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# DISSERTATION

Titel der Dissertation

„The potential of fish farming to contribute to the reduction of undernutrition in children (< 5 years); a pilot study at household level in the Central Province of Kenya“


Verfasserin

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***"After climbing a great hill, one only finds that there are many more hills to climb."***

(Nelson Mandela)

Dedication

To all the families who contributed to the completion of this dissertation.

Scenery of Mt. Kenya: fields with fish pond in Kirinyaga District, Central Province of Kenya

## ACKNOWLEDGEMENTS

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## EHRENWÖRTLICHE ERKLÄRUNG

Ich erkläre hiermit an Eides statt, dass ich die vorliegende Arbeit selbstständig und ohne Benutzung anderer als der angegebenen Hilfsmittel angefertigt habe. Die aus fremden Quellen direkt oder indirekt übernommenen Kenntnisse und Gedanken sind als solche kenntlich gemacht.

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Wien, 29. Oktober 2012

Mag. Kornelia Hammerl

## DECLARATION OF AUTHORSHIP

I hereby announce in lieu of oath that the present dissertation was written autonomously and without the use of any resources others than declared. Knowledge and thoughts which were directly or indirectly adopted from external sources are marked as such.

This thesis has not – in the same or in a similar form – been submitted to any other examination authority nor was it released to the public.

Vienna, 29th October 2012

Mag. Kornelia Hammerl

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## ABBREVIATIONS

| | |
|---|---|
| BMI | Body mass index |
| DES | Dietary energy supply |
| DGE | Deutsche Gesellschaft für Ernährung (German Nutrition Society) |
| df | Degrees of freedom |
| FAO | Food and Agriculture Organization of the United Nations |
| GDP | Gross domestic product |
| IAA | Integrated agriculture aquaculture system |
| KSh | Kenyan shillings |
| M | Mean |
| MUAC | Mid upper arm circumference |
| N | Number of cases |
| NGO | Non-governmental organisation |
| PEM | Protein Energy Malnutrition |
| SD | Standard deviation |
| UNICEF | United Nations Children's Fund |
| VAC | Vuon (= garden) Ao (= pond) Chuong (= cattle shed) |

# 1. Introduction and objectives

The first chapter gives a brief outline of the study's background, the current research's objectives and the thesis' hypothesis.

## *1.1. The study's background*

About one third of Kenya's population is deemed to be chronically food insecure. Especially among the rural population chronic and acute undernutrition remains prevalent. Inadequate household food security represents one of the main problems of childhood malnutrition [REPUBLIC OF KENYA, 2008b].

The Kenya demographic and health survey 2008/2009 draws a devastating picture of one of the country's most serious public health problems: undernutrition in children. According to the study, 35.2 % of children under the age of five were stunted and 7.0 % showed reduced values for "weight for height" (= wasted) [KNBS & ICF MACRO, 2010]. No significant change in the nutritional status of children under five could be achieved in the recent past [REPUBLIC OF KENYA, 2008b]. Children who are wasted or stunted face an increased risk of childhood mortality and morbidity. According to UNICEF [2012], 85 out of 1000 children born alive died before their fifth birthday in 2010.

Aquaculture in rural areas is being promoted in order to increase household food security and the supply of fish in farming communities. This may lead to nutritional benefits for individuals and significant increases of livelihoods of farmer households [BARG, 1997]. Aquaculture is furthermore often mentioned as a means to efficiently increase food production [CUNNINGHAM, 2005]. Hence, it might serve as an important tool to eliminate hunger and malnutrition [FAO, 2006].

The benefits mentioned above that aquaculture might achieve have been subject of the work of numerous researchers and scientists all over the world. Studies from

Malawi [JAMU et al., 2002], Vietnam [HOP, 2009] and several other Asian countries [AHMED & LORICA, 2002] evaluated the ways in which aquaculture may contribute to the eradication of undernutrition. Amongst others, they have led to the following outcomes:

Aquaculture is supposed to:

- improve quality and quantity of dietary intakes [HOP, 2009],
- reduce prevalence of undernutrition in children of less than five years of age [HOP, 2009; JAMU et al., 2002],
- increase food supply and food security through a more diversified on-farm production [AHMED & LORICA, 2002; JAMU et al., 2002] and
- increase employment and income on farms [AHMED & LORICA, 2002; JAMU et al., 2002]

In addition to this, Kenya and in particular children in rural areas may be able to profit from the advantages discussed in these research works. The Ministry of Fisheries Development of the Kenyan Government established a *Fisheries Strategic Plan* which, amongst others, should support efforts to increase fishery production. The opportunities concerning poverty alleviation and food security which may be derived from aquaculture, especially for small-scale farmers, are obviously recognised by the responsible authority of Kenya [MWANGI, 2008].

