology appropriate in the specific local context as well. They demonstrate that a successful introduction and development of a technology (in this case a bush pump) in a new region not only entails the physical transfer of technology, but also necessitates the appropriation in the locality. Their study shows how this technology was widely adopted and applied in Zimbabwe, because of its affordability, appropriateness, reparability, applicability, and compatibility. Therefore, it is critical to integrate different aspects of the local knowledge with the new technology by developing a customized and inclusive technology that benefits from the new aspects while taking into account all relevant and useful components of locally available knowledge. In this sense, the original technology is not merely fitted to the local needs, but rather merges within the local technology, creating a new agricultural possibility.

Along a similar line, but highlighting a slightly different aspect, Mordini (2007, as cited in Fischer, Frewer, & Gupta, 2012) has defined technology transfer as a "social practice that embodies the capacity of societies to transform themselves by creating and manipulating not only physical objects, but also symbols and cultural forms" (p. 782). Again, while I find the notions of social practice and societies transforming themselves valid and a good representation of technology transfer, I question whether merely creating and manipulating would do justice to how societies are affected by technology transfer. Creation and manipulation of anything imply an active and conscious process, where the actor decides and implements a change or consciously adopts it from the outside boundaries of its own culture, context, and geography. I rather observe that technology transfer is a factor, which affects societies in both direct and indirect ways, creating an altogether new environment where actors are evolved with it and within it. To clarify the point, I suggest that creation and manipulation is too active a notion to be suitable for technology transfer, as many effects can be and are realized passively.

So far, technology transfer has been discussed as a non-linear process, a rather complex procedure, which necessitates learning to understand, translation, transportation, and

integration of local knowledge and conditions, appropriation, adjustment, and customization. Another factor, making the transfer a complex process, is the many different barriers, which appear at each phase of the transfer. Lack of knowledge and understanding of the case; inadequate human skills; political or economic barriers; incorrect and unrealistic identification of the local demands and the circumstances; weak legal support; and investment are some examples of the potential barriers in transfer (IPCC, 2000). In order to accomplish a successful transfer, the barriers should be carefully identified, analysed, and prioritized. For example, one such barrier in the context of my research is an economic-political barrier, such as commercial and economic sanctions on international trades, which Iran has gone through in the past years could play an important role in the technology transfer under discussion.

2.2. Public Reaction to New Technologies

It is not always the case that technological innovations and transfer of them into new environments are accepted immediately and unquestionably by the society. Historically, the emergence of many technologies has been accompanied by societal controversies, which in many cases have led to the entire public rejection of their use. One such example is the public protest against Genetically Modified Organisms, which has been viewed as a significant barrier to the successful application and commercialization of genetically modified food in most countries (de Jonge, Fischer, Frewer, van Dijk & Rowe, 2013).

The public acceptance of new technologies is still a major concern for those who promote and develop technological innovations. While governments and industry usually attempt to promote trust in the arranging and governing of new technologies, civil societies express concerns by pointing out the potential problems and possible difficulties that the new technologies could bring. Researchers in various fields, more specifically in Science and Technology Studies, conducted studies to address and understand the factors, which contribute to unwelcome perceptions and lack of acceptance by the majority of a certain public. Therefore, it is important to understand how the public opinion and attitude towards an emerging technology is shaped and which factors influence it.

The introduction of a new technology into a society usually leads to varying attitudes of the actors that are involved, more specifically amongst those who are supposed to use the end product. As Jamison and Hård (2003, as cited in Jamison & Lassen, 2006) argue, people tend to talk about and create many different stories out of new technologies. Therefore, a mix of different discourses around the technological change occurs, which leads to complexity in analysing them. These discourses originate from various actors, target different actors, affect different actors, and pursue different goals. For example, various stories with an economic

theme can be created in which the business firms play the main role. Similarly, stories with a social theme can be constructed by referencing a variety of actors with different interests, who all attempt to satisfy their own needs through the development of the technology. There can also be stories with cultural themes seeking to discuss the appropriateness of technologies in different cultural contexts and life styles.

Jamison and Lassen (2006) similarly refer to the same grouping of public sphere debates, but look at them from a concerns angle rather than from a discourses angle. They categorize the concerns of the public about the introduction of new technologies into economic, cultural and social ones. By economic concerns, the authors refer to either the economic opportunities and threats or the costs and benefits, which come with every new technology. While discussing cultural concerns, the authors refer to ethical, moral and religious concerns. Finally, by social concerns, Jamison and Lassen mean issues related to environmental and health risks.

Although I find the discussion of concerns useful and necessary in exploring how new stakeholders perceive a technology, I theorize that a discourse angle provides a stronger lens with which one can look at technology transfer. Concerns merely imply that various groups may have objections or potential problems with the introduction of the new technology, but I do not see acceptance or concern as the only two possible outcomes of introducing a new technology. There are other dynamics that occur when technology is introduced, which is why I find discourse a more useful tool to cover these dynamics. These dynamics include not only how the people react, but also who reacts, which actors feel affected, which actors address various other actors through a variety discourses, what kind of interests and effects are discussed, what new relationships are formed, how power relations are changed, and what new objectives and goals are set as a result, etc.

Nevertheless, discussing the concern formed upon introduction of a new technology is a key part of the discourse discussion, as concerns can be major and critical in that they come to dominate most discourses surrounding a certain technology and, therefore, create a barrier to the visibility or fruitfulness of the other discourses. As most cases of technological controversies have shown, safety and health-related risks are a central concern of a certain interested public, who will to apply the new innovations. Protesting against nuclear energy is a vivid example of a public being worried about the safety and environmental risks, which could be potentially introduced by nuclear power plants. Health related risks are also considered as a major reason for uncertainty and opposition towards Genetically Modified Organisms still in many countries. As reflected in literature by Gunter and Harris (1998) and Fischer et al. (2012), negative social attitudes towards new technologies are shaped by the concern that the new technology could also pose risk to society. In accordance with the aforementioned literature, Barben (2010) argues risk perception is considered as one of the very first approaches towards understanding the public acceptance of science and technology. The underlying assumption

in Barben's approach is that the way the risk of the new technology is perceived specifies the way public reacts to it. The notion of risk here is defined as "the relationship between the probability of a hazard and the scale of harm it would cause" (Barben, 2010, p. 275). According to the risk perception approach, if people are provided with adequate knowledge about a technology, they would understand and perceive the related risks scientifically, thus more appropriately. Therefore, equipping the public with more information would overcome the lack of acceptance.

While Barben (2010) names the aforementioned approach as risk perception, it is also known as deficit model of public understanding of science (Irwin and Wynne, 1996) in many scientific literatures, which addresses the public reaction towards emerging science and technologies. Similarly, to the risk perception approach, the deficit model links the public scepticism or rejection towards new technologies to the public's lack of information. Thusly implying that the public is presumed to be lacking in scientific knowledge, as well as an unwillingness to acknowledge expert knowledge, a greater understanding of which would lead to better acceptance of emerging technologies. According to this school of thought, with every case of a new technology, the public matters as it sometimes acts as an uninformed barrier, sometimes serves as a promoting agent to the technology's development, and, yet, other times simply resists the establishment of the technology. Bauer (2002) stresses two reasons why examining the public sphere of a new technology is important, namely information deficit and legitimization deficit, both alternative forms to the same approach as the deficit model. Bauer (2002) argues around any new technological development in a society there is significant information deficit, including significant unawareness about certain widespread opinions, views, and perspectives; thus, leading to potential misunderstandings about certain technologies. The developers and regulators of the technologies might not have a correct understanding of the public's point of view and, therefore, make incomplete conclusions. From this perspective, it is necessary to meticulously investigate in order to find out the exact perceptions and attitudes that the 'nonexpert' public (Bauer, 2002, p. 147) holds regarding the development of certain technologies. Hence, the filling in of the information gap would be the key to gaining public trust and acceptance, through the informing of people on how the technology works, how it can improve things, and how the changes personally would affect their lives. Furthermore, Bauer observes that without public trust and confidence in development of new technologies, neither the inventors, the governmental regulators, nor the other mediators of the technologies - who all decide on behalf of people - would have legitimacy for their actions and, therefore, may run into complexities or even failures in developing new technologies. In short, what Bauer theorizes is that public opinion matters as a source of information and legitimacy. Meaning, the better the public understands the science or technology (some researchers maintain) the more effectively the gap between the perceived

and objective risks of new technologies would narrow (Frewer, Hunt, Brennan, Kuznesof, Ness, & Ritson, 2003; Sturgis & Allum, 2004; as cited in Drake, 2006). Another study, supporting the deficit model, was conducted by Bonny (2003) (as cited in Lassen, Mielby & Sandøe, 2013), and concluded that providing the public with more scientific knowledge would gain more acceptance towards gene technology.

However, this deficit model of public understanding of science has been widely criticized in Science and Technology studies, with many scholars arguing that the social indicators such as education, gender, and age influence how different people perceive science and technology (Barben, 2010), and these factors were not well considered in the deficit model. Furthermore, they argue the public is neither an ignorant nor a passive actor in the understanding of scientific and technological developments. Lee, Lewenstein and Scheufele (2005) disagree that providing public with more information does affect their attitudes regarding a technology and, hence, leads to more support from their side. There are cases, which show that public scientific literacy has resulted in positive public support for science and technological development (e.g., Miller 1995, 1998, 2004; Miller & Kimmel 2001; Miller & Pardo 2000; Miller, Pardo, & Niwa 1997; as cited in Lee, et. al., 2005). The main assumption of such studies is that it is essential for a certain public to have a general and basic knowledge about scientific and technological concepts in order to have a supportive attitude towards new technologies and science. For example, the aforementioned studies by Miller and his colleagues demonstrate that civic science literacy could lead to positive attitude towards federal funding for science and research. However, there are also other articles, which indicate no clear and assessable impact of having knowledge about certain scientific topic on public attitudes towards that technology (e.g. Bonney, Brossard & Lewenstein, 2005; as cited in Lee, et al., 2005). In their study, Bonney et al. involve a group of volunteers in putting bird nests in their yards and reporting their observation and data about the nest boxes to the research team. Their goal was to evaluate the relationship between increased knowledge on a certain scientific issue and participants' attitude towards the subject. The study in the end concluded that no research method at hand would be sufficient to assess the impact of public knowledge of scientific topics on their attitudes towards them (Bonney et al., 2005). Lee et al. (2005) claim that the relation between public knowledge and attitudes of the public depends on the socio-demographic characteristics of the society in which the technology is applied and upon the individual case at hand. In my opinion, the relation between public scientific literacy and public attitude on emerging science and technology is more complicated than assumed in the first category of studies mentioned above. The lack of knowledge about general scientific issues will not necessarily mean that the public will not form any attitudes towards a new scientific and technological development. People will anyways form their own opinions and judgement based

on the information they receive from outside world, such as social media, etc. On the other hand, higher scientific literacy will not necessarily always lead to a more positive attitude and, consequently, more support of innovations. I think this also could depend on the specific scientific topic, which is under discussion, and can vary from case to case.

It appears in other studies that improved knowledge of scientific and technological issues could potentially avoid hesitation, but does not always lead to acceptance (Biotechnology and the European Public Concerted Action Group, 1997; as cited in Lassen et al., 2013). As an example, Burgess (2004, as cited in Drake, 2006) highlights the role of the Internet in shaping and influencing the protest groups. Burgess notes that with access to large amounts of data and information through Internet, protest groups are increasingly becoming up to date on scientific knowledge, and in some cases even gaining access to further scientific knowledge, which helps them keep their position in opposing the technology with better justification. Madsen, Lassen and Sandøe (2003 as cited in Lassen et al., 2013) demonstrated the probability that the opposition towards new technologies could even increase by improving public knowledge. Lassen et al. (2013) have suggested that further knowledge on scientific and technological issues does not necessarily lead to better acceptance by the public, and this hypothesis should not be generalized from one application to another. They studied the influence of further knowledge on supporting gene technology. Their analysis in the end showed no definite conclusion could be drawn on the effect of knowledge on public perception becoming more positive towards gene technology. Even though some studies indicate a positive correlation between scientific knowledge and public support of technology, no studies were able to sufficiently prove the general influence of knowledge on support of technological innovation (Allum, Brunton-Smit, Sturgis, & Tabourazi, , 2008; Moerbeek & Casimir, 2005 as cited in Lassen et al., 2013). Indeed, even if we accept or put aside whether public support is increased with better knowledge, the deficit model, I observe, presents a relatively weak tool for exploring the dynamics between various actors affected by the introduction of a new technology. The model oversimplifies the actors involved and the relevant discourses by implying that the most material discourse occurs between a single actor (which they generalize as the public) and another single actor (which again they generalize as the introducers). While in my observation, not only various discourses occur simultaneously between various actors, but also within each discourse and within each actor group sub-layers and minor discourses occur. I find that there is no such thing as a single, unified public having reached a unanimous consensus, direct opposing or accepting the introducers' proposed technology. Discourses take place on multiple layers and the linier approach of the deficit model cannot address everything within a certain network.

However, even if, for the sake of argument, we accept the deficit model as a linier process, which can be useful in understanding some of the dynamics between the public and the

experts, we cannot ignore that the model has been criticized as a one-way relationship between experts and lay people (Barben, 2010). The reason for this criticism is that the deficit model merely implicates that experts should provide public with more scientific knowledge. Instead, it was suggested that a social, two-way communication should replace such relationship in which risk related issues remain the major focus. This new approach no longer addresses how risk is being perceived, rather the approach focuses more on attempting to understand how the issues are communicated. Barben therefore, relates the lack of acceptance to the lack of appropriate communication. This approach is interested in investigating the interactions and the channels of communication among lay people, scientists, government, policymakers, and industry. The lack of acceptance by the public could then be overcome by better communication of the related risks of the technology to the public. This approach was criticized as well, as it mainly focused on risks, which meant the issues related to risk were no longer clear and certain; the public perceptions and attitudes and the way they are shaped were not sufficiently addressed; and the issues were not practically communicated to the public (Barben, 2010). While the risk communication approach improves on the shortcomings of an approach using the deficit model, risk communication still falls short, in my opinion, of fully and correctly addressing all relevant discourses, which involve the public.

Finally, in response to the two aforementioned approaches, scholars suggested more public engagement by way of dialogues between scientists, experts, and certain interested publics. In order to create such dialogues, various participatory approaches were developed, such as citizens' panels, conferences, workshops, and round tables. These participatory approaches are supposed to facilitate interactions between lay people and experts (Abels & Bora, 2004; Joss & Durant, 1995; Barben, 2010). This approach takes into account some factors, which could potentially affect public perception of science and technology, such as social, ethical, and economic contexts. Moreover, the demographic and cultural contexts were included in analysing the public perceptions of science and technology. According to Barben (2010), this approach is considered to be the most effective current approach for addressing the perceptions and communication of science and technology to the greater public. Even though participatory approaches have proven to have an influence on the acceptance of certain technologies by the public, this approach also has been criticized based upon certain cases, which show a negative correlation. Further, some have criticized participatory approaches for only showing a fraction of the public, meaning they are unrepresentative of the wider public. While this approach can address some important aspects and discourses within introduction of a technology, it fails to comprehensively explore all relevant discourses or offer a useful tool to cover all material components, as demonstrated by Felt, Schumann and Schwarz (2015). The authors studied public reaction and positioning towards new technologies from a new

perspective, rather than a 'risk' point of view. When a technology is first brought into a certain society, it unavoidably must deal with the existing social, cultural and natural orders (Felt et al., 2015). An emerging technology can match, integrate, and reinforce the pre-existing social, cultural and natural contexts of a society or undermine them; thus forcing changes or creating new contexts. Therefore, Felt et al. (2015) argue that studying the public reaction to new technologies necessitates studying people's reactions to the potential social and cultural changes that the technology may bring, rather than public reaction to the technology itself. This perspective is highly helpful in addressing how certain technologies are widely accepted by majority of the society, some are controversial, while some are immediately and continuously rejected by the public. The authors investigated how Austrian lay people perceive and negotiate nanotechnologies. Using the concept of ethno-epistemic assemblages, by Irwin and Michael (2003; as cited in Felt et al., 2015), which allows for avoiding dichotomies such as lay/expert knowledge or citizens/experts, Felt et al. studied how citizens create assemblages (mixtures, hybrids) of natures, cultures, technologies when positioning themselves towards (nano)technologies. The concept of ethno-epistemic is already self-descriptive with the term ethno referring to the locally produced knowledge, while epistemic highlights that these are the assemblages, which define reality and truth (Michael, 2006; as cited in Felt et al., 2015). The study by Felt et al. (2015) suggests that the citizens' positioning towards nanotechnologies is a reflection of how these technologies interfere (fit or do not fit) with their existing cultural and social orders. The study implies that some people would not accept a new emerging technology if they found it to be in conflict with their values, pre-existing orders, or way of life. In some other cases, however, the techno-scientific innovation can overcome and change some existing orders, even though all the members of the society do not accept it. The study shows that people perception about technology is always connected with the dominant cultural orders, values, and practices. Bijker (2007) also highlights that if technological innovations are to be used they should get embedded to the culture, otherwise they will not work. People normally do not think about a technology as an individual, isolated actor. Instead, they evaluate and understand the technology based upon how it could potentially support, incorporate, or destabilize the pre-existing social and cultural values and orders as well as how it may influence the individuals' lives. In response to the emergence of any technology, people decide whether the existing cultural norms and values have to be maintained, or if they create problems and, thus, have to be reconsidered and changed (Felt et al., 2015). Therefore, a new technology is not a factor, which can be singled out, analysed, and reacted to, by the public. Rather, a technology transfer s a process of evolution, which should be explored not by how the target society reacts to the new technology, but rather by how it affects the society. As Felt et al. (2015) argued above importance should not solely be placed upon how the public perceives a technology. Instead, one also should focus whether the new identity, which the

introduced technology helps to shape, is in harmony with the target society, or whether it successfully manages to harmonize with the society's cultural context.