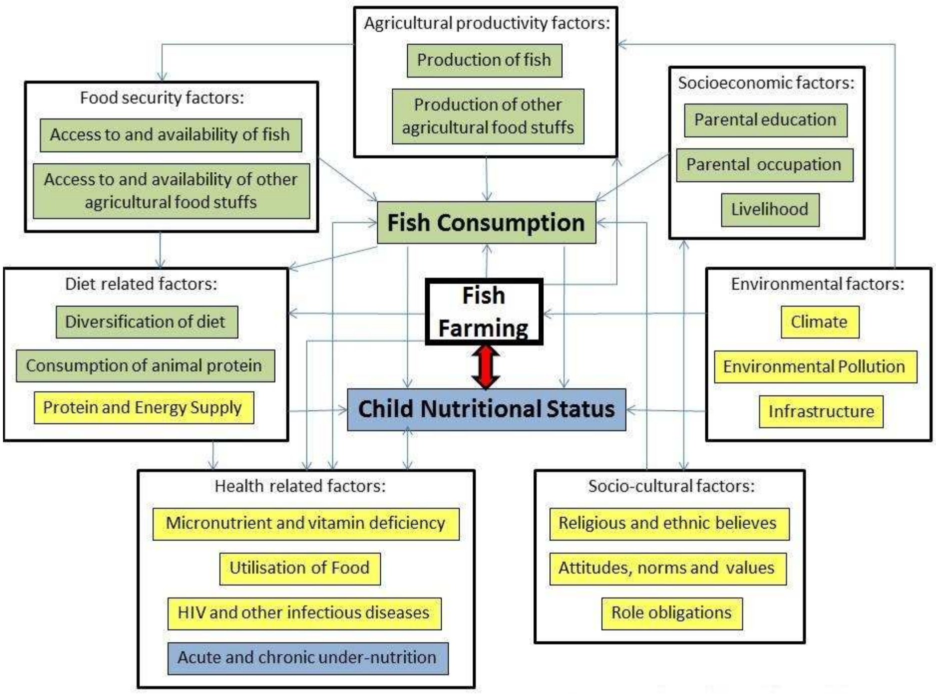
The evaluation of the efforts to enhance food security through aquaculture made by the Kenyan government is assessed to be rather weak [MWANGI, 2008]. Systematic evaluation, however, may lead to results which could represent incentives for national and international organisations and institutions to invest in the aquacultural sector of Kenya. It may furthermore increase the support of projects concerning the implementation and enhancement of small-scale fish farming in Kenya’s rural areas. If the experience made in other parts of the world was applicable to Kenya, the prevalence of undernutrition in children could be reduced and the situation of food insecurity may be improved.

Current research was conducted in order to evaluate and assess these specific links. Moreover, potential benefits which may arise through aquaculture for Kenya's poor rural population and in particular for its children should be exposed.

## *1.2. Study objectives*

This pilot study seeks to evaluate potential direct and indirect associations between child nutritional status and the existence of aquaculture within households and communities in the Central Province of Kenya. The following flowchart (Fig. 1) illustrates potential factors concerning agriculture and aquaculture which may be associated with child nutritional status. The investigation aims furthermore to expose details of the subject matter in order to provide suggestions for planning and designing further research.

**Fig. 1: Potential interrelating factors concerning the association between fish farming at small-scale farms and child nutritional status**




- Factors determined through carrying out questionnaires
- Factors determined through anthropometric measurements
- Factors described by literature

## *1.3. Study hypothesis*

In order to appraise the potential of the contribution of aquaculture to the reduction of undernutrition in children (< 5 years) in the Central Province of Kenya following central hypothesis was tested:

> There is a significant difference ($p \leq .05$) between the nutritional status of children (measured as mean values of percentiles for nutritional status indices, such as "weight for height", "weight for age", "height for age", BMI for age and MUAC for age) who live in households or communities of fish farming families and those without access to fish farming.

The considerations on which the before mentioned hypothesis is based on reflect ways through which aquaculture is assumed to directly or indirectly affect child nutritional status. Following sections seek to explicate these considerations.

Assumptions concerning potential direct determining factors of child nutritional status:

- The nutritional status of children depends on the frequency of fish consumption.
- Fish consumption is higher in children who live in fish farming households than in children who live in non-fish farming households.
- The nutritional status of children depends on the source of fish supply within the household.

Assumptions concerning potential indirect determining factors of child nutritional status:

The benefits concerning a reduction and/or avoidance of undernutrition which children may gain through the adoption of fish farming within their households or communities may not result from direct access to fresh fish and increased fish consumption alone. They may rather occur due to a complex system of determining factors:

- The household income (measured as money at disposal per day per person) of fish farmers is higher than that of farmers with fish farmers in their community and households, who do not have any access to fish farming.

- Children of fish farms suffer less frequently from specific health problems (measured as frequency of specific health problems such as diarrhoea, cough and fever) than children of non-fish farming households.

- Fish farms achieve an enhanced farm productivity (measured as number of planted crops, number of different kinds of livestock and number of different kinds of livestock products) than farms in fish farmers´ communities and farms without any access to fish farming.

- Fish farmers irrigate their field crops to a higher extent than households with fish farmers in their community and those who do not have any access to fish farming. This might lead to advantageous farm productivity on fish farms, which might bring a more favourable diet to children living at such farms.

- Fish farmers are able to offer their children a diet of higher quality (measured as diversity of habitually consumed foodstuffs, frequency of consumption of foodstuffs containing animal protein and diversity of purchased foodstuffs) than non-fish farming households.

- The nutritional knowledge (measured as mean scores for correct appraisal of statements about protein and fish as food) of fish farmers´ household members is better than that of members of households with fish farming in their community and those who do not have any access to fish farming.

# 2. Review of literature

Present chapter reviews literature related to the topic of this thesis in order to examine the background of the issue under discussion. While the first section outlines Kenya's situation concerning food security and undernutrition, the following part summarises facts on the status of food fish in human nutrition. The subsequent chapters characterise the role played by aquaculture in developing countries in general and in Kenya in particular. In this context literature is reviewed regarding pathways through which aquaculture may enhance food security and thus potentially contribute to the decrease of the prevalence of undernutrition. The final section describes the usage and applicability of anthropometric measurements for determining children's nutritional status.

## *2.1. The situation of food security and undernutrition in Kenya*

### *2.1.1. General overview*

Kenya covers an area of 5.818.000 hectares of arable land [FAO, 2011]. This is an enormous capacity, which is furthermore partially endowed with relatively advantageous climatic and natural preconditions for agricultural activities. Despite these favourable circumstances, the poor performance of the agricultural sector is deemed to be one of the major problems of poverty in Kenya, which is strongly related to food insecurity [GITU, 2006].

To handle this topic properly, the definition of "food security" upon which was agreed at the World Food Summit 1996 should be outlined at this point for further comprehension:

According to the FAO "food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" [FAO, 1996].

Present thesis utilises the above mentioned concept for explanations of outcomes at household level, if not further described. According to PINSTRUP-ANDERSEN [2009] “a household is considered food secure if it has the ability to acquire the food needed by its members to be food secure.”

Although Kenya is expected to be capable of producing enough food to meet its needs [GITU, 2006], food availability is currently deemed to be insufficient [KIOME, 2009]. The FAO country profile of Kenya on food security indicators reports that the dietary energy requirement cannot on average be satisfied by the dietary energy supply available in the country. This implies that food deprivation is still prevalent with 33 % of Kenya’s population considered to be undernourished [FAO, 2011].

In the 1970s, the production of maize, Kenya’s most important staple food, was so high that parts of the harvest could be exported. For a long period of time the country attained self-sufficiency in key food commodities such as maize, wheat, rice, milk and meat. Evidence shows, however, that even during that time food security at household level was not automatically achieved.

In order to solve the food security problem it is particularly vital to establish access for vulnerable groups to sufficient food [GITU, 2006]. Since the majority of people suffering from hunger and poverty are found in rural areas of developing countries [BROCA, 2002] such as Kenya [FAO, 2011], boosting agricultural production is assumed to have high potential to increase the accessibility to food for this target group through self-supply.

Kenya’s agricultural sector has been performing poorly for decades, however, and agrarian production as well as productivity remains inadequate. This is on the one hand attributed to the failure of policies in promoting agriculture such as an underinvestment in the sector, a disengagement of governmental support, poor infrastructure, limited access to credit, high costs of farm inputs and high taxation [GITU, 2006]; on the other hand it is due to natural constraints such as drought, floods and land degradation. Human conflicts are a further cause reported to be a challenge for agricultural development [KIOME, 2009].

In order to compensate for the lack of food supply resulting from the above mentioned impediments in agricultural performance Kenya has become increasingly dependent on food imports and food aid [GITU, 2006]. Accordingly, the share of food aid in total dietary energy supply (DES) increased from 1.2 % in the period of 1995 – 1997 to a value of 4.0 % from 2000 – 2002; more recent data are not available [FAO, 2011].

### *2.1.2. Qualitative aspects of Kenyan diets*

According to the FAO (Country Profile on Food Security Indicators), the dietary energy supply (DES; 2030 kcal/person/day) in Kenya was under the average dietary energy requirement (ADER; 2200 kcal/person/day) between 2006 and 2008 [FAO, 2011]. While this fact reveals the quantitative deficit of Kenyan diets, the diet composition concerning macronutrients appears to be quite adequate:

| | | |
|---|---|---|
| Carbohydrates | 68.2 %* | |
| Fat | 20.5 %* | |
| Protein | 11.3 %* | |
| * in % of DES | | [FAO, 2011]. |

The quality of nutrition in Kenya remains insufficient, however. Diets mainly consist of cereals combined with tubers, vegetables and fruits if available [BWIBO & NEUMANN, 2003]. Cereals (excluding beer) provide almost the half of the total energy consumption (49.5 %) [FAO, 2010b] whereat maize accounts for more than a third of DES (34.7 %) [FAO, 2011]; animal source foods are rarely consumed [BWIBO & NEUMANN, 2003]. This undiversified, essentially cereal-based diet commonly consumed in Kenya represents typical eating habits in poor countries [FAO, 2005a].

The lack of diversity in the diet of the inhabitants of Kenya's Central Province has already been subject of earlier research [BWIBO & NEUMANN, 2003]. Dietary diversity, however, has been reported to be associated with increased food access and caloric availability at individual level as well as with a higher dietary quality. Accordingly, diversification of diets leads to increased food security [IFPRI, 2002; HODDINOTT & YISEHAC, 2002]. ONYANGO et al. furthermore document the positive impact which food diversity has on anthropometric status (“weight for age”, “height for age”, “weight for height”, triceps skinfold, MUAC) in rural Kenyan toddlers [ONYANGO et al., 1998].

Above all, an unbalanced diet as a result of undiversified nutrition may lead to a lack of micronutrient supply and thus to deficiency disorders [RUEL, 2001]. Such micronutrient deficiencies represent serious public health problems in Kenya: the Kenyan Nutrition Profile of the FAO reports that disorders resulting from vitamin A and iron deficiencies are assumed to remain highly prevalent in the country. The authors, however, refer to the absence of recent data [FAO, 2005a]. This absence obviously still persists since the Kenya National Technical Guideline for Micronutrient Deficiency Control 2008 is as well based on data from 1999. More current data exist concerning iodine supply from the National Iodine Deficiency Survey 2006 which shows a decline in the prevalence of goitre by 10 % due to salt iodization [REPUBLIC OF KENYA, 2008a]. According to the results of the Kenyan Demographic and Health Survey 2008/2009 almost all households in Kenya use salt with adequate levels of iodine [KNBS & ICF MACRO, 2010].

A widespread prevalence of zinc deficiency in Kenya is mentioned to be likely, whereas the most recent data are derived from the 1999 Micronutrient Survey Report [REPUBLIC OF KENYA, 2008a]. Zinc deficiency is suspected to contribute at least partly to the high prevalence of stunting rates (“height for age” values < -2 *SD*) among preschool children in the country [FAO, 2005a].

Dietary diversification is stated as a strategy to combat the problem of the high prevalence of micronutrient deficiency disorders in Kenya aside from the need for food fortification and nutritional education [FAO, 2005a; REPUBLIC OF KENYA, 2008a].

The insufficient consumption of high quality protein from animal source foods represents a further problem in Kenya's nutrition habits [BWIBO & NEUMANN, 2003]: animal protein accounts for only 3.2 % of DES and has stagnated at this percentage since 1990 [FAO, 2011]. This share of protein sourced from animal foods (28.3 % of total protein intake) might be sufficient in adult nutrition, but does not meet the higher protein requirement during growth and development of young children. While plant protein shows a more or less incomplete digestion, animal protein can be digested almost completely in the human intestinal tract. This circumstance leads to an increased availability of (essential) amino acids of animal source protein compared to protein from plant sources. Moreover, animal protein has an enhanced biological value, which is determined by the ability to synthesise specific proteins in the human body [ELMADFA & LEITZMANN, 2004]. Consequently, including protein from animal sources into human nutrition is of high importance in order to meet the requirements for essential amino acids, especially in young children.