2.3. Actors Involved

As reflected across STS literature, every technology, which might appear as one single object at first, consists of a set of material and immaterial elements that worked and should still work together in order for the technology to function and develop well. Involved with each technological development is a growing set of co-operative actors, including human and non-human, which push or weaken a technology's development. With each case of technology transfer, there are multiple stakeholders involved who are in constant relationship. Other than the investors, developers, and owners there are other suppliers, buyers, scientists, researchers, institutes, politicians, government, marketers, mechanics, media, NGOs, consumers, laws and standards, and many other material and immaterial actors involved. These actors both shape and influence the on-the-ground function of this technology and, in return, are shaped and influenced by the development of the technology. As the associations and relations of the actors cannot be categorized purely into spheres of the social or the technological, Latour (1988) argues that technologies are completely dependent on social processes. Science and Technology scholars use the terms 'networks', 'seamless webs', or trajectories to describe these sets of equal actors, who link together to achieve a particular goal (Latour, 2005; Galusky, 2008). Bijker and Law (1992) investigate the interactions, which technologies hold with their social context. Offering up the term socio-technology, they introduce an alternative approach to studying technologies. Socio-technology, as they suggest, views the artifact and its social contexts as a single seamless web, providing a framework to study technologies in a network of other influential actors in which they are situated. For instance, in my study, the seamless web is made up of the technology in the centre, along with the various actors, which are both shaping the technology and being influenced by it. The technology itself is made up of equipment and various physical (non-human) components. Farmers, who are direct users of the technology and arguably most affected by its adoption, are key actors in the web. Research institutes and individuals are another actor group as they try to understand, optimize, improve and implement the technology (Akbari & Dehghanisanij, 2008). Governmental intervention and enforcement in the form of ministry subsidies, policy-making, and legal requirements (etc.) act influence both policy and financial matters (Ghaemi, Najafi, Rahmati & Tarazkar, 2007). Technical aspects as well as maintenance are covered by engineering firms that ensure the technology and equipment run well (Akbari & Dehghanisanij, 2008). Employment is another factor created by various actors such as governments and firms, through the creation of work for people that would otherwise not be employed, as most of the

physical production and administrative requirements will be dealt with inside the country (Ghaemi, et al., 2007). Labour and employment may also be impacted by the introduction of technology into the farming community, as most labour, which was previously performed by the human workforce, would no longer be needed. The market, the platform through which the end-farming product is traded, is as a key actor influencing farmers' adoption of the technology (Ghaemi et al., 2007). Religion, tradition, and culture together form a key socio-cultural actor that can significantly influence the acceptance or rejection of a technology. NGOs are normally significant actors; however, there is no strong presence of NGOs in Iran especially regarding environmental and social matters. This lack is due to various reasons such as weak democracy, lack of access to financial resources, tight government controls, and widespread suppression of public activism. Therefore, the roles of NGOs were not considered relevant in this research and I could not explore any existing activism around similar cases. A similar situation exists in the media, which is due to various undemocratic restrictions, lack of independence, and political suppression. These restrictions mean the various media outlets are not in a position to reflect on public issues critically; thus, their role, if at all, was marginal in this study.

Therefore, each piece of technology can be disassembled into many other human and non-human actors, each of which has a different story to tell. Actor Network Theory (ANT) - also known as the sociology of translation - provides a conceptual framework to explore the relations between people (human) and objects (non-human). ANT is most prominently associated with and developed by two French STS scholars, Bruno Latour and Michel Callon, and a leading British sociologist, John Law. The theory's aim is to describe a society of humans and non-humans as equal actors tied together into networks, which are built and maintained in order to achieve a particular goal (Galusky, 2008). In this case, the technology's development, is seen as an important component lying at the centre of ANT, suggests that society, organizations, agents, and machines are all the productions of patterned networks of human and non-human materials.

Focusing on the sociology of science and technology, ANT authors argue that scientific knowledge and innovation *"may be seen as a social product or an effect of a network of heterogeneous materials, … rather than something generated through the operation of a privileged scientific method; … an end product of a lot of hard work, in which heterogeneous bits and pieces that would like to make off their own are juxtaposed into a patterned network, which overcomes their resistance"* (Law, 1992, p. 381). In short, science and technology are generated through the interaction between human and objects when pieces of the social, technical, conceptual, and textual come together and become translated into a set of equally heterogeneous scientific products. According to Alatout (2009), these networks are constantly subject to change and the actors involved are always negotiating and struggling with whether

or not to belong to a network, as well as how much to belong to a specific network. Hence, the actors might not be fully absorbed into a network and can belong to various networks simultaneously.

Busch, Harris, and Yamaguchi (2003) suggest that the advent of a new technology is not only one single process of representing an artifact, but rather it comprises a processes through which decisions regarding implementation, development, and application of technology are made from various diverse perspectives and viewpoints (Hannigan, 1995; Harding, 1986; as cited in Busch et al., 2003, p. 51). In other words, with the advent of a new technology, actors are not passively following the imposed rules; rather instead, they are actively creating social reality by their actions. The diverse norms, values, and cultures in different areas create social spaces where actors can negotiate and construct the meaning of the situations through processes of interpretation (Glasersfeld, 1991 as cited in Busch et al., 2003, p. 51), rather than passively adapt to the scientific explanations that the inventors or the regulators provide. Actors, therefore, do actively attempt to create, recreate and revise the norms, values and cultural orientations, and then again negotiate and disseminate these reworked interpretations to the other actors through their actions and social relations (Touraine, 2000 as cited in Busch et al., 2003, p. 51). The result or product of the interaction between humans and non-humans in socio-technical networks is called *agency* in ANT (Cressman, 2009). Although the ANT approach is useful for mapping the interactions between various actors and an introduced technology, I find the approach does not contribute to a better understanding of social dynamics, in terms of active and passive interactions, within a newly formed network, which develops upon introduction of the technology. ANT theorises that rather than passively adapting, actors *actively* influence the trends. Perhaps, it cannot not be disputed that actors – both human and non-human – do play active roles within a network. However, ANT does not fully address the role of politics in shaping the social interactions around introducing a new technology. Winner (1986) acknowledges technologies as being essentially *political phenomena*, arguing that technologies hold political characteristics and, therefore, determine certain social foundations. Moreover, he observes how certain properties of certain kinds of technology are linked to a particular type of what he calls ‘‘institutionalized patterns of power and authority’’ (p. 134). In his arguments, this political link is unavoidable, almost seemingly inherent to the technology. Winner explains that a political link appears in one of two forms: either the technology (which can include its design, its accessibility or its arrangement) is targeted in order to ‘‘settle an issue in the affairs of a particular community’’ (p. 123) or the technology is inherently political by design - requiring or strongly compatible with a specific type of political relationship. If we assume these two forms represent the political property of most man-made technologies, then we can deduce that these political characteristics must

influence the network and its actors in ways that are mostly passive, meaning actors may not know or choose to be influenced by them, they certainly do not always actively respond (or have the ability to respond) to its influence. The technology affects the foundation of the actor-network under discussion and the interactions within it.

Busch et al. (2003) introduce the term *frames*, which are involved in the process of the interpretation by actors. Frames give meaning to the issues and make sense of them (Goffman 1986 as cited in Busch et al., 2003). In terms of technological development, frames refer to those packages of social norms and values, which influence and structure the actors' understanding and image of an issue; for instance, a new technology. Therefore, frames could be considered similar to templates of positions with which a new technology is understood and interpreted in different ways by different actors (Gamson and Modigliani 1989 as cited in Busch et al., 2003). Bijker (2007) also calls the ways of thinking and the fixed patterns of interaction, which arise within every emergence of a technology, *technological frames*. As an example, for those actors supporting the Micro Irrigation System the frame of science-based agricultural technology means better control over the usage of water and pesticides on the crops based upon the needs of the crops depending on the geographic and climatic characteristics of the agricultural land. For those actors opposing this irrigation technology, science-based agricultural technology means investing value resources into the implementation and maintenance of a new system in a poor rural area, where the farmers are already struggling with finances and some believe a reduction in water usage does not necessarily correlate to better lives for the farmers. Therefore, each group of the actors, having certain perspectives and holding a special frame, strategically use the farmers to form alliances (Snow and Benford, 1988 as cited in Busch et al., 2003). In fact, actors do engage with others to find support for their frames and perspectives (Callon, 1986 as cited in Cressman, 2009). Bauer (2002) demonstrates that while actors challenge each other in the public sphere, they also search for alliances and public support of their views. Once the specific frame and interpretation of a set of actors are recognized and supported by others, they become acknowledged as reality (Latour, 2005). The processes create support in order to continue to mobilize larger groups of actors, who gained enough power to achieve certain social, cultural, political or economic outcomes (Long and Long, 1992; Zald, 1996, as citied in Busch et al., 2003). For instance, in my study of the water irrigation system different actors mobilize each other and support (or discourage) the adoption of the technology in various ways. Larger farms or those more open to adopting changes will slowly mobilize and provide incentives for smaller, more conservative farms to take up new technologies. The government can incentivize farmers through subsidies and regulatory requirements. Markets (through suppliers' provision of better quality goods and through the customers' demands for them) can push farmers to adapt to ways considered

more modern. Religious belief and cultural values can greatly support or deeply discourage the adoption of a new technology as well.

3. Theoretical Framework

Actor Network Theory in the Case of a Micro Irrigation System

During my fieldwork in the agricultural lands in Lamlang village in Gorgan, I observed how a Micro Irrigation System, which at first seems to be one clearly coherent object, can consist of many different components (either human or non-human) each of which has a story to tell. Considering the variety of roles all these components play for the Micro Irrigation System to function, the system appears not only as an irrigation device, which stores water and delivers it to the plants' roots, but also as a structure, which is connected to a multitude of other factors each influencing or being influenced by the way it works. If the Micro Irrigation System is to work, different elements of the device itself should function and cooperate well with each other; devices such as the pipes, valves, tubes, emitting devices, flow control equipment, and other accessories. The continual functioning of the Micro Irrigation Systems is connected to the subsidy program through which the governments provide for the local farmers, the engineers, engineering companies taking care of system maintenance, the quality control companies, existing standards, laws at different levels of government, and the research studies, which are conducted at research institutes and universities for development of such irrigation projects. In general, there are multiple entities involved, other than just the investors, developers, and owners. Beside those three, there are suppliers, buyers, scientists, researchers, institutes, politicians, government, marketers, mechanics, media, farmers, consumers, politics, laws, standards, and many other material and immaterial players involved, all of which shape and influence the reality of this technology and are shaped and influenced by its development. All these agents, which seem to be separate, are connected, in a way or another, to the functioning of the Micro Irrigation System; thus, they shape how it works as an irrigation device. However, not all have the same level of influence on the system and not all have a strong connection to how it acts. Still, it is quite tricky to decide in an early stage, which entity is material, thus should be studied and tracked well, and which is not as important and, therefore, could be less emphasized. I would argue that no one agent or element is more important than another; thus, they are all equal, related and connected, while simultaneously playing their own roles in the whole assemblage in order to achieve their goal. Even though each of the aforementioned entities has an interesting story of its own, tracing and exploring each story in depth - although thought provoking - would require much more time than is available for a master thesis. In order to be able to touch all the existing technical, social, cultural, political,

and legal aspects required for the function of the Micro Irrigation System, while not to miss any party critical to system functionality, I intended to use of ANT as the framework for this project in order to show this tight connection and relation.

Actor-Network Theory is a framework used to study the technologies and their surroundings. As briefly mentioned in the previous section, ANT was developed primarily through the work of Callon and Law as a tool to help understand and perceive technological innovations and their dependence on their surroundings. Actor-Network Theory is defined as a conceptual framework to scrutinize socio-technical processes (Crawford, 2005, p.1). This theory is an attempt to perceive the relationship and interdependence of society and technology.

The basic concept of Actor-Network Theory is centered on the idea of a heterogeneous network, which consists of different elements called actors. One very common example of an Actor-Network is a Smartphone. The Smartphone is made up of different elements, such as plastic, glass, metal, buttons, circuits, a battery, speakers, a microphone, a camera, users and the companies, which deal with the phones production, i.e. the inventers, builders, and the retailers. The smartphone's network also consists of software components like the Internet, different applications, online social networks, and blogs, etc. All these humans and non-humans actors (things, objects, concepts, items, entities, and realities) work in a network wherein they all affect, change, and shape one another in various ways. The inventors decided what should or should not be included in the phone; therefore, their decisions are dictated to the user. The user then decides which apps and functions to use or not to use. The phone's Internet connection impacts the way the user works with the phone by affecting how fast the user can access the online information or how they can interact with other people and networks.

ANT can be regarded as a techno-sociological lens through which we can look deeper into things and how they work. It explores the relational ties within a network. Its main emphasis is that no technology acts in isolation from its surroundings and, therefore, each technology should be analysed within the network in which all influential and determining actors exist.

Therefore, application of Actor-Network Theory means, instead of focusing only on technologies as the driving forces for the changes around them, one should consider everything as results of webs of relations among the actors and their network activity. An Actor-Network is the immediate result of the interaction among the heterogeneous elements, which form the network (Callon & Law, 1995). This network consists of all social, natural, and technical actors, which all relate to one another and either influence or are influenced by each other in the network.

Law (2007) argues that Actor-Network Theory is a tool, which "treats everything in the social and natural worlds as a continuously generated effect of the webs of relations within which they are located" (P. 2). Actor-Network Theory's main focuses are the relational character of

things, how things relate together, which actors are linked together, and how these links should be traced.

Moreover, Actor-Network Theory respects the existence of both actors and networks, while emphasising that neither of the two would exist without the other. Action is neither preformed by the actors nor driven from them; instead, action is to be understood as the capacity of actors to engage within networks and to create effects of relations (Ren, 2011). An actor is constantly networking with other heterogeneous elements. Those heterogeneous actors construct a network and the network is constantly subject to change by elements, of which it is composed (Cordella & Shaikh 2004, as cited in Van der duim 2005). The relations amongst the heterogeneous actors change the network. Similarly, these relations are changed and reshaped by the network. The actors must continue their relationship with the others so that the network can sustain and continue functioning.

Important in the application of the Actor-Network Theory is, from the very starting point, not to predetermine who or what could be involved in the network of a case study; rather, one should attempt to remain as open as possible in order to create space for the actors to naturally reveal themselves through analysis of the empirical data. The researcher has the responsibility to identify the heterogeneous elements in a network, whose actions and roles may change or influence the network and, therefore, should be investigated. However, exclusion of element, whose roles are less relevant to the case of study, is still quite difficult as one might feel as if they are ignoring an import part of the story. Actor-Network Theory argues that everything we seek to investigate and describe should be treated in the same manner.

A unique characteristic of ANT is the emphasis the method places on approaching non-humans. Actor-Network Theory allocates the same amount of agency for objects and technologies in shaping and changing social worlds and the method considers no difference between humans and non-humans and, therefore, treats them all neutrally as ‘actors’. Actor – Network Theory grants agency to all actors. ANT acknowledges both agents as equal and discusses them using similar language, as a separation between these categories for this specific purpose is not only difficult, but also meaningless. According to Callon (1986) when facing conflicting standpoints among various actors, the analyser should not only explain them in the same terms, but also choose the best explanation, which fits the case best, and then be prepared to justify why this particular scenario was chosen.

Actor-Network Theory both holds no distinction between humans and non-humans and avoids any *dualism* (Callon 1986, as cited in Gad & Jensen, 2010), like truth and falsity, micro and macro, global and local, and social and technical, etc. (Callon & Latour 1981, as cited in Ren, 2011). Callon (1986) calls this avoidance and freedom from all the a priori distinction between nature and society *free association*. Hence, the analyser should abandon completely any differentiation between natural and social events. The goal of *free association* is to reject any

hypothesis, which would define a definite boundary between the natural and the social worlds. Actually, these boundaries should arise as a result of the analysis and not from pre-determined defaults.

Along similar lines, Law (1991, as cited in Oudshoorn, Van Oost & Verhaegh, 2009) introduced the concept of *heterogeneous engineering* to explain how technologies not only are the result of the work of engineers, but also, more importantly, are the effect of heterogeneous social, natural, political, cultural, and economic elements, which gather together to create an aligned whole or an Actor-Network. According to this concept, various attempts are needed in order to align and stabilize objects, artifacts, and technical practices into an Actor-Network so that the technology can function successfully (Law, 1987).

The concept of *heterogeneous engineering* goes hand in hand with ANT's notion of *hybrid assemblages*. This notion of hybridity offers a richer account of the technology and how it functions in its surroundings. *Heterogeneous assemblage* refers to the hybrid of human and non-human actors, which are collectively and cooperatively bound together. Actor-Network Theory is then interested in tracing these complicated interrelations (Nimmo, 2011).

In every-day life, we are bombarded with different facts, figures, statistics, opinions, and interpretations. In order to make meaning of such information and projections, we seem to make a distinction between the objective and the subjective, or in STS terminology, between the natural and the social. Similarly, in the case of my project, I had to create an order within what seemed like chaos and look for the patterns that would help me to understand the circulating stories and the meaning of different things, which I was witnessing during observations. To make my observations clearer, I needed to decide whether I would be focusing on the natural and technical ('objective') aspect of the Micro Irrigation System or on understanding the political and social ('subjective') appearances of it. For example, the pump, which is installed at the well or the water source, is clearly an entity to be studied, analyzed, monitored, and regularly checked by the engineers, who are informed about the technicality of this particular pump and, thus, could provide technical information about the pump based on their scientific knowledge. The engineers are, however, probably incapable of providing subjective information in regards to this pump, in terms of how this phenomenon could make a difference for the communities that live around the pump and would depend on it. This type information would be then left to the expertise of social scientists who are better equipped to focus on the subjective reality of the phenomenon and its relation with other elements surrounding the Micro Irrigation System. In brief, while some may look at this pump as a mere objective fact, others, like myself, can deconstruct the pump and look at it as a representation of social structures and political arrangements, which both shape and can be shaped by the pump. Latour (2004) considers nature as being still far from an obvious reality; yet, he sees it

as a way through which political orders are being created and assembled. He proposes an end to the existing dichotomy between nature and society and, instead, argues for a *collective community* - embodying both humans and non-humans and relying on the experiences of sciences. Akrich (1988, as cited in Akrich, 1993), using the example of the chassis of cars, argues that the speed of the car not only depends on the complicated compromise among the technical components of the car, but also on some social factors such as the permitted speed limit and its enforcement.

As discussed, Actor-Network Theory treats all the elements - regardless if they are social, technical or national - as inseparable. The question for the analyser should be more in the direction of how all these things are ordered and how the processes of ordering have happened in such a way. The nature of these actors should be of no interest to the analyser.