According to BWIBO and NEUMANN [2003], there is an urgent need to raise the consumption of animal source foods by Kenyan children. Apart from the high quality protein animal foodstuffs provide they bring benefits in terms of micronutrient supply and thus contribute to optimising growth, cognitive development and physical activity of children. Young infants are furthermore confronted with nutritional problems due to early weaning and a change to cereal porridge, which deprives them of protein and other nutrients. Still at a young age they consume diets of adults, which are monotonous and hard to digest [BWIBO & NEUMANN, 2003]. These poor preconditions regarding nutrition of Kenyan children contribute to high rates of stunting ("height for age" < -2 *SD*: 35.2 %; < -3 *SD*: 14.4 %), underweight ("weight for age" < -2 *SD*: 16.4 %; < -3 *SD*: 4.1 %) and wasting ("weight for height" < -2 *SD*: 7.0 %; < -3 *SD*: 2.1 %) of children under five years of age [KNBS & ICF MACRO, 2010].

### 2.1.3. Projects, programmes and governmental attempts to attain food security

Kenya's insecure food situation has been apparent for decades. Various attempts have been made in order to tackle the issue. Unfortunately, availability of and access to a sufficient quantity and quality of food, which are required in order to live active and healthy lives, still remain inadequate. On-going projects and programmes aiming at achieving food security in Kenya are reviewed in present chapter.

Nevertheless, the government of Kenya recognises its responsibility to go about eradicating hunger and malnutrition. Consequently the country devised the ***National Food and Nutrition Security Policy*** (FNSP) in 2011. It includes strategies for improving the availability of and access to food by increasing production of diversified and affordable food as well as by enhancing storage and processing in order to decrease post-harvest losses. The FNSP is considered as an overarching framework which creates synergy to other existing initiatives concerning food security and nutrition improvement in Kenya [REPUBLIC OF KENYA, 2011]. Other initiatives are:

***The Kenya Rural Development Strategy*** (KRDS) 2002 – 2017
It is considered to serve as a guideline concerning poverty alleviation as well as growth and development of rural areas for the government, the private sector, NGOs, rural communities and other development partners [GITU, 2006].

***Agricultural Sector Development Strategy*** (ASDS) 2010 – 2020
This aims at increasing the annual economic growth rate through the enhancement of the agricultural sector especially in rural areas. The need of appropriate management of natural and financial resources concerning the agricultural sector is another issue addressed by this strategy [REPUBLIC OF KENYA, 2010].

***Economic Stimulus Programme*** (ESP) 2009 - 2011
This programme aims at revitalising the economy and sustainably increasing economic growth in order to reduce perennial hunger and poverty. Diversification of agricultural outputs and enhancement of irrigation practices are furthermore integrated in the activities of the programme [REPUBLIC OF KENYA, 2012a].

***Kenya Vision 2030*** 2008 – 2030

This long-term national planning strategy was found to increase the value of agricultural products and aims at achieving a Gross Domestic Product (GDP) growth rate of annually 10 % [REPUBLIC OF KENYA, 2007].

***Njaa Marufuku Kenya (eradication of hunger in Kenya)***

Interventions within this project support community driven food security initiatives. Strategies include actions in order to improve health and nutritional status of vulnerable groups such as children of under five years [REPUBLIC OF KENYA, 2012b].

The above mentioned efforts focus on agricultural development in Kenya and thus on reducing mal- and undernutrition. By striving for this target they seek to achieve the first of eight ***Millennium Development Goals***, the "eradication of extreme poverty and hunger" on which the international community agreed in order to raise the socio-economic development by 2015. Additionally, international programmes such as the "Food Security Programme" of Caritas Kenya [CARITAS KENYA, 2012] and the "Feed the Future Strategy" of USAID [USAID, 2011] emphasise food security in Kenya.

Most attempts aim to increase food supply by boosting the agricultural sector. This strategy seems to be essential since agriculture is understood to play a crucial role for economic growth in Kenya. MASSET et al. [2011] state in their systematic review on agricultural interventions (which target the improvement of child nutritional status) that such interventions must be implemented with the explicit objective to affect nutritional status in order to have a greater chance of success. They mention that following projects hold this potential: production diversification projects (development of dairy, vegetable gardens, fisheries and livestock) and bio fortification projects (increase of nutritional content of staple food) [MASSET et al., 2011].

Agricultural development, above all, is mentioned as an essential element of alleviating mass poverty since it represents an important source of income for the rural poor. In order to fight undernutrition, however, income growth is reported to be necessarily combined with direct nutrition interventions in order to lead to a successful outcome [BROCA, 2002].

## *2.2. Fish as food and its role in human nutrition*

10 dietary guidelines for an adequate diet based on the most recent scientific knowledge have been introduced by the German Nutrition Society (DGE). Number four of these guidelines includes the recommendation to eat fish at least once or twice per week in order to sustainably conserve one's health [DGE, 2011].

In developed countries fish intake is promoted in order to prevent public health problems such as coronary heart disease and cancer of the intestinal tract. As fish fat contains a significant amount of long chained omega-3 poly-unsaturated fatty acids, its consumption is recommended in order to decrease the risk of the above mentioned potential causes of death [WITTNER, 2006]. Developing countries such as Kenya, in contrast, face nutrition-related constraints such as undernutrition and micronutrient deficiency diseases. The benefits which fish may offer in contributing to the eradication of hunger and malnutrition in those countries are the subject of public health and fisheries literature. Data concerning this issue, however, are rarely to be found compared to data concerning the association between fish intake and health in developed countries [KAWARAZUKA, 2010].

The positive effects of fish on human health are attributed to the favourable composition of macro- and micronutrients which it holds. Tab. 1 shows the proximate composition of fish discussed in present research.