Moreover, ANT is interested in how the function of actors are ascribed and maintained. In other words, Actor-–Network Theory seeks to understand the processes through which actors come together with other elements and establish networks. This effect of building Actor-Networks, assigning characteristics to them, and making relationship among them is called *translation*. Translation refers to the processes of ordering and correlation within networks; processes through which actors try to establish themselves in networks. Translation also involves processes of representation, negotiation, and displacement amongst the actors (Murdoch 1998, as cited in Van der Duim 2005).

According to this view of translation, actors do not remain the same in the processes of translation (relating to one another). Rather, they change when they move from one situation to the other. As actors are constantly transforming in their movements and relations, networks are also developing and changing through dynamic interactions amongst their composing actors (Latour 1986, as cited in Gad & Jensen 2010). Callon (1986) sees the process of translation as *displacement*, which happens in multiple moments of the life of a network. For Callon, displacement refers not only to the change in the physical location of the actors, but also to the change in their interests, goals, and preferences, etc. These moments of displacement and translation can occur at any time and sometimes are overlapping, conflicting, or totally against one another. For example, the function of the Micro Irrigation System can be seen as an efficient and cost-saving procedure for the community using it; while at a different point in time, the system can be seen as a burden for the neighboring community, who is experiencing trouble in water allocation. On the other hand, the community that is happy with the function of the technology and the advantages it brings for them suddenly see the technology as the useless method when the government changes its subsidiary program.

Akrich (1993) depicts how a technology functions in a system, which has its own complexity and constraints. She concludes, the success of any technological choice is tied to the constant

translations between the technical and the social dimensions and digging into both technical and social worlds at the same time. In other words in order to understand how technologies work and what exactly they do, one needs to figure out how the technology would function if their usage were not standard. In observing a technological phenomenon, one should avoid such a distinction between the social and the technical. Instead, one should pay attention to find out how the actors present their own situation and how these actors are translated among different worlds.

Actor-Network Theory is also a tool, which aids in investigating and explaining the processes through which systems and technological innovations either come into existence and successfully operate or fail to function. I will argue in the analysis section of this thesis that the success of a technology, as a term, is very general and patiently could have several different meanings and interpretations within different contexts. De Laet and Mol (2000) use the term *fluidity* to explain that technologies at first glance may seem simple. Yet, upon deeper inspection are actually advanced and fluid in their nature, as their success and failure depend so much on many factors; such as how rigorous they are bounded when travelling from one place to another; how much they serve the others; how adaptable and flexible they are; and what kind of changes they impose on their surroundings. The boundaries within which they work are not rigid. Consequently, their success and failure depend on their fluid nature and the various occurring in their surroundings.

The principles explained above have been essential in the progress of this thesis in terms of exploration, explanation, and justification of the relations, cooperation, and connections amongst the different actors, which I have treated and considered in an equal and homological manner. Instead of presuming distinctions amongst the actors, I asked how they had produced such relations and processes of ordering (Law 1994, as cited in Shove, 1995). This means, following an ANT framework, instead of focusing on the distinctions between human and non-human; nature, culture, and technology; and micro and micro (Felt et al., 2015), I have moved beyond these distinctions to focus on the mixtures, hybrids, assemblages, and relationships, which take place amongst the actors. In the case of the Micro Irrigation System, avoiding such differentiations let me realize the hybrid nature of the technology and that it is not just a number of physical objects (pumps, valves, etc.), which are connected to each other to deliver water to the plants. Beyond its physical components, the system is connected to many different elements, such as social, political, and power structures; people and communities; laws and regulations; and existing concepts and contexts, which both influence and are influenced by the work of this technology. While looking at such a case of study, this perspective definitely challenges the traditional view in treating power and power structures e.g. the head of the village or the government. The perspective supports the idea that no one actor is capable of acting alone and, thus, is incapable of creating any effect; rather, it is the network of relations

among different actors, no matter human or non-human, which can create such an impact. This approach then lets me investigate more in the processes of relations and translations, while exploring such effects in a more process-oriented manner. The shift from investigating *being* to exploring *doing* (Ren, 2011, p. 861) prepared me to realize how different concepts, metaphors, discourses, realities, and amongst other things could gather together and contribute to creating a network of actors, which all engage in the functioning of an irrigation technology and in the surrounding community.

As explained above, and as the tittle self-explanatory, the theory is about networks of relations between actors. However, this is just a very generic way of defining the concept. Though, one might feel uncomfortable when making an effort to explain and elaborate on the theory in a more specific way. John Law (1999) recommends that in order to properly represent the theory in a faithful manner, one would better perform it rather than summarize it. By performing Law refers to "exploring it in a number of case studies" (p. 1), rather than making an effort to uncover its fundamental rules. Inspired by Law, I tried to perform the theory during my experience in the field. In the empirical section of this thesis, I will reflect further on my observations and how I constantly related them to Actor-Network Theory. It goes without mention that ANT indeed had shaped my view on technologies within webs of relations even before I entered into my case study.

ANT fits well into the case of my project as I utilized it in order to show how this technology is, "constructed, reproduced and reinforced in and through materiality and performance, simultaneously displaying it as an opportunity as well as a repertoire of constraints" (Ren, 2011, p. 862). Using Actor-Network Theory, I could analyze the correlation and cooperation among the actors within the network of the Micro Irrigation System, keeping in mind that the network could be simultaneously empowering, while restricting. Rather than trying to see the actors, which were showing up as I was progressing in my fieldwork, I tried to look at how the actors in the network relate, structure, shape, co-create, and co-operate with each other (Ren, 2011). This feature of the networks is determining, because how the Micro Irrigation System is used and experienced depends fully on the different actors, which are constantly constructing and restructuring their own way of relating with the Micro Irrigation System. These relations can be either enabling or constraining.

In other words, instead of thinking about the various actors, what they are, and how I personally interpret their role, I thought about how the actors enact the function of the technology and bring it into being. Through Actor-Network Theory conceptual lenses and in accordance with Law and Singleton (2005), I treated the Micro Irrigation System as a multiple object, rather than ascribing multiple interpretations to the system. Therefore, the Micro Irrigation System could be multiple as it could "be enacted into multiple practices" (Law & Singleton, 2005, p. 339) very differently and in different contexts. Law and Singleton use the example of a disease,

which could be experienced quite differently by different actors (e.g. the patient, the patient's relatives, the doctors, the laboratory, and the insurance company), although being exactly one unique entity. The reason for this multiplicity is that these different actors enact the disease differently. More simply, the disease, similar to any other object, can mean differently or can be played and respectively interpreted diversely by various groups of actors. These distinct enactments of the disease could be similar or even contradictory. I always presumed the Micro Irrigation System in this project to be a system that is, indeed multiple and messy; yet, all the different actors can have different perspectives. Actor-Network Theory takes this into account and can deal with the different accounts, which are enacted by different actors in practicing this technology. Relying on Actor-Network Theory, I needed to explain the different existing interpretations and then attempt to discover the multiplicities of the meanings out of those multiple perspectives (Law & Singleton, 2005). My project focused on a network, which incorporates different actors and is a hybrid of people, physical objects, laws, regulations, concepts, and discourses, amongst others. In my fieldwork, I made use of Akrich's (1993) principle of *historicizing* the case of study and her recommendation that in entering a fieldwork one should not hold any predetermined assumptions about the technical and the social orders of the things being studied. Rather than being biased in advanced, one should be as neutral as possible in observing and analyzing the technology and its surrounding society. Otherwise, one could not find out the ways in which technologies integrate into the societies or how they shape and are shaped by their cultures and the worlds of living. Akrich (1993), therefore, recommends that one should wait for the actors to unfold their potential and display themselves. Her main argument is that one should not represent the actors, as well as, try to decide on the complexity of their stories too early. In her mind, researchers should stay as far as possible from uncertainties and let the actors tell their own stories.

It was not any different in the case of my project. Having Actor-Network Theory as well as the principle of Akrich in my mind, I looked around in my fieldwork to see that the technology and its function is a composition of various heterogeneous actors, each of which has a story to tell about the integration of this artifact. Actor-Network Theory's principle of heterogeneous actors could be well identified in the case of the Micro Irrigation System. At very first glance, the function of this technology seemed to be connected to the combination of the physical elements, e.g. the tank, the pipes, and the valves. However, there are many other heterogeneous elements, which might not be found very easily, even by a closer look at the whole physical object. Nevertheless, if one was to investigate further, they would find a series of other elements without which the technology would fail to function or would not even exist. Iran's subsidiary program, agricultural policies, and legislations on use of water in agriculture are just three examples of such. Avoiding such "a priori distinction between what is technical and what is social in what is being observed" (as recommended by Akrich, 1993, p. 331), is a

useful approach in identifying traces of different determinant elements. Such an approach in confronting different existing elements lets me freely see and follow any traces of something playing a role in the function of this technology. I could gradually follow the categories from which the actors showed themselves and, consequently, now I am able to tell more stories about the human and non-human actors, which are involved. Most importantly, I could avoid deciding in an early stage whether the Micro Irrigation System was a technical requirement in the region, a political force, or a social support for the region and the community. I did not worry about such categorizations in advance and, instead, I just let the story emerge.

4. Research Questions and Methodology

Through my research on the Micro Irrigation System in Lamlang, I attempted to answer the following main question:

How do the livelihoods of a community transform through the introduction of the technology of Micro Irrigation?

To answer this question, I chose to study the Lamlang village in the Iranian province of Gorgan and investigated the rearrangement that took place once the technology was introduced.

For the purpose of this thesis, I use *community* to refer to the farmers and their families living in the village of Lamlang, as well as some local authorities.

The Micro Irrigation System, as referred to previous elsewhere in this thesis, is the technology that uses a dripping method to transfer water and nutrients to the roots of plants through a set of pipes, valves, and emitters.

Gorgan Province is a province in Iran on the Caspian coast, where agriculture and farming are a significant source of income for the residents of the region.

Lamlang is a village in the central part of Gorgan province. This village has around 560 inhabitants, making up around 150 families according to the latest census (Statistical Centre of Iran, 2011). In my research, I focus on a sample of five agricultural lands in Lamlang.

Through application of Actor-Network Theory, I look at the key aspects of transfer and introduction of the Micro Irrigation technology into the village, the community reaction to this new technology, their perception of the technology, their concerns, the actors involved in the function of the technology, and the resulting changes in the dynamics of the surroundings. I have explored further in detail the following sub–questions:

How did the introduction of Micro Irrigation System change the work environment?

How did the consumption patterns for water and energy change?

How did the farmers' social credibility and their power in domestic markets change?

What would the community perceive as benefits of Micro Irrigation System?
What would the community perceive as challenges of Micro Irrigation System?

Briefly, I have used four different sources to collect the research data: personal observations made during my field ethnography, situational maps, interviews and official documents.
In order to maintain the structure of this section, I will explain separately how I have used these four methods. I will also argue that they are quite complementary and interrelated and should have been conducted simultaneously on some occasions.

4.1. Field Ethnography

Inspired by some ethnographic works in development projects in the field of STS[1], I have decided to make use of this qualitative approach to study my case of interest. In order to make this study happen, I conducted ethnography, i.e. a qualitative research method, which includes applying observations instead of oral testimonies. Based on the nature of my research project and its key objectives, I chose to use this specific method of investigation as a part of data collection process. Fieldwork, as Bernard (2006) states, extends the validity of the data that has been observed and gathered through interviews or other research methods by the researcher. In the specific case of my project, an ethnographic approach allowed me to open up the system and investigate how it mattered in the context of everyday lives of farmers.
Observation, as Spradley (1980, as cited in Fife 2005) declares, necessitates an engagement in a social situation as well as the observation of the activities, people, their lives, patterns of behaviour, and material aspects of that situation. This method allowed me to be involved personally in the research field in order to the witness the on-going social activities and the day-to-day life of the individuals or the community. Conducting fieldwork was a helpful method, as it provided me with the opportunity to study in depth the social and cultural configurations, which the Micro Irrigation System created in the community. It gave me an intuitive understanding of what was going on in that specific cultural context and permitted me to retell stories of the situations that I observed. Moreover, the method allowed me to understand the socio-cultural dynamics at work in this specific context. During the actual fieldwork, I spent some time studying the routines and activities taking place in the community. Practically, the building of trust and confidence with the people, whom I wanted to observe or interview, took a while until they were ready to cooperate and participate in my research. Ethnography is usually referred to as an *actor-oriented* research approach as the main effort in ethnography is to reflect the subject's point of view as closely as possible (Scheyvens & Storey, 2003).

[1] such as the Zimbabwe Bush Pump and how it makes a difference in Zimbabwe community by De Laet and Mol (2000), and the pumping possibilities in Egypt by Barnes (2012).

Using Actor-Network as my theoretical framework in the background, field ethnography was my approach with which to observe and study people, the Micro Irrigation technology, and their relational network. Such field ethnography entailed my interpretation of the observed cultural settings through my own participation in those settings and the oral testimonies. The result of the interpretation of these observations and testimonies is the qualitative data and the ethnographic text, which I will be presenting in the next section of this thesis. The result is also a *thick analysis* (Fosket, 2002, as cited in Clarke, 2005), or a *thick description*, which Geertz (1973) has adopted from the philosopher Gilbert Ryle. Geertz explains that ethnography is a thick description and what the ethnographer is faced with is basically a complex set of structures many of which have an effect and relationship with one another, which may seem unrelated, strange or irregular, but should be comprehended, interpreted, and described by the ethnographer. By delivering a thick description, I tried to bring the reader "into touch with the lives of strangers" (Geertz, 1973, p.16). Geertz describes, there exists a vast variety of events, facets, and aspects all of which should be seen, perceived, and explained in details and in a thick way by the ethnographer.

The actual trip to the field occurred in July 2015 at which time I was prepared to stay in *Lamlang* village in Gorgan and observe there for approximately two weeks. I had asked a friend from Gorgan province, to accompany me during the fieldwork as he was a local; meaning he knew the community relations well; could help me build up relations, trust, interest, and support in the community (and the potential participants). Lastly, he was essential in informing me about different crucial issues (e.g. safety issues, cultural habits, etc.), which I needed to know and keep in mind before entering the field.

In order to create more trust and gain more support from the community, every time I was meeting or visiting a new person I tried to fully introduce myself, explain from which university I was coming, the purpose of my study, what exactly I was doing in their community, what precisely my research was about, and potential outcomes. Also, I provided the same, yet briefer, information in paper format in an accessible language, in case they wanted reference later. I did bear in mind another key point, which was how I treated the individuals and the community would directly affect the responses I received and, thus, could play an important role in how my fieldwork would proceed.

In this period, I collected a large amount of data and made notes about everything that I was observing related in one way or another to the Micro Irrigation technology and its users. During these two weeks, I have written about fifty pages of note in a medium-size notebook. The notebook was the only means by which I wrote down information about my observations in the field, as it was the most comfortable means for me at that stage. I then summarized my notes digitally and saved them as a backup of my collected data.

During this trip into the field, I took about 80 pictures with my cell phone camera, which was again small, light, and readily available. I have added a number of these pictures in different sections of this thesis where I thought they would either make sense or add value and clarity.

4.1.1. Ethical Issues in Doing a Fieldwork

In this part, I will briefly mention some key features, which I have taken into account when conducting the fieldwork.

Informed consent: Informed consent implies clearly informing a potential participant about the research and, after being informed, the person needs to agree freely to contribute to the project. I tried to give the participants a complete understanding of the aim and processes of my research project. I have fully and honestly explained to the people of the community, attempting to justify to them what the research was about, why I was doing this research, asking questions, participating in community activities, and what the outcomes of the project would be. Furthermore, I informed them about the people, institutes, or organizations who may use or have access to the research information. I ensured the participant that I was available and happy to answer any questions they would have in regards to the research. I believe obtaining their informed consent helped me a lot in carrying out the research. At the same time, I have warranted people's freedom in case they would decide not to participate or to quit participating whenever they wished. I got my research participants' consent through an information sheet, which I had provided in advance in an accessible language.

Power: According to Desai and Potter (2006), any research is intertwined within different layers of power from those between the researchers and the researched to those between different cultural settings and classes, educated and illiterate, rich and poor, female and male. In order to conduct my research in the most ethical way possible, I had the responsibility to attempt to be as neutral, unbiased, and unprejudiced as possible in my research. Scheyvens and Storey (2003) also argue that the researcher should seriously avoid reinforcing powerlessness in the participants. I have carefully considered how I interacted with the contributors and, more generally, how I behaved in their community to avoid affecting them emotionally. I tried to build a close rapport with the participants, gain their trust, and break these power structures.

Accountability and Co-construction: According to Beaulieu (2010), an ethnographer should keep accountability and transparency, instead of anonymity. By establishing *co-presence*, as

she puts it, I tried not only to make myself available and accessible, but also to make the ethnography a more social process by building social interactions. This new mode of the relationship between the ethnographer and informants is based on the interactive, accountable, and transparent engagement of all the actors including the ethnographer. This engagement is what Fischer (1998, as cited in Hess, 2001) refers to as "ethnographies of science and technology in the emerging worlds" (p. 240). He argues one of the key features of ethnography of science and technology, which distinguishes it from more traditional ethnography, is that in STS it is considered to occur through interaction, negotiation, and a close relationship between the ethnographer and the field participants to collaboratively generate data in the field. The ethnography I practiced is a product of social interaction and is based on the interaction and the co-construction of the community and myself.

Anonymity and Confidentiality: As a researcher, I feel a responsibility to keep the participants anonymous in the project's output, as they desired. Furthermore, I have ensured data confidentiality, meaning that any information and data collected in the field will be kept private in a secure location, only to be used for the research purposes. Confidentiality also entails removing the information provided by a participant, if they later withdraw. I was asked to remove two parts of the testimonies by two participants during the course of my data collection. As I strongly believed that anonymity and confidentiality would minimize the risk of harm to participants, I happily removed the parts of the information that these two participants were referring.

Even though anonymity and confidentiality are desirable standards in qualitative research, Tilley and Woodthorpe (2011) argue that in the 21th century with Internet evermore increasingly available and the extreme demand for information, managing confidentiality and anonymity in the research context could become increasingly challenging for researchers. In the information age, with sophisticated search engines, protecting the identities of the research participants has become a significant problem, if not impossible. Still, I tried to make this happen in the small community of my research.

4.1.2. Doing an Ethnographic Research at 'Home'

Since I conducted my research in my home country, there were clear practical advantages for doing so. First, my knowledge of the society and culture has undoubtedly made the research much easier. Doing fieldwork in a limited amount of time would become much easier if the researcher does not have to spend too much time and effort on getting familiarized with new social and cultural settings (Desai & Potter, 2006). Secondly, as people in the community speak Farsi, I did not have to spend an excessive amount of time learning the language of the

community that I wanted to observe. Moreover, the processes of translation into English, interpretation and analysis of the data gathered were more convenient and precise. Thirdly, as Desai and Potter (2006) state, working as an insider provided me with access to particular social situations, which would possibly remain inaccessible to outsiders. I, an insider, had the opportunity to gain a deeper understanding of the field that an outsider could ever attain.

However, doing ethnography at home was not without drawbacks and difficulties. Sometimes while speaking to people in the community, I had the impression that my time was being spent on unrelated issues and topics, which were not adding any value to my project. As the community perceived me as one of them - who speaks the same language and who comes from the same region. This familiarity sometimes meant they felt comfortable enough to talk (sometimes really for long periods) about private issues and irrelevant matters. I purposely tried not to stop and avoid such talks and discussions; instead, I tried to give them the time and opportunity to talk about other topics as they wished, so they would feel more comfortable with me in discussing issues related to my research. Moreover, I realized that sometimes they would get quite board and exhausted if I wanted to only dedicate time on discussions regarding the topic of my research field. Even though very challenging, I tried to manage my time and balance the parts, which we were dedicating to discussing other topics.

4.1.3. Photo Documentation

I do believe in the material effects of including pictures within texts. As already mentioned above, I have taken around 80 Photographs in the fieldwork and selectively included them in this thesis document, in order to be able to better convey and present the meanings and the contexts on which I want to elaborate. According to Desai and Potter (2006), photographs are used to construct meanings: they provide a means by which we can understand the agency of actors and their complexities. In various sections of this thesis, I have used photographs to explain the materiality of such infrastructures. In my ethnography, I have used photography as a complementary technique to provide the readers with more insights into the social settings of the actors in my field and, therefore, to allow the reader to understand and interpret the meanings and concepts themselves. Photographs not only can create better perspectives but also can allow us to move away from purely, sometimes boring, analytic discussions.

4.1.4. Gender Issues in Ethnography

Considering gender issues in a project plan is necessary and one must be aware of the gender perspectives in cultural settings in the particular field of study. Specifically, it is crucial for the researcher to gain an understanding of the woman’s and man’s needs, priorities and constraints (Department for International Development 2002, as cited in Desai & Potter, 2006).

I have adequately asked for participation of women in my research and included their views and ideas in my research equally to those of men. Even though women in the rural area of my study are more likely to be less educated and have less explicit positions of power in comparison with men, I have made a purposeful effort to engage with them during the project. I believe equal consideration of women and men could provide me with more comprehensive understanding of local knowledge. Therefore, by ignoring women (or including fewer of them as compared to men), I would have missed a valuable insight of the social world of my study. Before I entered the field, a serious concern of mine in relation to gender issues was how my own gender would affect the fieldwork, e.g. how the community would accept and welcome a female researcher; how much locals would be interested in participating in my work; to what extent they would give me access to wider information; and, most importantly, how my age and gender status would influence the data being gathered. From my experience at this fieldwork, I got the impression that my gender (and age) indeed did have an influence on the processes of collaboration and interaction with the community, but not in the negative way that I had expected. The community members seemed to be even more happily welcoming a young, female researcher and participated in my research project in order to support me as much as they could.

4.1.5. The Main Challenge

Ethnography involves systematic and continuous observation of behaviour during a set period of time. It is the ethnographer's task to figure out what is occurring in a particular social setting over time. A deep understanding is gradually shaped until the researcher achieves repetitive results. The key challenge for me here was that it was quite difficult to say when exactly this understanding occurs. For me, it was rather challenging how I could ensure that I have produced results and, further, how I could assess my progress in my research. Specifically, since I have only spent about two weeks in the field, I was not sure to what extent I could go forward in this limited amount of time, precisely when enough data was collected, or whether 14 days would suffice. However, now that I am at the end stage of this project, I am rather confident that I spent enough time in the field, was able to gather enough data, collect enough stories, and documented an adequate amount knowledge exchanges. Since the completion of my fieldwork, I have stayed in contact with my friend from the region and made use of his knowledge in cases where I needed more insight regarding certain field issues and activities, which are still running in the community in relation to the Micro Irrigation System.

Along with observation, it was absolutely necessary in my case of study to conduct informal as well as unstructured and semi-structured interviews. I believe interviewing is, indeed, an

essential part of ethnography, aiding in the gathering of testimonies. This will be elaborated more in detail later on.

4.2. Situational Maps and Analysis

From the very first moment when I wanted to transform my interest into a master thesis, I confronted the problems of how to translate my field of interest into a research question, how I can specify the boundaries of my research, and how I can conduct the relevant fieldwork. Situational analysis introduced by Adele Clarke (2005) could, in practice, offer me a path through which I could enter the field of study and explore the existing boundaries. Through this approach, I could layout and specify a range of data sources, from which I could then extract stories. It seems that applying this approach helped me to find my way through the multiple actors, moments, elements, and texts to engage in the actual research project.

Situational maps, as stated by Clarke, can be regarded as a means of illuminating and analysing some of the complexities and intricacies of social life. Indeed, this approach can be used in a variety of interview-based or ethnographic research projects. According to Clarke, this methodology allows researchers to bring together a wide range of discourses, agencies, actions, structures, images, and contexts in order to analyse a particular situation. Since the aim of creating situational maps is to situate the research individually, collectively, temporally, materially, culturally, discursively, and symbolically the outcome would be a thick analysis (Fosket, 2002, as cited in Clarke, 2005). As mentioned earlier, I am borrowing the notions of thick analysis by Fosket and thick description by Geertz (1973) in order to describe the stories surrounding my research case and provide a thick description of the situation of my study.

As explained by Clarke (2005), a situational analysis is accomplished through a set of three main cartographic maps:

1.) *Situational maps* outline the main human, non-human, discursive and other involved elements in the situation of the research. This first approach lays out the messiness and complexity of the situation of focus.
2.) *Social worlds/arenas maps* outline all the key collective actors in the arenas of commitment in the situation, in which they are involved. Social maps depict the situation, engaging in collective action from different social, institutional and discursive dimensions.
3.) *Positional maps* outline the main existing positions in the data versus particular surrounding issues in a situation (e.g. controversies, concerns, etc.)

In the following, I will present how I have applied these approaches (situational maps as well as arenas maps) in my case of study.

4.2.1. Situational Maps

In the first phase, I tried to outline all the human, non-human, material, and discursive elements I could think of in the area of my focus. In doing so, I attempted to answer questions such as: who and what exactly exist in this particular situation? Which elements make a difference in the situation? Which actors have stories to tell?

My goal in this phase was to outline the analytically involved and pertinent actors, as many as I could imagine so that I would be able to see things visually, think more deeply about the situation, and find the direction that would be appealing to pursue as my research. This working version of the map has, of course, been manipulated over time as I have decided to add, remove, or edit certain elements. The messy situational map, then, was transformed into an ordered version, showing all the actors in a categorized manner. It is clear that over time, not all the elements specified in these maps would remain of interest; rather, I considered them powerful visual tools, which would give me a perspective of the situation as a whole or of a particularly interesting area on which I can choose to focus. During the course of the fieldwork some of these actors stayed relevant through the flow of the stories, while others gradually became less interesting as they were not playing any influential or determining role in the whole network. Additionally, some new actors appeared, which I had not thought about before entering the field.

Having these hard papers in my hand allowed me to easily interpret what mattered or what was more prominent in the research situation and was deserving of further emphasis and investigation. Simply, the maps helped me to find out the areas, which needed attention and the stories they had to tell.

Writing notes and memos while creating the maps stimulated my thought process and helped to discover the areas that need further analytic attention, i.e. those that could be theoretically interesting. Since these memos and notes aided me in thinking systematically whilst designing my research project, they have been significantly powerful tools, which not only gave me a direction to follow in order to end up with a theory, but also helped me to decide how I should gather satisfactory data.

4.2.2. Social Worlds/Arenas Maps

In creating these maps, as suggested by Clarke (2005), I tried to illuminate the various existing social worlds in particular arenas, while making a collective sociological sense out of the situation and specifying the salient social worlds.

It is important to mention that there might be no clear–cut boundaries between social worlds or arenas; thus, boundaries have a certain porosity. Moreover, the overlaps of the social worlds demonstrate (visually) that some collectives exist and contribute to more than one social world. In some cases where it was not physically possible in the drawing of the map to show an overlap among two or more arenas, I have linked them through a line in order to show the existing relationship and dynamics among them. These maps, finally, told me in which key social worlds I am particularly interested, in term of analysis, and which stories I am capable of investigating and telling coherently. Once I could locate the stories of interest in the social worlds, the next step was figuring out what is happening between particular worlds. I tried to explore and investigate this question during the actual fieldwork.

As it is illustrated in the social worlds/arenas map (see below), I was interested in investigating the arenas, a few of which I have briefly mentioned below:

- Material elements of the irrigation system: The system, per se, constitutes several elements. The components of the Micro Irrigation System include pipes, tubes, water-emitting devices, flow control equipment, installation tools, fittings, and other accessories. Thus, I scrutinized the necessity of existence and the role of each element in the technology's function.
- Research institutions: To promote the technology, research and study are conducted in Agricultural Engineering Research Institute (AERI), Soil and Water Research Institute (SWRI), Ministry of Agriculture, Universities and state governments (Akbari & Dehghanisanij, 2008). Hence, I studied the role of research in the technology's development and promotion.
- The subsidy program: Due to the technology's high initial cost, the Ministry of Agriculture has provided the subsidy program for the farmers (Akbari & Dehghanisanij, 2008). I tried to find out how the subsidy program, which changes by time, influences farmers' financial affairs and causes different rates of development.
- Engineers and maintenance: To obtain the full advantages of the technology, the Micro Irrigation System needs careful maintenance. Some basic maintenance and operations are feasible for farmers to execute, while for some other more serious problems or maintenance practices engineers or engineering companies should interfere. I tried to examine the engineering companies' role in the technology's function and shaping the farmers' practice.
- Producers: Many of the parts of the Micro Irrigation System, including pipes in different sizes, connectors, valves, pumps, and filtration systems are produced in the country (Ghaemi et al., 2007). I studied how the system creates or affects job opportunities in the country.

- Quality control: Iranian universities, research institutes, and governmental organizations constantly control the quality of the products. I could investigate how influential and determining is this quality control for the community who uses this technology.
- Policy: Political decisions are made on several issues, such as ensuring availability of standards materials, field-based research activities, evaluation of projects, solving the operational and maintenance problems, irrigation scheduling, system management, and precise irrigation (Akbari & Dehghanisanij, 2008). I tried to understand how these policy-makings, which sometimes are in favour of farmers while other times put farmers under pressure, influence the farming community, their lives, and their farming practices.

As already indicated, each of the aforementioned (collective) actors, in different arenas, are trying to manage and develop the technology to be used in agriculture. The network as a whole reveals the relations between farming communities, governmental agencies (like the Ministry of Agriculture), engineering companies, and manufacturers as well as universities and academic research institutes - as different parties work to manage the system.

As it is explained above, a situational maps and analysis approach helped me to characterize the intriguing areas present in my research, which I then investigated. Through these maps, I could form an understanding of both where and how to enter as well as what I should focus on. As already mentioned, situational and social worlds maps helped me to find my way to enter the fieldwork; of course, by progressing in the project, many elements changed, many new element appear, and many arenas were subject to changes in their dynamics. The next step was to collect data through ethnographic observation, interviews, and field notes. In the previous section, ‘Field Ethnography’, I elaborated how I have conducted the fieldwork and identified the relationships and negotiations that flow between the arenas and worlds in my case.

You can find a (polished) figure of the social worlds/arenas map below.

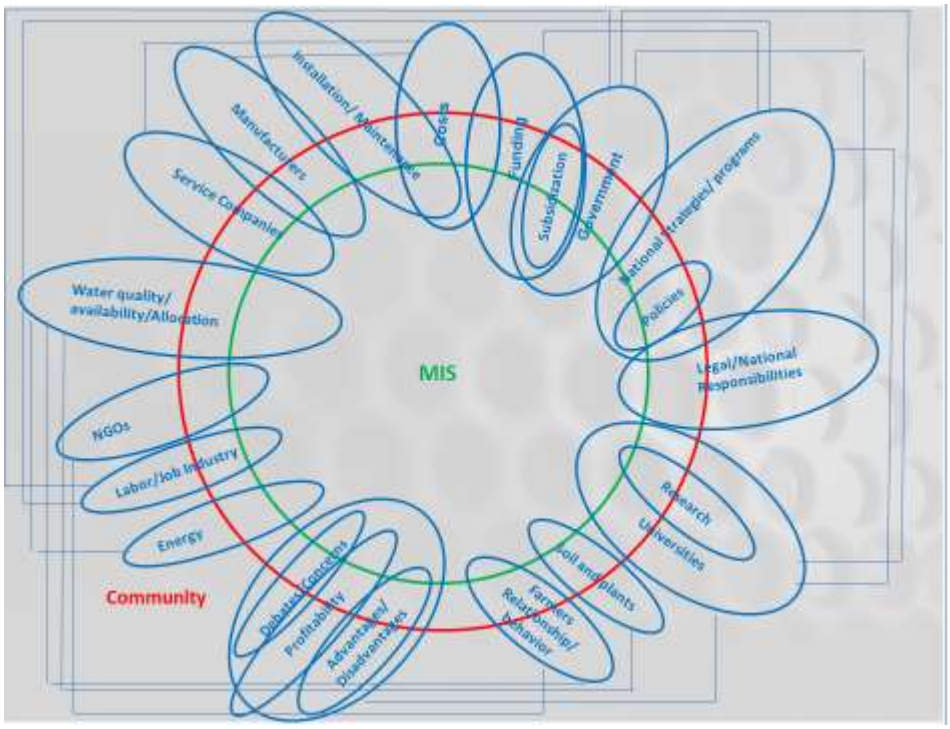

Figure 1. Social worlds/arenas map

4.3. Interviews

Conducting interviews was an essential facet of my research process, as I would not have been able to understand many things without talking to locals. Thus, as a part of participant observation in the fieldwork, I tried to make use of all the conversations that I had or heard during the course of a day in the field. This is what Bernard (2006) calls informal interviewing, as a category of interviews, which always takes place spontaneously. Such informal interviews, which happened during my fieldwork, were not planned, structured or controlled; rather, they just occurred in the field as normal conversations between the local people and myself. I tried to remember them by writing notes and memos, which I would use them afterwards. Overall, I have had such interviews with around 20 people in the community for which I have noted down some key words in my notebook very quickly in order to be able to follow the conversation. Later on during my down time, I added more details about what I remembered regarding those key words. These informal interviews in my study took place almost anywhere in the field - in local's homes, while walking along a road, or in any other unanticipated situation. In my experience in the field, such informal interviewing could build a great relationship between the participants in my fieldwork and myself.

Besides informal interviewing, I also conducted face-to-face unstructured and semi-structured interviews, as a background to support the ethnographic data that I had collected.

Unstructured interviews are those interactions, which do not follow a certain structural framework, though still based on a clear plan designed by the researcher. The aim for me with such an exercise was not to control the people's responses or reactions. Rather, my idea was to get people express themselves and present honest ideas. I have specifically used unstructured interviewing method for those questions of mine, which I could not get any answer through the informal talks. This included the five farmers in the fields, with whom I spent most of my time. Using this unstructured interviewing method and through avoiding a more formal settings of interviewing, I could create close relationships and seemingly effortless conversations with my interviewee and obtain valuable data.

I have also made use of the semi-structured interviewing method, which I had scheduled in advance. I have used these interviews for the elite members of the community, e.g. the oldest person who is regarded as the leader of the community, who had limited time, as well as his wife. These interviews were open-ended, but followed a list of topics that I should cover. I conducted these interviews in a way that I posed a topic-initiating question and then produced follow-up questions until I was satisfied with the answer and would proceed to the next topic-initiating question. This interview method allowed me to not only to pursue a form of interview schedule with planned themes addressing a certain list of questions, but also to provide the interviewee with enough room to develop their own position.

Where practically possible, I have recorded the unstructured and semi-structured interviews. I have about two hours of recorded interviews to which I referred back during content provision for this thesis, when necessary.

Critical Issues in Interviews

Similar to ethnography, there were also some issues that I kept in mind while interviewing. First off, I ensured anonymity and confidentiality. I explained to the interviewees why I chose them to be interviewed and how both their cooperation and opinion about certain topics were essential to my research.

While I got the interviewee on to a topic and kept the conversation focused, I tried to give the participants enough time and space to express themselves and provide information that they thought was relevant.

Since I had planned to potentially record the unstructured and semi-structured interviews, I, therefore, considered the ethics of recording. Voice recording allowed me to concentrate completely on the interview without having to worry about taking notes or remembering points later. It also provided me with a valuable archive to refer to at any time. Even though voice

recording seemed unavoidable for me in conducting some interviews, I had asked for permission to record. There was one case wherein the participant was reluctant to be recorded. I respected their wishes and relied only on the notes, which I wrote during the interview session. There were also some cases for which voice recording was not ideal. For example, once there was a loud noise in the background and in another instance, I had a technical failure with my cell phone recorder.

I believe the most critical issue in interviewing was that most of the times I was the one who guided the interview, progressed it by asking questions on different topics, and gave direction to the interview by the questions I decided to ask to follow up on certain topics. Therefore, I always bore in mind that, as the interviewer, I was playing a central and active role in the production of the interviews through the questions I posed and the way I followed up the discussions (Timothy, 2001). Since any questions that I wanted to ask could in a way lead the informant, I tried to be open and neutral by avoiding directly orienting the interviewee's responses. I was to be attentive throughout the interview about not leading the informant and not being directive. I followed what Denzin (2001) suggests by performing a *reflexive interview*, which entails that both the storyteller and listener participate in an experience by informing one another in a relational way, communicating knowledge, and understanding and co-constructing the meanings and contexts.