**Tab. 1: Proximate composition of raw fish (relevant for present research; in g per 100 g)**

| | **Tilapia** | **Common carp** | **Catfish** |
|---|---|---|---|
| **Proximate composition** | | | |
| Water | 78.08 | 76.31 | 79.06 |
| Protein | 20.08 | 17.83 | 15.23 |
| Total lipid | 1.70 | 5.60 | 5.94 |
| Ash | 0.93 | not available | not available |

[USDA, 2011].

The data in tab. 1 indicate a high content of protein in tilapia, common carp and catfish and even the FAO appreciates fish and fishery products as valuable sources of protein [FAO, 2012a]. Accordingly, fish protein contains a respectable quantity of essential amino acids and therefore it reveals a high biological value. As it holds a considerable amount of lysine, methionine and cysteine, fish protein has the potential to raise the value of cereal-based diets which lack these essential amino acids [FAO, 2005b]. Increasing fish consumption might thus be an efficient strategy to contribute to the improvement of the quality of Kenyan diets as they are mainly based on cereals [BWIBO & NEUMANN, 2003].

Besides the benefits which fish offers due to its favourable protein content, it additionally provides significant amounts of essential micronutrients such as vitamins (D, A, B) and minerals (including calcium, iodine, zinc, iron and selenium) [FAO, 2012a]. Micronutrient deficiencies are still highly prevalent worldwide with more than two billion people suffering from these health problems. The most widespread problems are deficiencies in iron, iodine and vitamin A, affecting mainly pregnant women and pre-school aged children. Inadequate diets lacking micronutrient dense foods such as fish are assumed to contribute to the development of micronutrient deficiencies [WORLDFISH CENTER, 2011a].

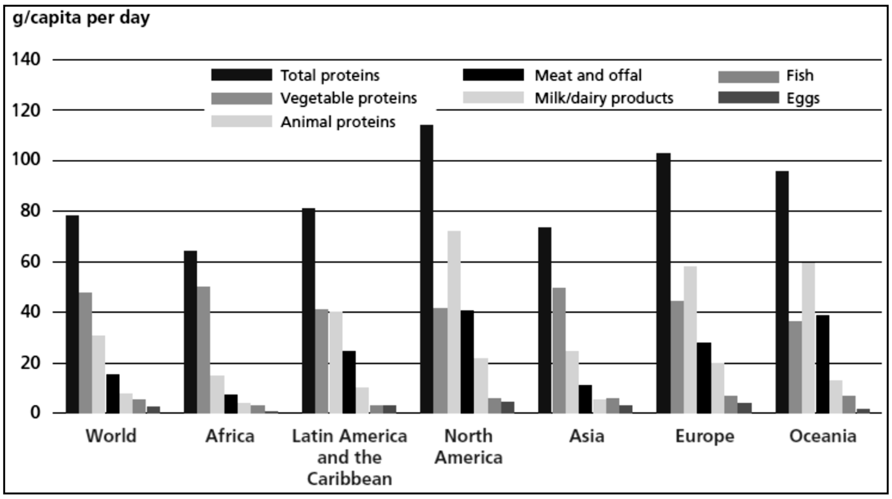
## *2.3. Aquaculture in developing countries*

While global fish consumption has been increasing drastically since the 1960s, fish intake in developing countries during the same period of time has stagnated. Sub-Sahara Africa represents the region with the lowest levels of fish consumption in the world [KAWARAZUKA, 2010].

As a result, these areas fail to profit from the increasing benefits which fisheries and aquaculture bring to other parts of the world concerning food security and the generating of income. Awareness of the potential of small-scale fisheries for enhancing food security as well as alleviating and preventing poverty in the developing world is increasing nevertheless. In spite of this, a failure to include the fishing sector into national and regional policies hinders the positive effects it could have on rural development [FAO, 2012a].

In various developing countries, however, even in Sub-Sahara Africa, fish still represents a vital source of animal protein and thus an important dietary component [FAO, 2012a; KAWARAZUKA, 2010]. Overall protein intake levels are low in those regions and the bulk of protein is sourced from plants. Fish frequently is a major source of animal protein, however, as it is usually more affordable than other animal products and sometimes it is preferred or represents a part of traditional recipes. Fish consumption in developing countries depends nevertheless on local and seasonal availability and is conditioned by supply rather than demand [FAO, 2012a]. Graph 1 shows the total protein supply by continent and major food group.

**Graph 1: Total protein supply by continent and major food group (average 2007 – 2009)**




[FAO, 2012a].

Although the contribution to the world aquaculture production of least-developed countries is negligible, some developing countries in Asia, the Pacific and Sub-Sahara Africa, amongst others Kenya, have successfully become important aquaculture producers in their region. As a consequence, developing countries have achieved an essential status as suppliers to the world markets in 2010. Their share of fishery exports in terms of value exceeded 50 % and reached more than 60 % in quantity; hence, fish trade already has become a vital source of foreign currency earnings for many developing countries [FAO, 2012a]. Apart from the potential of aquaculture as an income generator for (rural) populations, a source of employment and a promoter for food security, these economic advantages at the federal level underline the necessity of supporting the sector.

## 2.4. Aquaculture, undernutrition and food security

Several researchers have examined the link between aquaculture, undernutrition and food security during the past few decades. Food security represents an extensive concept which is determined by various factors and exerts influence on health outcomes such as nutritional status.

Food production, quality and diversification of the diet, women´s role, household income and health amongst other factors are deemed to be determinants of food security [NEGIN et al., 2009]. The same issues are also supposed to be noticeably impacted by aquaculture and particularly small-scale fish farming in rural areas of developing countries. The current chapter seeks to review the available literature concerning the above mentioned relations.

### 2.4.1. Generating high quality protein (animal protein)

As outlined in previous sections, fish represents a valuable foodstuff in human diets. On the one hand it holds an increased proportion of protein compared to plant source foods. Hence, it is a very efficient source of protein. On the other hand its protein digestibility and absorption is superior to that of proteins derived from plant sources. Lysine, an essential amino acid which is deemed to be a limiting factor for protein quality, is highly concentrated in fish while plant based foodstuffs hold a comparatively low amount of this amino acid [KAWARAZUKA, 2010].

Fish produced at small-scale farms in rural areas of developing countries where protein consumption is already inadequate and diets are mainly based on cereals, might therefore distinctly increase the quality of nutrition in those regions. Moreover, increased fish consumption may contribute to the reduction of the prevalence of PEM (Protein-Energy-Malnutrition). PEM accounts for high mortality rates in children younger than five and is the most prevalent form of malnutrition in the developing world. It occurs as a consequence of a general shortage of food intake and in particular due to an insufficient supply of essential amino acids and food energy. The syndrome exists in various types, from mild subclinical to severe clinical forms (Marasmus and Kwashiorkor) [ELMADFA & LEITZMANN, 2004].

In terms of supporting adequate child nutritional status, aquaculture might thus contribute through increased supply of animal protein. In relation to their body weight children require an even higher amount of protein compared to adults, since protein is essential for growth and development [WHO, 2007a]. Additionally, estimations suggest that if a child is moderately undernourished at least one third of the protein in the child's diet should be derived from animal sources [MICHAELSEN et al., 2009].

Already in 1997 LATHAM appreciated fishing and aquaculture in developing countries as strategies to ensure better supply of high quality protein in a FAO Food and Nutrition Series. He stated that "wherever water is available, fish provide a simple way of increasing protein consumption" and that the establishment of fishery infrastructure should be more intensively encouraged [LATHAM, 1997].

### *2.4.2. Fighting undernutrition and malnutrition*

The condition of malnutrition is generally caused by an improper or insufficient diet. This term is associated with undernutrition as well as overnutrition. More particularly, malnutrition is a consequence of deficiency or excess of energy, protein or other essential nutrients like vitamins and minerals [KATSILAMBROS et al., 2010].

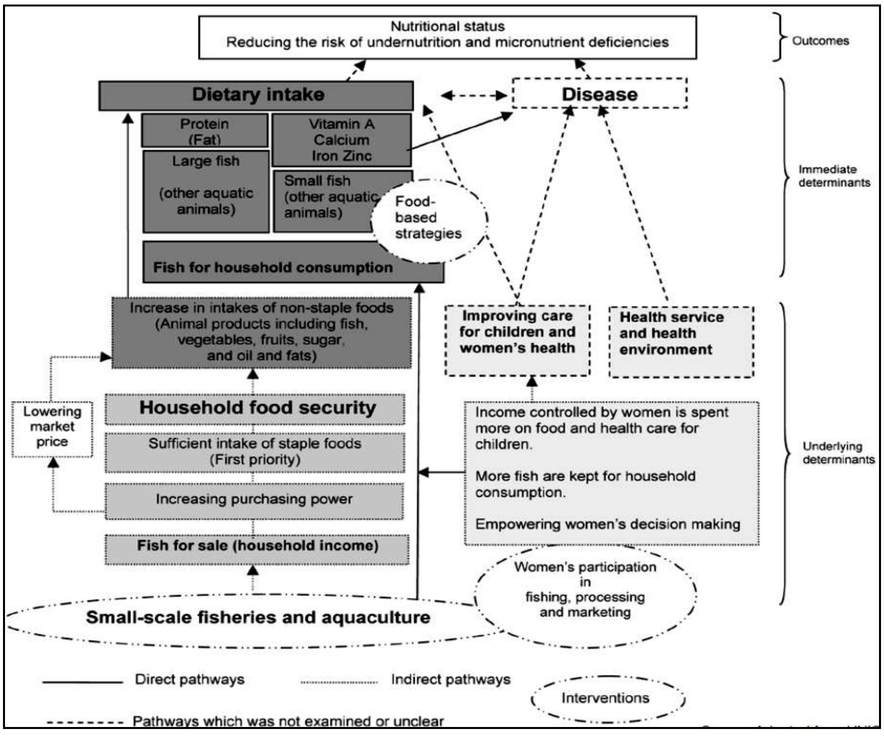
According to the United Nations Children's Fund (UNICEF) "undernutrition is defined as the outcome of insufficient food intake and repeated infectious diseases." The following terms describe the appearance of children suffering from undernutrition: "underweight" (inadequate weight for one's age), "stunted" (too short for one's age) and "wasted" (inadequate weight for one's height) [UNICEF, 2006]. These terms represent indicators of human nutritional status [VESEL et al., 2010].

*2.4.2.1. Aquaculture and child nutritional status*

Aquaculture may be linked with child nutritional status in various ways, but all of them eventually influence the child's diet and/or his health status. Basic determinants may be manifold and range from household income, access to health services, environment and available natural resources to child and maternal care – to mention only a few.

Fig. 2 illustrates how aquaculture may be incorporated into the associations mentioned above. The following sections review the extant literature on the subject matter, even though it is scarce, and thereby seek to further examine the meaningfulness of the research at hand.

**Fig. 2: Potential contribution of fish related activities on nutritional status**




[KAWARAZUKA, 2010].

Associations between fish farming and benefits to the nutritional status of children under the age of six years in Malawi have been documented by JAMU et al. [2002]. One of the two reviewed studies exposed lower rates of stunting in children of fish farming families compared to those living on non-aquaculture farms. Nevertheless, different levels of underweight and wasting were not found. The second study also revealed disadvantages concerning “height for age”, but additionally observed higher rates of underweight and wasting in children who lived in families without fish ponds [JAMU et al., 2002].

A cross sectional study also conducted in Malawi investigated the difference between the nutritional status of children aged from 6 – 59 months who lived in fish farming and those who lived in non-fish farming families. The research revealed a higher prevalence of stunting (“height for age” values below -2 *SD*), wasting (“weight for height” values below -2 *SD*) and underweight (“weight for age” values below -2 *SD*) among the subjects of non-fish farming households compared to those of fish farming households [AIGA et al., 2009].