4.4. Secondary Research

Even though this research project with its specific focus could not have been accomplished without conducting a fieldwork, sometimes I felt the lack of a large part of the story, which I could never pick out from the observations or the interviews. In some cases, in order to figure out a complete view of the story, I needed to refer to websites or organizational reports and documentaries. At times using such documents and references was necessary and unavoidable. In those cases I needed some official references to further investigate a certain issue, which was not possible or was not answered during the fieldwork. For example, to obtain statistical information about the village inhabitants, I needed to refer to an official governmental website. Also, I needed to search and investigate in more detail in the governmental websites to get to know the promotional and supportive plans of the government in regards to application of the Micro Irrigation System. Clearly, I could not form an understanding of such issues during the field experience and online search seemed to be the only possible option in these cases. Luckily, some of the websites or online materials, to which I have referred, were also available in English. However, there were some websites and reports only available in Farsi and I had

no chance than to refer to them, as I could not find any other credible source available in English.

Reviewing the official websites and reports has been very useful for me to understand some issues at place. I might not have used them all in the content of this thesis as references, but they have indeed been valuable in shaping my overview of the situation and its context - helping me to better comprehend the dynamics.

Access to these websites and documents were mostly free. I have experienced almost no difficulties in collecting the required official and organization data from such sources.

5. Empirical Analysis

5.1. Getting a First Impression of Micro Irrigation System

It is the 15th of July 2015 as I enter the village of Lamlang accompanied by my friend Hojjat (a made-up name to keep anonymity of the participant) from Gorgan province. After my first visit to this village, I became very excited to once again travel to this village and stay there for at least two weeks in order to study the Micro Irrigation Systems, which were installed there in the fields. According to Hojjat, the systems were making a difference in the lives of the villagers. As I knew I could not stay for a long time in this village, I did a lot of online research about this region and the agricultural practices there (including the application of the Micro Irrigation System). My preparatory research also included collecting various available news pieces about this technology, which had very recently come to this region. Unfortunately, there was not a lot of information available online in English for this specific purpose. My preparatory research, therefore, includes only some material in English, as well as a general overview in Farsi, which shaped and to a certain extent organized my mind before entering the actual research field. I searched for pictures of such an irrigation system to have a basic idea of what to expect and what could be the potential aspects to investigate, question and analyse. Most online pictures of the Micro Irrigation System were showing two distinguished parts of the whole system: the first is comprised of the water sources and the control zone, while the second covers the agricultural field, where the water is transferred to the plants through valves and pipes. Below is a very widespread and easy-to-understand sketch of a Micro Irrigation system, which provides one with the concept and components of this irrigation technology. Such visuals gave me a structure to help conceptualize what I would later encounter in the field.

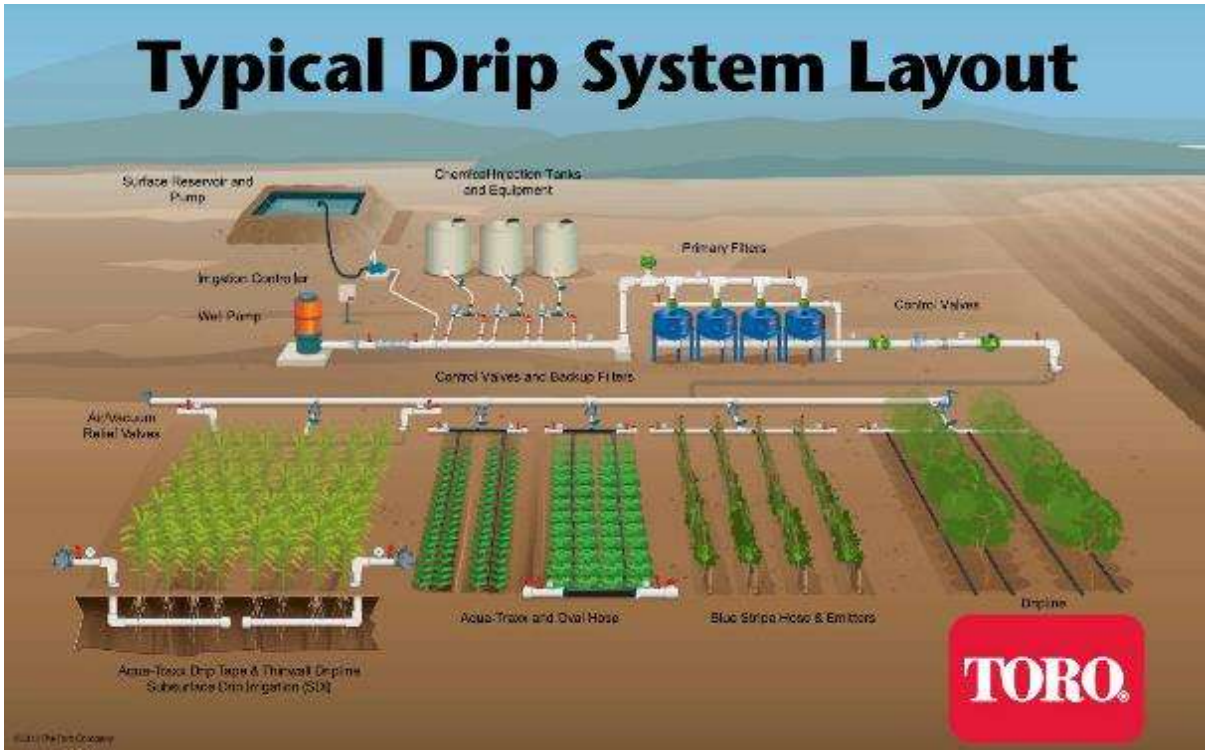

Figure 2. Typical Drip System Layout. © 2013 The Toro Company. Retrieved from http://driptips.toro.com/drip-irrigation-layout/

As mentioned above, entering the first field, I was a little bit confused, because the Micro Irrigation System I encountered was quite different than the one I had conceptualized. When attempting to capture the real–life system, as the field was rather large and the Micro Irrigation System was not only one physical object, I tried to provide a long shot[2] of the whole view. Fink and Medoff (2012) have described the long shot as the beginning of the story-telling, which should in most cases be the first shot of photography. Similarly, as the most important step, I took a long shot in order to capture the entire setting in my project. As mentioned by Fink and Medoff, I tried to show the field of my project "from head to toe" (p. 68) with a relatively wide angle of view. Following Fink and Medoff's techniques of creating such a wide shot, I had to bring all the elements of the Micro Irrigation System and its surroundings into my scene. Moreover, such a shot should have been able to tell the story of this irrigation technology in a nutshell.

I knew that I had to include all the key elements and components of this system together with all the possible or potential relationships among them. This shot should have had the capacity to provide valuable information about the story, which I was planning to pursue and tell. However, in setting up the camera to capture the view, I realized how difficult it was for me to capture all at once everything, which is involved in the function of this technology in this community and how almost impossible it was to incorporate all the elements, which were

[2] I am referring to this term in photography, which means showing the subject on a rather small scale in comparison to its surrounding, and placing it in some relation with the environment – also known as 'master shot'. Such a shot captures a relatively large area of the view, with the main subject being rather small.

present. It was really challenging to describe an all–inclusive story, all-inclusive in one wide shot. Therefore, I decided to use the long shot only as the beginning of the story, as mentioned by Fink and Medoff, and, instead, provide more detailed shots afterwards to complete my story. Below picture is my very first trial of providing a wide and detailed shot of the scene.

Picture 1. First trial of a wide shot

In the picture is the first agricultural field that I have observed together with the residential area in its surrounding. However, nothing from the Micro Irrigation technology, which I knew was installed on that field, is detectable in the picture. In addition, nothing from the dynamics around is noticeable.

Picture 2. Long shot of the second field

This picture shows the second field, which similarly to the first one shows nothing from the stories around the technology or its relation to the community.

Gradually, when I saw the next fields I completed my collection of pictures, as I was facing more scenes, people, and objects, which were of interest to my research and the stories being told to me by the villagers. Every picture I took had something to add to my stories. Even though I failed to provide a single long shot showing the whole situation 'in one sentence', I could still provide some pictures with a clear view of the areas surrounding this typical irrigation technology. I believe these pictures afford a fair overview of the landscape and can provide the reader of this thesis a proper grasp of the region and probably some existing dynamics. Although these pictures give a rough feeling of my project and what I seek to investigate, it would be simplistic to assume the collection of these pictures could provide a comprehensive perspective of the complexity of the function of this technology. The pictures themselves are not a major part of what I have seen, heard, or experienced during my fieldwork. Yet, they remain quite valuable as they formed the basis of many stories, which I told afterwards about the entire field. Finlay and Leggett (2001) argue that there are limitations in images and pictures to bridge cultures, but the images could definitely be used as a starting point from which the reader can follow the story of a certain context and make their own perception and conclusion. Images could at the very least help one to reflect on a specific aspect of a story; thus, they should be added to the context we aim to investigate.

In brief, I have never been able to create an all-encompassing depiction of the Micro Irrigation System and the surrounding community, which could show all the narratives of the system. Nonetheless, I could afford taking multiple pictures of the village, each representing different parts of the overall story. The stories were improved gradually through personal notes, voice recordings of the interviews and, of course, by my memory.

5.2. Engaging with the System

Having prepared myself for the field observation, finally the time arrived to visit the village. Hojjat picked me up from Gorgan's main bus station and we drove about an hour to the village. Soon after entering the village, I met Mahmoud and his wife Aameneh (again, both are made-up names to keep anonymity of the participants) who were my hosts during my stay in the village. Right after being invited to a lunch of local cuisine in their cottage, they took us to the first agricultural land.

From the moment that I entered the village, I was looking forward to finding the neatly ordered Micro Irrigation System, similar to the typical layout (page 44), which I had in my mind. We passed by two not very large agricultural fields. Approaching the third, I stopped by a well to have my first sight of the Micro Irrigation System. The well was not what I would have imagined to be a part of Micro Irrigation System, standing in contrast to the very clear and well-ordered image I had in mind. I was not even entirely sure that I was in the correct place and if the field in front of me was one of the places where we were about to stay and study. I double-checked with Hojjat if this was the system.

Picture 3. My first contact point with 'the system' (1)

Picture 4. My first contact point with 'the system' (2)

I took the pictures above to remind myself about my very first contact point with the system: such a small and dirty well, from which there was only one thin tube coming out, and if you looked closely under the water, there was a small pump.

Even though what I just saw was quite far from what I thought I would see, I was there to study the irrigation technology. I needed to enter the field in order to explore other components of the system and see how they worked with one another to reshape ways of doing agriculture. I was about to start my research and investigate the power and capacity of this system, which claimed to optimize water consumption, and its direct or indirect effect on people's lives. I strongly believed that this community, who had taken on the risk of installing a new irrigation system, deserved some attention. It was absolutely worth it to me to dig deep into the social, economic, cultural, and potentially political footprint of this seemingly mundane technology. Later on, I will argue that this technology, which appears mundane at first glance, can make a big difference in its surrounding, be it social, environmental, economic, or political.

Apparently, Hojjat noticed the look of disappointment in my face, asking, *"What are you staring at? Were you waiting to see a colourful brand-new high-tech piece of art, as you would expect to see in the middle of Europe? Here is a small village in Iran, they clearly cannot afford a high-tech system, the government simply does not support. These people are happy to have this technology, though it is mundane, at least it could let them sleep in piece at night without worrying about water scarcity and drought of wells… just come with me, let me show you these fields. There is a lot to see; we don't have much time..."*

His reference to water scarcity and how the Micro Irrigation System has turned out to be solution, made me wonder how such a seemingly simple technology could partly address the issue of water shortage in Iran. For this reason, it would be worth briefly explaining the issue of water scarcity in Iran in order to give the reader an understanding of how this technology could play such an impressive role in dealing with water shortage. Geographically, Iran is located in Southwest Asia with a hot and an arid to semi-arid climate. The average annual precipitation in Iran is reported to be about 200 millimetres (Climate Change Knowledge Portal, 2016). For already many years, precipitation has declined steadily in Iran, while water consumption and water waste have increased in the country. According to Masoumeh Ebtekar, the vice president of Iran and Head of Environmental Protection Organization, Iran's water consumption is twice the world's standard level (Rezaian, 2014). The rapid growth of the population and, consequently, the rapid increase in water consumption (especially in the agricultural sector), the occurrence of drought and lack of allocation of financial sources for proper investments on water projects are named as the most important factors contributing to water shortages in Iran (Babran & Honarbakhsh, 2008). In a similar, but more locally-oriented way, Issa Kalantari, adviser to vice president Eshaq Jahangiri - the former minister of agriculture - has pointed to water mismanagement, the wrong movement towards agricultural

self-sufficiency, the building of numerous, poorly–conceived dams, and the subsequent drying up the county's bodies of water bodies as the key issues leading to this unprecedented water shortage in Iran (Khajehpour, 2015). The water shortage has become a more serious problem during the last decade. Unfortunately, not much effort has been made to address this situation in Iran, which is rapidly approaching a crisis.

I was very happy to hear that the Micro Irrigation System was already employed as tool to partly deal with the water shortage - at least in agriculture. It seems that Micro Irrigation System is, as a technological possibility, making a difference in dealing with this momentous matter in recent years. According to what I was repeatedly hearing, the Micro Irrigation System consumes much less water for irrigation, and the farmers can adjust the irrigation amount to the level, which is really necessary for the plants to grow. With this method, there is almost no water being wasted. This is considered already as a significant improvement in comparison with older method of mass irrigation, in which excessive amount of water was being given to the plants and a lot of water was being wasted due to evaporation, amongst other reasons. The system consumes less water, saves water from being wasted, contributes in tackling water scarcity in the regions, and lets the community worry less about their future water resources. The work that this technology does - beyond only giving water to the plants - seems to be quite influential in the region, as the people in the community were constantly referring to the system. Maybe this system could also be called an admirable or appropriate water technology, as mentioned by de Laet and Mol (2000), as it serves the community on more matters than only irrigation.

During my time in the village, I have observed in total five agricultural fields. In the previous decades, the entirety of the agricultural fields of the village belonged to only 4-5 people, who were referred to as *the village elders*. Over time, the agricultural fields, which are about 500 hectares in total, were taken over by the inheritors of the elders and this trend has continued through the generations until now. This means the large pieces of agricultural fields, which were once owned by only a few elder members of the village, have been gradually divided over into smaller lands, which are now owned and managed by different generations of the previous great landowners (e.g. sons, brothers, and grandsons). Currently, there exist around 560 inhabitants or about 150 families in Lamlang (Statistical Centre of Iran, 2011), with each family owning some hectares of agricultural lands - the distribution of lands among the villagers being approximately one hectare per inhabitant. Therefore, a family of three has about three hectares of land and a family of five owns five hectares, etc. This pattern of even distribution of land among the villagers occurred gradually over decades, when the elder members of the village have assigned an equal amount of land among their inheritors. In my study, I have surveyed five of these families, who own about 20 hectares of agricultural lands all together.

In the field, the irrigation function was explained to me. My host, Mahmoud, started by telling me "*this irrigation technology was built here in order to partly tackle our water scarcity issue and to improve irrigation in this area.*" Mahmoud continued to explain the basic function of this technology is quite simple. Water is being pumped from the well (pointing to the well) through tubes, which lead the water to the roots of our plants.

Picture 5. The water tube coming out of the well

This picture shows the tube, which comes out of the well. The water is being pumped through the tube, where it is transferred into smaller tubes branching off the main line.

Mahmoud's interpretation of the irrigation system was quite simplistic at first and I was wondering if he was familiar with how the system actually works and whether or not he was responsible for its maintenance. Mahmoud said he is theoretically not responsible for the maintenance of the system. Although, in reality, he is taking care of most parts of its maintenance, as he wants to save the money on the maintenance and system checks, even though this service should be free and covered by the government. As Mahmoud is basically in charge of most maintenance tasks related to the irrigation system, he could describe it more in detail when I asked him "*Mahmoud, tell me exactly what happens when the water is pumped from the well… how does it work?*"

Then Mahmoud continued, drip irrigation[3] is a method of irrigation in which water is dripped with low pressure to the root of the plants. He said they also call this method of irrigation regional irrigation as it only spreads the water into a specific and limited region of the soil, and overall only a small surface and depth of the soil is getting moist (only down to the root as it is needed). He said in this way significantly much less water is immediately evaporated after watering the plants and it will help them a lot in dealing with water scarcity. Of course, this is not free of problems and disadvantages, but overall in managing the water consumption, it has helped them a lot. The system consists of the water source (the well), the pump, the filtering device, fertilizer containers, pipes, valves, and small emitting devices. It works, as the water is pumped from the well, through the filtering devices where sand and finer particulate, such as algae or other suspended particles in the water, are removed. Then a portion of the filtered water passes through the fertilizer and chemicals tank and then this solution re-joins the main watering pipe. From there the water is transferred to the plant roots through small emitters.
As the first field was quite small, and did not include all the above-mentioned elements (such as fertilizer and chemicals containers), I am including below further pictures from other fields I observed in order to give a visual, more comprehensive understanding of the system to the reader:

Picture 6. The well of a larger farm

[3] Apparently, the term 'drip irrigation' is more common than 'Micro Irrigation' among the gardeners in Iran.

This picture shows a larger well, which belongs to a much bigger agricultural field. The well is on the left, while the field is seen to the right. As it is visible in the picture, the structure is similar to what I had observed at first, water is being pumped out of the well and transferred to the field through tubes.

Picture 7. The fertilizer and the chemicals containers

Picture 7[4] shows the fertilizer and the chemicals containers, which are adjustable to the required amount of chemicals and fertilizer and could be even planned on a timely manner.

[4] The participant in this picture was happy for the picture to be included in my thesis.

Picture 8. The filtering device

Picture 8 shows the filtering device, which filters external elements from the water being transferred to the plants roots.

Picture 9. The main valve and tube

Picture 9 shows the main valve and tube containing the filtered and nourished water, which is ready to be transferred to the plants.

Picture 10. Water tubes on the field

Picture 10 shows a part of a field in which the water tubes are visible alongside the plants rows. These water tubes are derived from that main tube shown above.

Picture 11. Water being transferred to the plants' roots

Finally, picture 11 shows the location where the water is transferred to the root of the plant.

Even though prior to my field study, I had already formed some understanding of the Micro Irrigation System, how it looks, its components, and how it works, it was still rather difficult to follow the water source, water current, and the irrigation system as a whole. For somebody who was not there, the irrigation system remains largely invisible. As elaborated above on my first contact with the system, I even had difficulty to see the technology I was seeking. That technology had to be made visible to me. The first glance, the small and dirty well for me the viewer was not an indicator of an irrigation system. My challenge then was how to look for something invisible to show it as a whole and how to unpack my existing knowledge of this system in that field.

I realized later on that this low-tech character[5] of what I saw in the fields was actually the most interesting part of the whole story that I aim to tell in this thesis. Because it shows how a seemingly mundane technology (to use a phrase by de Laet and Mol (2000)) could be so fluid in serving and shaping its surroundings and, at the same time, be adaptable in order to satisfy the requirements and dynamics of its new environment.

[5] In contrast to the high-tech character mentioned in reference to the image of the technology, which I had in my mind prior entering the field.

5.3. Time Management - Engaging with the Community

Despite the fact that Mahmoud tried his best to give me a very detailed version of how the Micro Irrigation works in their small agricultural lands, I was not at all convinced that his narrative captured the complexity of introducing such a system. What I had heard so far from the local people seemed to be only a rough introduction of their own irrigation system. I was there to explore more about this technology, also in the other agricultural fields in that region. I was there to see more, hear more, and ask more about the function of this tool, how it changed people's practices, and if it was making a difference for this community. From the very first moments of our talk, whenever the villagers were mentioning something new, interesting, or sad, I tried to make notes and flag issues, which I thought would be worth having a look at a later stage. Already on the first day, I could collect a good quantity of stories about the irrigation system and the lives of the community members. Most of the information and the narratives I heard and saw during my stay at the village form the content of this chapter.

Even though I spent only about two weeks in the field, I trusted that this relatively short period could provide me with enough chances to make an observation and assessment of the situation. I did not have the advantage of doing a long-term field observation, as it is part of a master thesis, but I could run what Bernard (2006) calls a rapid assessment in an applied ethnographic research within this short period.

Bernard (2006) describes applied ethnographic research as being often done in only a few weeks, where the applied researcher does not have the chance or opportunity of staying in the field observation for a long period and running a long-term ethnographic research. In such cases, the researcher would rather use the rapid assessment method, with which the participant observation and assessment of a certain practice is done rather rapidly in terms of time. In rapid assessment where the task of data collection is being achieved without spending months in developing the fieldwork, the researcher should be equipped well with a rather comprehensive and all-inclusive list of questions and issues to be addressed. In doing my fieldwork in the village I have taken advantage of the concept of participatory mapping in rapid assessment in applied ethnography (Chambers, 1991, as cited in Bernard, 2006). I did so by drawing the map of the village, where I was studying and flagging key places and areas of interest on the map. Later on, in the fieldwork I could walk through the area involving people in the village into discussions, conversations, and explanations about everything I saw along the trip and sought for more information about.

Of course, in my project, I did not have the opportunity to stay in the field for a very long time and collecting more of informal stories. I have, however, tried my best to run the fieldwork as

efficiently as possible and collect sufficient amount of data without spending several months staying and observing these agricultural and irrigation practices.
I have made use of the tips given by Handwerker (2001, mentioned by Bernard, 2006), in running a quick and at the same time high-quality ethnography. I have attempted to specify clear questions in advance to be addressed in the fieldwork. Due to this being only a master project, I have narrowed my focus areas on the factors, which would be the most important ones playing a role in the function of this technology and the technology's influence on its surrounding. For this purpose, I was prepared enough with a list of queries that I wanted to examine and investigate in the course of the fieldwork. As an applied ethnographer, I ran a rapid assessment of this small village by bringing people into my research project as research partners in order to achieve the most out of my short stay in the field. Of course, I could have allocated more time in the field to focus on my study and the more time I was spending there, the more I could have heard, seen and understood about the complexity and stories of such a system. However, I could only trust on Bernard's (2006) advocacy for rapid assessment, as he highlights the fact that when the researcher has clearly defined questions and focus areas, they can produce a high-quality study in much less time than assumed to be enough.
I had no doubt that this fieldwork had brought me to the right place where the diverse functions of the technology did unfold in practice. It allowed me to collect a variety of data and narratives. It seemed that my companions in this fieldwork fully agreed that I was in a good place to learn and see more about this technology and its influence on the village life.

"If you want to hear our voices, how this [the Micro Irrigation System] has changed our lives, here is the right place. Be patient with us, and promise that you will stay enough and listen to what all of us want to say about this, and promise that you will try your best to communicate our problems to the responsible people…", said a local farmer.

All the participants in this field study mentioned that my research meant a lot to them and they see this as a great opportunity to be able to talk about this system and the benefits it brought them, while expressing their concerns and discussing the future prospects. They were unsure why and under which criteria I had chosen their field and land to study. Yet, overall they seemed to be happy to be chosen. One of the very first questions most of them asked me was why I chose such a case to study and why this had mattered for me to research. They were enthusiastic to find out how I actually found out about the existence of this irrigation technology in this particular village and how I happened to be interested in understanding its role in the lives of those villagers. I then explained to them my project, which I am currently doing, is an effort to write a thesis for a master degree in the field of Science, Technology and Society (STS) at the University of Vienna. By connecting it to their case of irrigation technology, I made

it clearer for them that STS partly looks at how technologies are deeply interwoven within our lives and that our lives are constantly changing because of technological options. STS argues that technologies affect and compete with our existing ways of life and create differences. It was interesting for my companions to hear that while technologies might bring changes to their surroundings they might also be changed by them. I continued, I was exactly there to understand that specific and complex relationship between that technology and them in their village and how it is influencing while being influenced by its surroundings. In answering their question on *how* I chose their field and why *this particular* technology, I told of how I had to look for a related STS case, which was, first of all, interesting and secondly, for a case that would bring some value to where I had lived and come from, my own country. When listening to the Iranian daily news, I heard more and more about droughts and water scarcity in Iran, which were causing problems for many agricultural lands, I became more interested to follow up what the government is providing in response to such challenges. I heard that the government, as part of the solution, was promoting and subsidising the Micro Irrigation System in order to tackle the issue of so much water waste during the mass irrigation practices in many agricultural lands in Iran.

5.4. Actors, Technology Transfer, Public Discourses, and How the Technology Was Changed and Shaped by its New Surroundings

So far, I have explained how challenging developing a complete picture of the system was; meaning one picture, which simultaneously depicts how it operates and how it engages with the surrounding community. In this section, I will elaborate on how further aspects and angles involved in the functioning of the system, which could never be summarized in a single picture. I have dedicated this section to the narration of how this technology was introduced and transferred into this village, how the community reacted to this technology, and finally how important visiting the system and the fields it nourishes was for me as well as the importance of talking in order to be able to grasp an overview of the influence of this irrigation technology in each area. I will explain the very interesting, yet at times sad, stories I heard, followed, and figured out regarding the role of this technology in the village. I will elaborate on how I was able to prove to the villagers that my specific case of this specific technology in this particular small village was worth investigating, as there were so many important related issues, which needed attention, investigation, and hopefully further follow up. Even though I was able to provide a collection of photos, each of which I thought would represent a specific part of the overall story, I still realized there were many more complicated relationships and connections existing amongst each of the elements, which were not at all visible and present in those images. These

aspects required a certain attention, more follow up, and the ability to connect to a wider overall picture. I have referred to these aspects as the existing different actors, their acts, and the specific correlation among them to the theoretical part of this work.

It is still the first day and I am trying to take a long shot of the entire area containing the system. I had to start somewhere and found taking the right shot was difficult for me, i.e. locating where precisely to start and what exactly to choose as the starting point. I knew that this project should have a beginning and that I could start from the moment when the villagers first heard about the project; however, I was finding that understanding how to approach these stories to be very challenging, as it seemed, entering into the field was not at all close to what I had expected. Although, I knew that the three eager people standing by my side wanted to support me in finding way through the maze of uncovering all the aspects surrounding the system. I was sure that if there is a story to tell, they were the ones who would know the story the best or at the very least could put me in contact with others who did. Of course, I was not expecting to find out the intricacies of such a technology very easily; yet, I knew the stories were there and I needed to search and try to discover them, sometime for days, in order to write about them. As I will explain below in more detail, most of the stories were revealed during my talks with the various villagers, including my interviews with more elite members. My conversations with people - e.g. simple chats with villagers or more formal dialogues with others - were the most important source of collected information. After transcribing all my interviews, I realized I had too much information, which I had to handle, and too many important facets to bring to my story, none of which should be missed. The number of interview transcripts, together with the pictures I took during my stay in the field, my online research, and the copies of papers and letters, which I received from Mahmoud, left me with a massive amount of information with which to deal. I was then wondering if I would be able to compact them all in a master thesis or if I had to neglect a proportion of the data (a thought, which was of course very disappointing). I then decided to provide a summary version of everything I had witness and, instead, not to fear the potential loss of anything important.
My concern then changed from where to start to how to handle this much knowledge and how to connect all aspect together to create one coherent story.

In order to tell the story in an orderly and sequential way, I have started by providing some historical background of this project and how it was introduced into the village, then the community reaction to this new technology, the current phase of installing this technology in the region, and finally the difference that it is making to its surroundings.
In Iran, the Micro Irrigation System was introduced around 1990. The promotion of the Micro Irrigation System in the agricultural lands of Iran was a project of the Iranian Government,

which aimed at reducing the consumption of water by agriculture as a solution to the problem of water scarcity. As the issue of water scarcity was approaching a crisis and the top-level managerial efforts proved inefficient, the government aimed to import the modern technology as well as the know-how of water management from abroad, where this technology was already under practice, having proved to be successful in managing and reducing water consumption.

Since then, the government has made great efforts to promote this method of irrigation. Of course, along with the transfer of this new technology into Iran, some new influential factors in the functioning of this technology also came. As an example, the amount of salt in the water in this region is rather high and, therefore, it is necessary to place extra equipment in the whole system in order to reduce the frequency of clogging due to the salinity of the water. In Iran, the manufacturing companies equipped the pipes and valves with extra airing devices, which let air pressure in and out in order to avoid clogging due to the high salinity of water.

Therefore, this technology was adapted to the specific needs, specifications, and conditions existing in the region. In other words, the technology had to be adapted and customized according to the new environment. The system became subject to change in order to fit the local situation

Here the technology has been rebuilt accordingly or replicated to satisfy the specific local context.

Other than the need to adapt and customize this new technology to the local requirements, the technology needed to be brought alongside the processes of learning to understand. As with every other new technology, this technology transfer was a social process in which people were involved and these people needed to understand, learn, replicate and apply this new method. As the manufacturing knowledge for such a new technology did not exist in the country, the government had to invest in training and knowledge-sharing programs in order to educate a skilled workforce as well as expert technicians to manage, promote and maintain the newly introduced technology. A comprehensive learning process was necessary in order to introduce this technology into Iranian society. The government, together with Agricultural universities of different provinces (including Tehran, Gorgan, Mazandaran, Khorasan, Gilan, Isfahan, and Shiraz) held conferences and seminars in order to disseminated knowledge and information about this newly introduced technology. Farmers or representatives from the villages were invited into these conferences and later on contributed in related workshops, which were organized by the government in each province.

Since the beginning of the introduction of this technology, research and development have been pursued by different organizational and official entities such as research organizations, universities, and the Ministry of Jihad-Agriculture. Agricultural Research, Education and

Extension Organization (AREEO) and Central Institute of Cotton Research (CICR), which work under Jihad-Agriculture, are two main research bodies in Iran that undertake specifically the research and development of the Micro Irrigation method. On a higher level, related policies were developed in order to ensure successful adoption of this approach. There always have been researching activities, together with monitoring, assessments and problem solving plans available to complete this achievement (Akbari & Dehghanisanij, 2008).

This technology not only has been appropriated and fitted to the new local context and requirements, but also has been incorporated with existing local technologies. As an example, in order to pump water from the well to the Micro Irrigation pipes, farmers could use the same pumps as they were traditionally using for their mass irrigation. Therefore, merging the new method with the existing local technologies created a new agricultural possibility, without the need to provide and supply everything new. The Micro Irrigation technology in this case has shown a flexible and responsive character, which is not strictly bound to any specific environment; instead, the technology could be made local and adjust to another environment. This ability to adjust could be regarded as part of the success of this technology. The community perceived themselves as in control of this system; meaning that they were not obliged to adapt to it and they did not refuse to use it. The technology itself was new, but not made from entirely new elements, which could be seen as imposing by the community. Rather, the technology is flexible and adaptable, able to be fit into the local existing infrastructure. The term *loveable*, which was first applied by de Laet and Mol (2000) in explaining the relationship between the Zimbabwe Bush Pump and the surrounding village, could be assigned to the Micro Irrigation System, as it seems it has attracted its community to a similar extent.

Due to the high initial costs of installing the Micro Irrigation System the government, or the ministry of Jihad-Agriculture to be more precise, provided special subsidy programs to facilitate the process as well as support the farmers, while encouraging them to change to this method of irrigation. These programs have been quite diverse since the beginning of the introduction of this system in Iran and, subsequently, have led to different adoption rates. The support of government also has been in the form of granting loans to the farmers through which they could buy and install the new technology.

In Lamlang, the Micro Irrigation Technology was only brought into practice in 2011, when the issues with water shortage and drought became more challenging. In the meantime, the government had introduced its special new program for subsidy and loan grants when applying for the Micro Irrigation System, which seemed rather reasonable to the farmers. If a farmer is willing to adopt this technology, the government will send a few experts to his agricultural land and according to the assessments of this expert group, the installation cost will be roughly

estimated. Based on the cost estimation from the expert group, the Agriculture Bank of Iran, which works under Jihad-Agriculture, grants loans to the farmer with low interest rate. As an example, if the normal interest rate in Iran is currently 14%, the interest of the loan for farmers to buy Micro Irrigation equipment is about 8%. Moreover, the farmers are exempted to pay around one-fifth of this amount back to the government. Therefore, the farmers should overall pay around four-fifths of the whole required cost, plus a low interest, through one-year debts. Hojjat stated, "*The government offers this as a grant for those who are willing to be involved in this profitable program… one which is profitable for both the farmers and the government"*.

The above paragraphs indicate that the process of introducing this new technology into the region was not a linear or straightforward; rather, the process was more complicated, requiring a certain understanding, adaptation and appropriation, integration of local knowledge and existing technologies, facilitation, developing policies and providing subsidy and facilitation program, and conducting research in order to further develop the technology and its application.

In line with the national policies on water management, since 2000 the government has begun to focus on the northern provinces of Iran - Gorgan included - in order to promote and introduce this technology to the farmers in this region. According to Hojjat, in the beginning, the process of introducing this new piece of technology into the province has neither been easy nor straightforward. The community of farmer did not accept the technology immediately and unquestionably. Rather the majority of farmers showed initial reluctance to accept this new method of irrigation, as it seemed too technical to them, being far from what they had experienced before and different from their traditional practices passed down through generations. Over generations, the farmers had become used to the traditional method of mass irrigation and, therefore, they could not see any reason at first to change to a new more technical method, which was completely foreign and seemed complicated. They were questioning why they should change to a new method, while the old method was already working. They had concerns and questions about the installation of the system, the related costs, the maintenance, and the potential negative outcomes. For some time, the farmers in this region remained resistant to this irrigation technology. Even though the government and industry both were attempting to promote the technology as reliable, while further developing it, they still were unable to instil trust in farmers. Most farmers were more concerned about the potential problems and possible difficulties that this new irrigation technology would involve. These concerns shaped negative attitudes towards this new technology and led to a lack of widespread acceptance in the beginning.

Therefore, the introduction of the Micro Irrigation System into Iran, more specifically this region, was accompanied with varying attitudes among different involved elements. This included the

government, which was strictly pro application; the universities and the research institutes, which were open to conduct further research and development programs; and the farmers, who would use the end product, but mostly were concerned about the potential complexity and unknown outcomes. Therefore, in the public sphere, there were many different discourses, which covered the different existing dynamics around the introduction of this new technology.
Slowly, due to water shortage in the region, the farmers began to show interest in trying out this new method, which claimed to consume much less water. Still the initial, as well as the maintenance costs, were a burden for the farmer, hindering full acceptance of the technology. As the water shortage was becoming ever more critical in Iran, including this region, farmers began to change their mind-set and be more careful about the amount of water they were using for their irrigation practices. Gradually, this society transformed through the creation of new cultural norms and values, which believe that everyone should contribute in finding and applying water saving methods. Therefore, the farmers had to create or change values and cultural elements in order to apply this newly introduced technology. This is in line with Felt et al. (2015) approach of studying the public reaction to new technologies, which suggests one should study people's reaction to the social and cultural changes that the technology might bring, rather than the public reaction to the technology itself. The farmers' positioning towards this new irrigation technology is a reflection of how this technology interferes with the farmers' existing social and cultural orders. In this case, most farmers did not initially accept this new technology, as they found it conflicting with their pre-existing orders and ways of farming. However, in this instance the new technology was able to somehow overcome and in the end changed some existing norms and orders in. This technology was accepted and used by the farmers, only when it could get embedded into their culture. Finally, this technology seems to manage and to harmonize with the farmers' cultural context.
As explained, in the specific case of the introduction of the Micro Irrigation System into this region, as opposed to the widely criticized deficit model of the public understanding of science, the acceptance or rejection of the technology was not due to lack of knowledge by the farmers, but rather to their concern about the complexity of the system, the unknown results of application (with specific geographical, water and soil conditions), the potential high installation and maintenance cost, the difficulty of producing the required equipment of the system and the potential upcoming technical failures and problems of the technology inside the country. As it seems, the deficit model oversimplifies all the involved actors and the related discourses. This model only considers the farmers' community as one single actor (a generalized group), which has to deal with the new irrigation technology, and the introducers (as another generalized group), on the opposing side, as those who want to sell this technology to their target group. It simply assumes that the discourses only happen between these two groups, ignoring all other existing actors and the dynamics around them. While in my field observation not only did

various discourses exist simultaneously among various involved actors, but also various discourses existed within each group of actors. For example, not all farmers were initially against this new irrigation technology. According to Mahmoud, some of the farmers in the region were willing to try it from the very beginning. As discourses vary at different levels and among different existing actors, the linear approach of deficit model cannot address everything within this dynamic network.

As explained above, as a comprehensive learning and knowledge-transfer process, the government, together with Agricultural universities of the different provinces, held seminars and workshops in order to inform and train the farmer in this new irrigation technology. In this way, the community of farmers engaged actively in dialogues with experts and introducers of this technology and, thus, contributed to knowledge sharing process. This process is in line with the approach of the public understanding of science, which takes into account all the factors, which could potentially affect public perception of a newly introduced technology.
As discussed, the farmers of Lamlang gradually became interested in the big change. At the time of my field trip, Mahmoud reported that around 70% of the agricultural lands in Gorgan were practicing Micro Irrigation. Two main reasons for this shift were the lower level of available water in the north of Iran in the recent years and the high cost of energy consumption for pumping. I will explain further below how Micro Irrigation has helped farmers consume much less water and energy while irrigating their lands. Therefore, more farmers have become encouraged to change to this irrigation system. Hojjat added, this system has become common enough, that most farmers equip their fields with it any time they extend their lands.