MASSET et al. [2011] systematically reviewed literature published since 1990 on agricultural interventions which target to improve children’s nutritional status. These researchers included aquaculture and small-scale fisheries in their investigations and found very little or no evidence of an impact on the nutritional status of children. Methodological weaknesses of the reviewed studies such as a lack of statistical power are mentioned, however, to be the reason for the absence of clear results, rather than an unsuccessfulness of the interventions [MASSET et al., 2011].

Even at national level promotion of aquaculture which was intensified in Vietnam within the framework of the VAC-system (refers to three Vietnamese terms: Vuon = garden, Ao = pond, Chuong = cattle shed) is reported to show remarkable results concerning dietary improvement and the prevention of malnutrition. The VAC-system was launched in the late 1980s within a reform of the agricultural sector and represents a traditional farming system which integrates fish farming in field crop activities and animal husbandry. It targets at diversifying agricultural production in order to supply the population with food which meets all nutritional requirements of human beings. Studies show that since the implementation of the VAC-system undernutrition of children under five has been noticeably reduced. This concept therefore is considered a successful solution for dietary improvement and eradication of malnutrition in Vietnam [HOP, 2003].

Nevertheless, nutritional status is determined by a great number of different factors including breastfeeding practices and diseases among others. Consequently, assessing the direct contribution of fish farming activities to the improvement of children's nutritional status is somewhat restricted [KAWARAZUKA, 2010]. Despite of this limitation it seems to be reasonable to assume a connection between the two, as aquaculture directly and measurably influences factors which obviously impact nutritional status. Such factors might be agricultural productivity linked with food self-sufficiency of households and factors related to nutrition quality such as diversification of the diet, consumption of animal protein and fish protein in particular.

In this regard, research conducted in Malawi revealed increased farm productivity in terms of increased crop harvests and enhanced farming of livestock apart from fish production. Fish farmers hence achieved improved household food security [DEY et al., 2006; JAMU et al., 2002; NAGOLI et al., 2009], as for example higher availability of staple foods throughout the season [JAMU et al., 2002]. Increased agricultural productivity of farms integrating aquaculture is reported to be partly attained due to the development of water resources from fish ponds [JAMU et al. 2002; NAGOLI et al., 2009] and partly due to the use of pond sediments as crop fertilizers [DEY et al., 2006; NAGOLI et al., 2009].

Increased fish consumption in households of fish farming families is documented by several researchers who conducted studies on the subject matter [DEY et al., 2006; JAHAN et al., 2010; MASSET et al., 2011; NAGOLI et al., 2009; THOMPSON et al., 2002]. DEY et al. [2006] even refer to a higher intake of animal protein sourced from other foodstuffs than fish in households who adopt aquaculture compared to non-fish farming families. These benefits concerning nutritional quality might provide advantages in terms of dietary diversity, which in this respect is linked to food security [IFPRI, 2002] and nutritional status [KAWARAZUKA, 2010].

MASSET et al. [2011], however, state that increased fish consumption as a consequence of the adoption of aquaculture on farms might not contribute to an improvement of the quality of the overall diet due to the potential occurrence of substitution effects in consumption. The authors add that, in order to appropriately assess positive impacts of agricultural interventions on diet composition, researchers should rather collect data on overall dietary diversity of single foodstuffs than using the number of food categories [MASSET et al., 2011].

#### *2.4.2.2. Aquaculture and micronutrient supply*

Besides the occurrence of low weight or height as a consequence of inadequate nutrition, the term *undernutrition* furthermore includes a deficiency in vitamins and minerals (micronutrient malnutrition) [UNICEF, 2006]. The following sections give an overview on available literature dealing with how aquaculture may contribute to the reduction of the high prevalence of certain vitamin and mineral deficiencies in developing countries.

Deficiencies in vitamin A, iodine, iron and zinc are deemed to be widespread in Kenya in particular and in developing countries in general [REPUPLIC OF KENYA, 2008]. The ensuing health problems are outlined at this point for a better understanding of the issue.

<u>Vitamin A deficiency</u>

Several problems affecting the eyes develop as a consequence of vitamin A deficiency. Destructions of the cornea such as Keratomalacia and Xerophthalmia, a disorder which potentially leads to complete blindness as well as night blindness, are still highly prevalent in the developing world. Other human tissues which are damaged by a shortage of vitamin A supply are the skin and mucous membranes. Additionally, negative effects on reproduction are known to occur as a consequence of vitamin A deficiency [ELMADFA & LEITZMANN, 2004].

Iodine deficiency

Together with vitamin A deficiency and anaemia iodine deficiency represents one of the most serious nutrition problems in developing countries. Goitres, a compensatory growth of the thyroid gland as an answer to low blood levels of thyroid hormones resulting from a lack of iodine, are a visible sign of this deficiency [ELMADFA & LEITZMANN, 2004]. A deficit of iodine during growth and development of the foetus as well as of infants and children leads to irreversible mental retardation as a consequence of a damage of the brain and the central nervous system [WHO & FAO, 2004].

Iron deficiency

Iron supply still represents a critical issue in developing countries. Iron deficiency anaemia is the most prevalent micronutrient deficiency worldwide with one to two billion people suffering from this health problem. Unspecific signs such as general weakness, disorder of thermoregulation and problems concerning learning aptitude and the immune system are deemed to be consequences of this deficiency [ELMADFA & LEITZMANN, 2004]. Infants in the weaning period who need an adequate supply of iron for the development of their brain and other tissues, as well as women in reproductive age are the most vulnerable groups [WHO & FAO, 2004].

Zinc deficiency

An inadequate supply of zinc primarily leads to disturbance of growth. Further complications associated with zinc deficiency are reduced cure of traumata, loss of appetite, skin lesions and immunological abnormalities. People in periods of increased requirements, such as children while growth as well as pregnant and lactating women, are especially at risk [ELMADFA & LEITZMANN, 2004].