5.5. Linking It All Together: How the Technology Made a Difference

In this section, I will present what I have learned during my stay in the village. I will elaborate on the stories I have collected and consolidated from the five agricultural lands in the village.
I will explain what I have witnessed, observed, heard, and was told about the overall changes that this technology has brought to the communities.

5.5.1. How Did the Introduction of Micro Irrigation System Change the Work Environment?

Micro Irrigation System has changed the work environment in its surrounding on different levels. One of the very first and clear outcomes of installing the Micro Irrigation System in this village was that it requires less human resources for the task of irrigation. As Micro Irrigation can bring water to the plants in an automatic way, human labour is no longer necessary to manage and preform the crucial task of irrigation in a timely manner. Three of the farmers, who did not have a grown-up son in their family to help with irrigation, stated that this technology

made their work much easier, as they did not have to always worry about the time when they had to water their crops. They said they are quite happy that with this great system, as irrigation is done by simply pressing a button. They were also content with the fact that they did not have to regularly visit and supervise their fields in order to make sure everything is working fine and irrigation is being done properly. Two farmers also stated they knew that by aging, they would not be able to irrigate their lands on their own and, hence, they were quite happy to have this mechanized method of irrigation.

Before installing the technology, the farmers could not afford to handle the whole irrigation practices themselves, as farming necessitates a lot of labour intensive work. Therefore, the farmers had to either ask for their wives' help or employ somebody for the task of irrigation. In most cases, women were reported to be unwilling to do task, as they found it usually a burdensome activity, especially during summer, and they needed to take care of the children. Although, I found women in general to be very happy to be involved in other farming activities, they seemed to be reluctant only to help with the irrigation. Accordingly, in those cases, farmers had to employ workers to do this job. Two of those three workers whom I met, were young boys in other families in the village who were students and were seeking for part-time work. The other one was from a close village and could not find a farming job, the only profession he was experienced with, in his own village. These young people claimed, though, that they found their working hours not quite flexible, as irrigation had to be done at certain times during the day. Two of them found their part-time job a bit conflicting with their studies. Nonetheless, they were happy to do it as they rely on the money they were earning.

By applying the Micro Irrigation technology, farmers found an improvement in their work and no longer had to worry about irrigating, particularly during summer, as they could plan and run the irrigation regardless of their own physical presence. They could also save more money, as they did not have to pay young people to irrigate. Even though Micro Irrigation System made farmers' lives and work much more convenient, as they were free from the task of irrigation and from external labour cost, it meant hardship for the young part-time irrigators. Installing the technology in the agricultural lands of their villages meant for them to lose their jobs. Luckily, though, two of them were able to find another job in that village or a village around. There was only one of them who, on purpose, did not search for another job after losing this one, as he wanted to focus more on his studies and travel to the city to prepare for university entrance exam.

As mentioned, bringing this technology to the village reduced the necessary workload for the task of irrigation and allowed the farmers enjoy some economic benefit by not having to pay the external irrigators. However, this change in required labour led to the young irrigators losing their jobs. Fortunately, nobody was left suffering from unemployment, as the surrounding

community were kind and charitable enough not to let anybody worrying about losing his job. I found this very humane that the neighbours cared about people losing their jobs and helped to find, or in some cases to create, other agricultural positions for them.

The establishment of Micro Irrigation technology in this village affected the work environment also by providing some job opportunities. Since the introduction of Micro Irrigation technology, the industry of pipes and polyethylene fittings was also developed in the country in order to promote this method of irrigation and gradually replace the old traditional irrigation methods. In line with the recent movement towards less water-intensive methods of irrigation, private investments were made to develop manufacturing of Micro Irrigation devices. As reported in the Database of Pipe and Fitting Industry of Iran (2016), more than 180 companies are currently mass-producing Micro Irrigation equipment in Iran. *Irrigation and Water Supply Equipment Manufacturing Company* in Isfahan and *Iran Plastic Industries Development Company* in Shiraz, working under *Iran Drip Industrial Group*, are two of the major producers in this industry. The suppliers of pipes and fittings are now able to design, manufacture and assemble the equipment, while providing almost the entire country with their products and services. Most parts of the technology are now produced inside Iran. This includes supplying polyethylene tubes and pipes, pumps, valves, connectors, emitters and filtration devices. Still, the Micro Irrigation manufacturers import some machinery and technology from abroad, but they are mostly independent in producing the products.

Furthermore, continuous research and development is being conducted to improve the quality of the products and to tackle the problems associated with this system. The manufacturers' laboratories also support the research institutes and universities on different projects by controlling the quality of the equipment in order to ensure all the required standards are met. However, still the quality of locally produced emitters is not high enough to be approved for broad usage, and, therefore, emitters are mostly imported from abroad.

As discussed, the Micro Irrigation System has helped to create job opportunities in Iran. The system seems to have created many more jobs in the region than it has destroyed. Even though it has led some people losing their job, it has established an industry, providing many more employment opportunities in Iran.

Another aspect in work environment remarkably affected by the technology is the level and condition of farmers' cooperation. Prior to the introduction of the Micro Irrigation System, the relationship among the farmers was competitive. As stated by all the framers in my case of study, before having this system they did not have a close relationship with one another, having no common ground for cooperation. However, this changed since the introduction of the new technology. From the very beginning of the installation process of the system, farmers started to actively cooperate with one another to make the best out of the system. As the system was new to them, the farmers changed their attitude and started to bring a culture of knowledge

sharing, cooperation, and support into the village. They cooperate well in order to learn from each other's experience and knowledge and to avoid or reduce potential upcoming costs through sharing of their knowledge. This is especially important in Iran where usually there is only a very short-time warranty after a purchase and user support is unavailable. Therefore, farmers try to learn as much as possible by trial and error, informing and teaching each other about their know-how processes and gradually-achieved expertise. In most cases when issues or problems arise, instead of relying on and paying service companies, the farmers try to find a solution amongst themselves.

This spirit of actively letting each other know about their new findings and experiences had not existed before. This shows how this seemingly simple technology has been successful in making the farmers cooperate, how it influences their relationship, and how it brings the community together.

5.5.2. How Did the Consumption Patterns for Water and Energy Change?

I asked the farmers whether they have seen for themselves any changes in the amount of water, which is consumed by the new irrigation system and if the system could help them save some water. All of the farmers clearly claimed that since building up this system they have seen a significant or high improvement in reducing the water quantity consumed by irrigating their fields. They described, in their traditional way of mass irrigation, so much water was being lost due to evaporation and runoff. They seemed to be quite happy to be able to control their irrigation exercise and to avoid this loss of water through the use of the Micro Irrigation System. They were even connecting it with their religious beliefs and concerns, stating that they felt much more satisfied now, because by avoiding the wasting of water they now have their lord's contentment. Water conservation and correct use of water are repeatedly reminded in Islam and Islamic doctrine. Since religion has still quite some influence on the society, awareness and action plans in better use of water and avoiding waste of water have proved to be useful among rural and farming communities in Iran. These people hold improving water consumption in high regard. The farmers stated that, more efficient water consumption and water-saving were the promises that came with this technology and these promises were some of the main reasons, which convinced them to adopt this new technology.

Three farmers even confirmed that with the amount of water they save by using the Micro Irrigation System instead of mass irrigation, they can even afford to irrigate two up to three times the area of the field than they do currently. Although other researches and literature (Bhamoriya & Mathew, 2014) similarly support such claim, I cannot assess if this assertion was actually valid in the specific case of my study. At the time of my fieldwork, two of the farmers were thinking about expanding their fields in order to make use of this saved water

and make more profit. However, this was just a thought at that time and I have not investigated further whether this has happened in the meantime.

One farmer also reported a few times he had sold the saved water to another village, which was still practicing mass irrigation. He said that he was not planning to continue this and, instead, was planning to expand his farm, similarly to how his peers were planning, as mentioned above.

Overall, even though Micro Irrigation has allowed these farmers save some water, the resulting saved water is being either sold or about to be used for the expanded agricultural lands. This being said, the saved water will apparently not contribute to increasing the level of available water in the whole region as the farmers are planning to make use of it, which is not a very promising outcome.

Many farmers claim they were under extreme the pressure due to the water shortage and were unsure how the future of their farming activities would look with the condition of water shortage in the country. They pointed out that the Micro Irrigation System, in the end, turned out to be like a miracle to their concerns, as it could assure - to a certain extent - that they could continue their agricultural activities

I asked whether the Micro Irrigation System was an answer to their concern about water availability. Two of the farmers clearly confirmed that the Micro Irrigation System has been beneficial for them concerning the amount of water they have available in their wells and they the safety they feel about having enough water for their daily agricultural activities. They considered the Micro Irrigation System an end to their concerns about water consumption and water availability. On the other hand, three of the farmers remarked that although they have more water available in their wells, they still worry about water availability, as the region is still facing water scarcity, and runs the risk of experiencing drought in the near future. Therefore, although these farmers are happy with the amount of water that Micro Irrigation uses to give them the same amount of crops - as will be explained further below -, the farmers still do not feel entirely safe, as they see themselves running the risk of water shortage due to the contemporary regional conditions.

Overall, Micro Irrigation saved the villagers considerably for the time being. Although there was the concern of water shortage and the risk of drought, the farmers were able to continue their farming with the help of the Micro Irrigation System. The technology helped to sustain agriculture in this region with many of the villagers stating before the introduction of this technology, they were thinking about migrating to the nearby cities to find work. In general, the Micro Irrigation System has had a positive impact on the agriculture water situation in this village.

Micro Irrigation not only has played an influential role in consuming much less water in irrigation, but also has made a change in the amount of necessary energy for such practice.

All of the farmers in my study reported a reduction in the amount of energy, which to use for their irrigation practices. These farmers all have water containers at a height of approximately three meters above the ground and close to their wells, which was pumped from those wells. With Micro Irrigation System, the water was pumped once to the container, and from there was transferred through the pipes in a timely manner. Therefore, the pump has to work only for a short time and much less frequently as compared to the time when the mass irrigation required for pumping. In the farmers' opinion, Micro Irrigation has benefitted them by influencing the amount of required energy for pumping. For them, the Micro Irrigation System meant a reduction in energy cost and for this reason, they are satisfied with the system.

As discussed, the Micro Irrigation System has had such a major effect on energy consumption and consequently cost-reduction for the farmers. However, this was not the only benefit of Micro Irrigation regarding energy consumption and energy requirement. The farmers reported that through the help of the Micro Irrigation System, they were better equipped to cope with the lack of electricity in the region.

Due to water shortage, especially in summer, some cities in Iran experience a few hours without electricity every day – as hydroelectric plants are one source of electricity production in Iran. The cutting off of electricity is practiced by the government in order to tackle the issues of water and electricity shortage. Recently, Gorgan province has had some hours with no electricity almost every year. These daily outages have created so much trouble for the farmers in regards to their agricultural activities and, especially, irrigation, which needs energy for pumping water. Micro Irrigation has apparently solved this issue; because farmers can plan their pumping needs, from the well to the water tank, in accordance with the times when electricity is available. Micro Irrigation does not need the pumping to be done exactly at the time of irrigation. Water can be pumped literally any time during the day, when the electricity is available, and can be saved in the water tank for a later use. In addition, as with the Micro Irrigation System, no labour is anymore required for irrigation or fertilization, no one would need to wait long for electricity to come to be able to carry out the work.

Therefore, Micro Irrigation has proven effective in solving the problems associated with the untimely availability of electricity. This benefit, together with reduction in water consumption, and energy for the task of irrigation could be regarded as important changes, which were brought into the community by the introduction of this technology.

5.5.3. How Did Farmers' Social Credibility and Power in Domestic Markets Change?

In Iran, similar to the other countries in the developing world, people are becoming more and more aware of the concept of sustainability and how to manage the limited resources of earth more efficiently. This trend is also gradually occurring in rural areas, and as a result, people are becoming ever more conscious about their consumption patterns. For many of them, it now

makes a difference to buy a sustainably-produced product or one wherein much less water was wasted in its production, as was the case in my study.

As water scarcity is becoming more critical in the region, farmers are increasingly showing willingness towards more efficient ways of irrigation. The farmers in my study have all agreed on the point that after applying the Micro Irrigation System, they have achieved a much better social status in the regional and domestic markets, as local people have now recognized that these farmers have adopted an irrigation technology, which wastes much less water, and in this way can contribute to tackling the issue of water shortage in the area. Rural people in Iran are becoming more sensitive about improving sustainable practices, especially in agriculture. For them, this change in adopting a less water-intensive technology is considered a great asset. They prefer to buy the food, which has been grown with less water - an increasingly limited resource. I have contacted a number of people (here I refer to end-consumers) in the food market in Lamlang and they all tried to convey this message to me that they know how much water is being lost in mass irrigation method, and they find this as a big waste of water and one of the main contributors to water shortage in the village. They stated that they support those farmers who changed from mass irrigation method to Micro Irrigation, as the waste of water in this method is significantly less. One villager argued, *"Due to the recent decrease in our country's water savings level, we have to change our life style and consumption patterns, and adapt to the new environmental conditions. I would really support the idea that we should start from ourselves and go for products, which less water has been consumed in their production process".*

Four of the farmers claimed that in the local markets they have become more competitive, as people are now seeking for the products that have been irrigated through a Micro Irrigation method, which consumes and wastes much less amount of water. These people stay loyal in that they only buy from these farmers, wishing to convince the other farmers who are still using mass irrigation method to adopt this technology.

My study shows that farmers have become socially stronger among local people since they adopted this technology, which consumes less water. People grant more credit and honour to those farmers, who underwent the implementation of this new irrigation technique, as they believe it will help address the water shortage issue in the region. By staying loyal to these farmers and not buying from others, people not only support these farmers economically, but also grant them higher social power and, yet finally provoke the others to change to this more efficient irrigation system.

5.5.4. What Would the Community Perceive as Benefits of Micro Irrigation System?

I have asked the farmers whether the Micro Irrigation System has had an impact on the quality of irrigation water. All the farmers agreed that they clearly see the impact on water quality, as

the system has some steps for filtering the water; therefore, all the heavy and smaller solid particles in water such as rocks, sand, sludge, organic materials, and clay are filtered out before the water is distributed to the plant roots. Two of the farmers used the term significant in describing the impact they have experienced on the quality of water.

All of them highlighted that this has left them with much less work in taking care of the farm land by reducing the need to constantly clear external particle from the soil from. These particles were disbursed over the surface of the farmland through mass irrigation of unfiltered water from the well. Apparently, these particles were even blocking the surface of the soil, acting as a water-absorbing barrier in their previous method of irrigation. Four of the farmers added, they see fewer weeds growing in their field, because with Micro Irrigation there will be no water running or standing in the free spaces between the plants allowing for the weeds to grow. The reduction of weed growth has reduced their work of removing weeds from their fields. The remaining one farmer has not perceived this impact to be very remarkable.

As indicated, all of the farmers observed an improvement in the quality of irrigation water by switching to the Micro Irrigation System and almost all of them saw a positive impact on the required efforts and physical work to clear up the fields from either weeds or the external particles.

Micro Irrigation not only affects the quality of water, which is being transferred to the plants, but also affects the quality of soil and, therefore, results in the better growth of plants.

Among the farmers, three mentioned that they saw improvement in plants' growth and appearance, due to the constant level of soil's moisture and better quality of soil where the Micro Irrigation System is practiced. As in the Micro Irrigation System water is distributed evenly throughout the land, thus, the soil quality and consistency is also improved. For the above-mentioned farmers, the Micro Irrigation System means a better quality of soil and, therefore, fewer burdens in growing crops, better quality of crops, and more profit as a result.

Similar to how Micro Irrigation has managed to improve the growth of the plants, resulting in better quality of crops, it has caused an improvement in the quantity of yield as well.

Among the farmers, four of them confirmed harvesting a higher tonnage of crops after applying the Micro Irrigation System. This has also been mentioned as one of the advantages of the Micro Irrigation System, discussed by Dehghanisanij et al. (2008).

The other farmer could not report any such result, as he had just changed his cropping type and, therefore, was unable to judge whether he had produced a higher amount of crops.

The mentioned four farmers believed they not only achieved more profit by selling more crops, but also contributed to nation-wide creation of jobs. They stated, by producing more yields, they have created more local jobs for selling fruits. Moreover, they contributed in exporting more products to the other countries and in this way have brought profit to the country.

They believed mechanizing irrigation through this system allowed them earn a greater profit by being able to harvest more crops. This was a favour not only to the farmers, but also to the whole country.

The economic profit, which came with Micro Irrigation to this community, is not limited to improvement in yield amount or consumption of less water and energy as discussed in the previous section. The system also requires fewer fertilizers and nutrients compared with the traditional way of fertilization and nourishing the plants; therefore, it necessitates much less costs for the farmers.

As fertilizers can also be pumped into the water pipes in a liquid format and be brought directly to the plants via the Micro Irrigation System, the amount of fertilizers and nutrients necessary is therefore reduced. Three of the farmers claimed that by using the Micro Irrigation System, they not only could reduce the amount of water, but also could save fertilizers and other nutrients. One of the farmers was uncertain if there were any changes in the amount of fertilizer consumption with the new system, as he could not easily compare the amount versus the price of previously used solid fertilizers with the new liquid ones.

However, it is only optional to change from normal fertilizers to the liquid ones (pumped into the Micro Irrigation pipes) and in my case of study, not all the farmers had chosen this option. One farmer was still using the solid granular fertilizers that he always used and, hence, had nothing to add to the argument here.

In case of one farmer, the Micro Irrigation System let him save more money, as previously he had out-sourced the task of fertilization (together with irrigation) in his farm. With Micro Irrigation, it was no longer necessary to pay for such human resource for this job, as in this system fertilizer and nutrients could be applied together with water.

As discussed, in most cases farmers had a positive view on the impact of Micro Irrigation in consuming less fertilizer and nutrients for the plants; therefore, potentially having less costs for such tasks.

Similarly, some farmers believed that Micro Irrigation had an effect on the occurrence of insect pests and pesticide consumption. Even though I have not received very similar responses as to if, and in what ways, the Micro Irrigation System has an influence on pest occurrence. I believe, from the statements that I have heard from the majority of farmers, I can conclude such an influence. Three of the farmers claimed they have witnessed a significant reduction in the number of insect pest incidences after switching to Micro Irrigation technology. Therefore, they reported a reduction in the amount of pesticide consumption, accordingly. This would imply that Micro Irrigation could directly affect the costs for pesticides used, which is a positive economic impact.

Between the other two farmers, one had a different opinion, stating he has seen no clear impact on the pest incidences and the need for pesticide consumption. The other one was not quite sure if he could relate the reduction, which he has witnessed to the number of pest incidences while using the Micro Irrigation System. He believed that he needed to continue observing such effect for a longer period in order to be able to judge better whether Micro Irrigation is directly linked to a reduction the pest occurrence.

Thus far, I have reflected upon how farmer perceive Micro Irrigation methods as reducing the consumption of water, energy, nutrients and fertilizers; gaining better quality of water, soil and yields; resulting in higher amount of yields; and achieving a better control on insect pest occurrences. As already pointed out, these changes clearly correlate with an economic benefit for the farmers.

From a rather different point of view, I have heard a few narratives of improvement on the behaviour of some farmers, who had not acted correctly in the past in supplying water for their irrigation practices.

Two farmers reported on a similar case when they had suffered a few times from water being stolen by farmers from other villages during the night. Especially in the previous years, when water scarcity was a more of an issue, they had lost a significant amount of water. This had created some conflicts among the villages and resulted in tension between them for more than a year. Both farmers confirmed though, that Micro Irrigation provided them the opportunity to save water and sell the extra amount with an appropriate price to the other villages, which used to steal their water out of desperation. The farmers confirmed, all parties get along well now and the situation is now win–win. Micro Irrigation seems to bring these two villages together again by resolving their conflict while providing them both with a chance to benefit from having enough water for their livelihoods.

A farmer of a rather small field declared he had changed his cropping arrangement from mixed intercropping (with no distinct row arrangement) to row cropping of fruit trees to be able to adapt to the requirement of Micro Irrigation. He did not state if he was unhappy with this shift. He seemed quite neutral about the change in irrigation method. What he claimed clearly was that the new crops are more profitable than what he previously used to cultivate. However, he did not highlight if there was any relation between higher profitability and new irrigation method. Apparently, he was the last farmer practicing mixed intercropping. Even though this farmer changed his cropping pattern only in order to adapt to the method, I believe there is still not sufficient proof that his increased profitability is due to adopting this new technique. As he has also changed his cropping arrangement as well as the crops type, I cannot strongly argue if the new irrigation method was the only factor, which led to more profit.

5.5.5. What Would the Community Perceive as Challenges of Micro Irrigation System?

The Micro Irrigation System is definitely not a piece of technology, which is without any need for maintenance and care. In order to keep the system running, the farmers have the task to constantly control if all the equipment work correctly and handle any issues or problems, which occasionally arise.

All the five farmers in my study declared that due to the technical nature of the irrigation system, they now face problems in maintaining the equipment. As their irrigation practice has changed from a manual to a technical one, they need to maintain different components of this system to make sure they always function as they should and fix the issues, which happen every now and then. One of the very common problems with the Micro Irrigation System is clogging of the emitters and pipes. This has also always been mentioned a disadvantage of this system. One example discussed in a paper by Breman, Gazula, Hochmuth, Lamont, Simonne, & Treadwell (2015) considers clogging as a common problem with the Micro Irrigation System, which necessitates both high quality of water and experience on how to avoid the clogging.

In this village, as in most cases, the farmers are the ones, who are left to deal with the technical failure of the system. They stated the service cost of repairing the system is normally too high and they cannot afford to ask for the maintenance company when some parts of the system need a repair. In general, the farmers handle most repair issues on their own in order to reduce the repair expenses. They also reported that even if they call for a service, the service is not delivered timely and in the end they have to manage the problem on their own in any case. Therefore, they claimed it is not worth waiting for a delayed service for an issue, which in most cases they can handle on their own. They said they have become professionals in technical aspects of the system over the years. They added, over time they have learned how to fix the equipment, so they would not have to call a mechanic. However, they stated, there are sometimes issues which could not be fixed without support and interference of maintenance companies.

Therefore, from a maintenance point of view, this system has brought the farmers some challenges, as the traditional way of irrigation did not require much of maintenance of any kind. To keep the system running they need to more actively supervise the functioning of the system and take care of failures when they happen. The farmers said the system has enough components to make us busy all the time, as the tools and belongings of the system need to be repaired and fixed in succession.

The amount of effort necessary to keep the Micro Irrigation System continuously running, is an issue that all the farmers who have switch to this technology must deal with, regardless of their land specificities. There is, however, another aspect of the Micro Irrigation System, which could be considered a disadvantage for those farmers who have smaller agricultural fields. This system is known to have more installation and reparation costs for smaller fields.

Installation of the Micro Irrigation System has some fixed costs, regardless of the size of the agricultural field. This includes an initial investment in certain components of this irrigation system or necessary maintenance and renovation of the components none of which depend on the size of the land. Considering this, farmers argued that installing the Micro Irrigation System would have more initial and fixed costs in smaller fields compared with larger ones. Even though the operating costs (e.g. water consumption, electricity supply, labour, length of the required pipes, etc.) entirely depend on the size of the land, the fixed costs are the ones, which should anyway be paid by the farmers, no matter how large or small the area of their lands is. Therefore, the total cost per square meter of the land under irrigation is higher for the smaller fields. The larger the field is, the less the overall cost would be for every unit of irrigation area. Consequently, some argued that owners of smaller farms benefit less from the new irrigation system than the ones for larger lands.

6. Discussion and Conclusion

The Micro Irrigation System, which was installed in this community, has a lot to tell. Not only because it provides water to the plants in the agricultural lands of this community, but also because it influences the work environment in the community (and potentially the communities in the surrounding areas). Having this technology in place, farmers need less human resources for irrigation and, therefore, dedicate less time and cost to this task. This indeed has affected the work of those, who previously were doing the task of irrigation for the farmers, as their work was no longer needed. Moreover, this technology, in general, has provided some job opportunities in the whole country, as there now exist more than 180 companies who are involved in producing Micro Irrigation-related equipment (Database of Pipe and Fitting Industry of Iran, 2016). Research and Development activities should also be mentioned as another job opportunity provided by the introduction of this technology into the region. Last but not least, working with the new technology has improved the cooperation dynamics amongst the farmers, and has brought it to a more positive, supportive and knowledge-sharing level.

Other than affecting the work environment, the Micro Irrigation System has also impacted the consumption patterns of water and electricity. Farmers reported a significant reduction in the consumption of required water and energy for irrigation. Micro Irrigation also has left its footprint on farmers' social credibility and their reputation in the domestic food markets. Costumers are now more willing to buy from producers, which irrigate in a more sustainable way, as water shortage has become a critical issue in the region already for some years. This has given a higher social status and credibility to those farmers who practice Micro Irrigation, which has proven to consume less water and energy.

Furthermore, the Micro Irrigation System, through filtering devices, has improved the quality of water, which is transferred directly to the root of the plants. This means less work is required to clean up the farmland from external solid particles, which can block the soil from absorbing water. Similarly, farmers have reported a better quality of soil after applying this irrigation technology, as water is distributed evenly throughout the land, keeping the moisture level of the ground consistent. In addition, increased tonnage and quality of crops is observed by farmers as a result of using the Micro Irrigation System. Applying this technology also makes a difference when it comes to requirements of nutrients and fertilizers.

The way that the Micro Irrigation System brings all these dynamics in the community, tells us how a technology could act as an actor in its surroundings. What I have tried to reflect in this master thesis is the various aspects of this actor. Here I borrow the notion of a fluid technology from de Laet and Mol (2000) in their work 'The Zimbabwe Bush Pulp', where they explain the intricacies of this water pumping technology. The Micro Irrigation System can also be seen as fluid in its boundaries, as there is no one boundary in which the Micro Irrigation System acts. There are a number of arenas in which this technology is under practice and making changes. However, these boundaries are not quite sharp and sometimes even overlapping - as my situational/arenas maps also demonstrate. This system is a combination of mechanical entities functioning as a system transferring water to the plant roots, but also changing the labour and work environment through the shifting of water and energy consumption patterns, the influencing of farmer's social power in the community and the market, and the impacting on the quality of soil and crops as well as quantity of harvested crops. The Micro Irrigation System, indeed, has each of these mentioned identities, with which its functions are defined and its boundaries are shown. Each of the mentioned characteristics of the function of this technology has its own boundaries, however sometimes unclear, sometimes sharp and distinguishable, and other times overlapping. Referring to the notion of fluidity by de Laet and Mol (2000), the Micro Irrigation System is fluid in its boundaries. At each of its aforementioned boundaries, the system has a specific character, which affects one or more arenas of its surroundings. The Micro Irrigation System acts differently and leaves different footprints in each of the various environments where it operates. During this study, I was able observe how such a system, which seems to be rather a mundane technology at first, could consist of a variety of human and non-human actors, each telling a specific part of the whole story. The Micro Irrigation System, as a non-human actor on in its own right, can be seen as a structure containing different elements each of which somehow influence or are influenced by the way it functions. The function of the technology is tightly connected to the function of all the mechanical devices and their cooperation. The system is also connected to the government's subsidy program facilitating installation of the device in the community and is connected to the necessary existence of engineers and engineering companies in order to maintain and control correct

function of the system. Similarly, it requires existence of manufacturing facilities, which produce different equipment and tools related to the Micro Irrigation System, and is affected by the existing laws and regulations on a national and regional level, as well as research and development programs. All of these actors are connected to the function of this system and have their individual roles to play in its function.

Indeed, during my stay in the village, I observed many different aspects of the Micro Irrigation System and how it affects the dynamics of the surrounding community. However, I realised the more I dug into the stories that I was witnessing, the more I found new aspects worth investigating. Considering the time and space that I could allocate to a master thesis, I had to stop somewhere and here is where this project should end. Of course, there are still a lot of stories and connections, which could be discovered, and I may have skipped some parts of what I uncovered. Even though I am convinced that I investigated many parts of the dynamics and the complexities of the technology as well as its influence on the community, still many stories remain untold. Contrary to my prior intention to provide one coherent and demonstrative view or picture of the whole story, I have, in the end, decided on a number of stories; each revealing parts of the function of the Micro Irrigation System in the community. It became clear to me how difficult it is to provide a comprehensive account of this technology and its different functioning aspects.

It is quite interesting to observe how such a seemingly simple technology could cause such big changes and play such important roles in its surroundings. In the end, I collected a number of stories around this piece, showing its fluid actorship. In these stories, the Micro Irrigation System was acting a fluid role in different contexts and creating changes in different arenas. In these arenas, there were many people involved. It seems the technology is somehow intertwined with the community around it and is changing their livelihoods. STS scholars have argued technologies constantly influence and are influenced by the social processes around them, as if they are seamless webs or network of actors, which cannot be distinguished purely between spheres of technological and social. These network of actors are tied together in order to accomplish a certain target (Latour, 2005; as cited in Galusky, 2008).

As a technology, the Micro Irrigation System is a case of such a seamless network in which livelihoods of the society in the surrounding area are involved. The Micro Irrigation System acts in many different arenas and leaves a lasting effect on a multitude of other actors while being influenced by a number of them. Even though at the beginning of my project the farmers and their families were wondering why I am spending time on researching *"such a simple technology, which is not quite important"* (says a local farmer), I am quite convinced that my ethnographic research could prove the contrary, that this technology does make changes in its surrounding. Therefore it is *"important"* (to refer to the term used by the farmer), as it influences the community's livelihoods and their social, economic, moral, and cultural orders.

Of course, my research is not all encompassing and it has only opened up space and potentially a basis for further investigation into how such a technology can act amongst other actors or roles, which might be ignored at first. Actor-Network Theory, indeed, could provide me with this conceptual framework (or in simpler term lenses) though which I could figure out these socio-technical processes. This theory could assist me in my attempt to find out the relationship and interdependence of the Micro Irrigation System and the other actors around it; such as, the community, the government, policies, and laws, etc. Following Actor-Network Theory, I have sought to understand and explore the relationships and interdependence of all these actors. This approach let me realize that such a technology does have a hybrid nature, which is connected to other social and cultural orders, people, things, concepts and contexts, which are all influencing one another.

Actor-Network theory supported me in the tracing of these actors, giving me the ability to reveal how the surrounding society in a certain case is made. As the researcher, I tried to follow the actors in the networks and listen to the stories they constantly describe out of their interrelations with other existing actors. I could, to a certain extent, understand how the associations and relationships among different actors in a heterogeneous network can result in various social affects, as well as how a technology has an active role in shaping and influencing all these processes.

Similar to the Zimbabwe Bush Pump (de Laet & Mol, 2000), the Micro Irrigation System is an admirable, lovable, and appropriate technology. All this is due to the fluid nature of this system, which does not remain strictly within its original boundaries, but makes itself flexible and open to changes in order to be adaptable in its new environment. This technology did not force itself on the new environment, but rather was adjusted accordingly and, in the end, served the community. My study showed the relationship between the technology and its surroundings, how they shape new configurations in each other, and how they influence and are influenced by one another. The Micro Irrigation System in this case shows a crucial facet about the actorship role technologies have. This system, which includes a number of non-human actors, could be both regarded as high-tech, when it serves as a water and energy conserver, as well as low-tech, when it includes only a dirty well, an old or used pump, and tubes. In the various chapters of this thesis I have borrowed the notion of fluidity from de Laet and Mol (2000) to emphasise that the boundaries of this technology are not strict and straightforward, as my situational/arenas maps illustrate; instead, they are fluid and flexible. The Micro Irrigation technology is a mechanical system per se, but it is also a system, which has been changed, adapted, and installed by the community. Moreover, the technology changes the work and labour dynamics in its surroundings; saves water and energy; and helps farmers gain a better social status by using it. It is influenced by the national policies, development plans, research results, as well. The system carries each and every of these identities, each with its own

boundaries. My study shows that this technology is not only an artifact in isolation from its environment, but also is an actor surrounded by a large socio-political environment. This technology is unavoidably in a constant relationship with its surrounding environment. By having such influence on its surroundings, the Micro Irrigation System could be considered as a meaningful and remarkable actor, at least for the community, as it plays a role in their present and future life.

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Abstract (English)

Science and Technology studies scholars argue the ways in which a technology is used cannot be understood without exploring how it is embedded in social and political contexts. In line with the notion that technologies both influence and are influenced by the social, political and cultural dynamics of their surroundings, in my project I attempt to answer the following question:

How do the livelihoods of the community transform through the introduction of the technology of Micro Irrigation?

To answer this question, I decided to look at the village of Lamlang, located in the Iranian province of Gorgan, as a case study in order to investigate the rearrangement that took place following the introduction of the Micro Irrigation technology.

Within a technology there exist a large number of heterogeneous actors that aggregate to form a network, which in turn shapes the function of the technology as well as the world around it. When a technology emerges, this newly formed network begins to stabilize and must work actively in order to ensure the technology functions well. By focusing on the Micro Irrigation System not only as a tool for delivering water, but also as a network interacting with social, cultural and political elements of the Lamlang community, this project will investigate the complexities of such a network and demonstrate how this technology, shapes the socio-cultural configurations of the entire Gorgan region.

Actor-Network Theory (ANT), which embraces technology and society as integrated elements, is the theoretical backbone of this project.

I provide an ethnographic account of the aforementioned case, focusing on five different agricultural lands in Lamlang, where the Micro Irrigation Systems are under practice. The study also employs semi-structured interviews with selected farmers and their families residing on the agriculture lands. The statistical and expert organizational data was gathered through in-depth literature research and a review of various organizations' latest documents, such as the ones available on the Statistical Centre of Iran Database of Pipe and Fitting Industry of Iran.

Abstract (German)

Science and Technology studies zeigen, dass die Art und Weise, in der eine Technologie genutzt wird, nicht vestanden werden kann, ohne ihre Einbettung in soziopolitische Kontexte mit zu untersuchen. Der Annahme folgend, dass Technologien die sozialen, politischen und kulturellen Dynamiken ihrer Umgebung sowohl beeinflussen, als auch durch diese beeinflusst werden, werde ich in der vorliegenden Arbeit folgende Frage zu beantworten versuchen:

Wie haben sich die Lebensgrundlagen der Gemeinschaft durch die Einführung der Mikrobewässerungstechnologie transformiert?

Um diese Frage zu beantwortet, habe ich mich entschieden, das Dorf Lamlan in der Iranischen Provinz Gorgan als Fallstudie zu betrachten, um die Neuordnung zu untersuchen, die der Einführung von Mikrobewässerungstechnologie gefolgt ist.

Innerhalb einer Technologie existiert eine große Zahl heterogener Akteure, die sich zu einem Netzwerk aggregieren, welches wiederum die Funktion der Technologie, sowie die sie umgebende Welt formen. Wenn eine Technologie zum Vorschein kommt, beginnt dieses neue Netzwerk sich zu stabilisieren und muss aktiv Arbeit leisten, um das Funktionieren der Technologie zu gewährleisten. Durch den Fokus auf Mikrobewässerungssysteme als nicht bloß ein Werkzeug um Wasser zu liefern, sondern auch als Netzwerk, welches mit den soialen, kulturellen und politischen Elementen der Lamlang-Gemeinschaft interagiert, wird die vorliegende Arbeit dessen Komplexitäten untersuchen und nachzeichnen, wie diese Technologie die sozio-kulturellen Konfigurationen der gesamten Gorgan-Region formt.

Den theoretischen Hintergrund dieses Projekts bildet die Akteur-Netzwerk Theorie (ANT), welche Technologie und Gesellschaft als integriertes System begreift.

*Ich werde eine ethnographische Darstellung fünf verschiedener landwirtschaftlicher Flächen, in denen Mikrobewässerungssysteme eingesetzt werden, vorlegen. Zusätzlich bedient sich die Studie semi-strukturierter Interviews mit ausgewählten Landwirt*innen und deren Familien, die ihren Wohnsitz auf den Ackerländern haben. Die statistischen und organisatorischen Daten wurden durch tiefgehende Literaturrecherche und Durchsicht verschiedener Dokumente, beispielsweise jenen des Statistikzenzentrums der Iranischen Rohrleitungs-Industrie, erhoben.*