Aquaculture might help to tackle the problem of micronutrient deficiencies in developing countries through increased supply of fish as food for involved households and local markets. Particularly small indigenous fish species are rich in micronutrients. One advantage of these species is that they are consumed as a whole, including micronutrient dense parts such as bones, heads and viscera [KAWARAZUKA, 2010]. Evidence mainly drawn from Asian countries such as Cambodia and Bangladesh indicate the importance of the consumption of small indigenous fish for the status of vitamin A, iron, zinc and calcium [KAWARAZUKA, 2010; THILSTED, 2012; ROOS et al., 2003; ROOS et al.; 2007].

This being said, the research at hand focuses on tilapia, carp and catfish, however, which all belong to the group of large fish species. Supporting polyculture of nutrient dense small fish in already established fish ponds populated by large fish might potentially serve as a successful strategy to fight micronutrient deficiencies [THILSTED, 2012]. Fish products in general represent a nutrient-dense kind of foodstuff and accordingly, they serve as a primary source of preformed vitamin A and haem iron in the human diet and as a moderate source of zinc. Iodine is solely highly concentrated in marine fish, while fresh water fish contain a rather low amount of this micronutrient [WHO & FAO, 2004].

Aquaculture may thus indirectly improve the quality of diets of fish farming households. This improvement might be achieved through increased dietary diversity [DEY et al., 2006] which is recommended in order to optimise micronutrient intake [RUEL, 2001; WHO & FAO, 2004]. Diversification of diets is reported to be essential in order to achieve adequate supply of critical nutrients, particularly in diets which predominantly contain cereals and tubers [WHO & FAO, 2004] as it is common in Kenya and other developing countries [BWIBO & NEUMANN, 2003]. Critical nutrients in this context are vitamin A, iron and zinc, among others. Including even minimal amounts of animal source food such as fish into one’s diet enhances bioavailability and absorption of such nutrients and thus often provides a sufficient complement for staple diets. Raising fish is recommended as a strategy to accomplish dietary diversity in order to prevent micronutrient malnutrition, especially in poor populations with limited access to food [WHO & FAO, 2004].

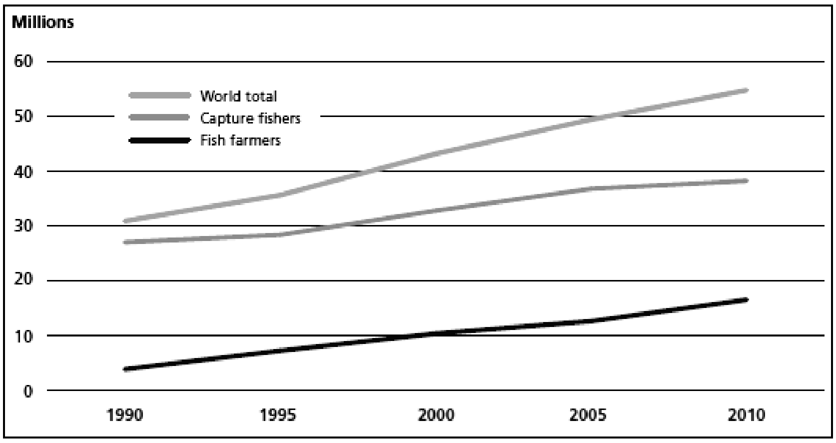
The before mentioned VAC-system, for instance, which supports the integration of aquaculture in Vietnamese farms, is documented to be successful in terms of reducing the prevalence of micronutrient deficiencies. Consequently, the prevalence of corneal lesions and subclinical vitamin A deficiency in children has been noticeably reduced since the implementation of the programme [HOP, 2003].

Further indirect pathways through which aquaculture may contribute to an enhancement of dietary quality – especially for children – are stated in the reviewed literature. These methods can be realised due to an increased household income achieved by fish production and better child care as a result of women empowerment through participation in aquaculture. These issues will be discussed in subsequent chapters.

### *2.4.3. Generating livelihoods, labour and household income for small-scale farmers*

According to the FAO, more than 50 million people gained their livelihood and income from fisheries and aquaculture in 2010 and about 13 % of them through small-scale fishery activities [FAO, 2012a]. The vast majority of those aquacultures can be found in the developing world [WORLDFISH CENTER, 2011b]. The employment of this sector as a crucial factor for well-being strengthened the economic capability of remote areas and encouraged young people and women through enhancing their socio-economic status [FAO, 2012a]. Graph 2 illustrates the distinct increase of employment in the fisheries sector during the last decade.

**Graph 2: Employment in the fisheries sector 1990 - 2010**



[FAO, 2012a].

The potential of small-scale fish farms for generating employment is limited, however, because they are usually family enterprises. If those farms expand – in terms of being linked to markets and increase inputs – they might, however, provide additional jobs for their community [MILLER, 2009]. Moreover, at community level, local fish farming may bring benefits concerning accessibility and affordability of food fish by lowering market prices [AHMED & LORICA, 2002; DEY et al., 2006; AIGA et al., 2009; JAHAN et al., 2009].

At household level, the harvest, sale and processing of fish increases people's purchasing power and consequently contributes to food security [WORLDFISH CENTER, 2011b]. Several studies, predominantly carried out in Bangladesh and Malawi, reveal financial benefits through aquaculture activities on small-scale farms [AIGA et al., 2009; DEY et al., 2006; JAHAN et al., 2010; JAMU et al., 2002; NAGOLI et al., 2009; THOMPSON et al., 2002]. Besides this, the direct impact on household income through sale of fish increased farm productivity is mentioned as one of the reasons for higher incomes among farmers which engage in fish farming [DEY et al., 2006].

This additional income, drawn from aquaculture, is used for purchasing staple foods as well as non-staple foodstuffs such as animal-source foods. Dietary intake is hence improved in terms of quality and energy intake [KAWARAZUKA, 2010]. Higher income and a better diet are associated with positive effects on the health of household members [DEY et al., 2006]. Furthermore, small-scale aquaculture farmers use parts of their fish harvest for barter and gifts and thus satisfying other household needs [MILLER, 2009]. Apart from nutritional and health benefits, increased household income through fish production is reported to enhance social status, child education as well as housing and sanitary facilities [AHMED, 2009].

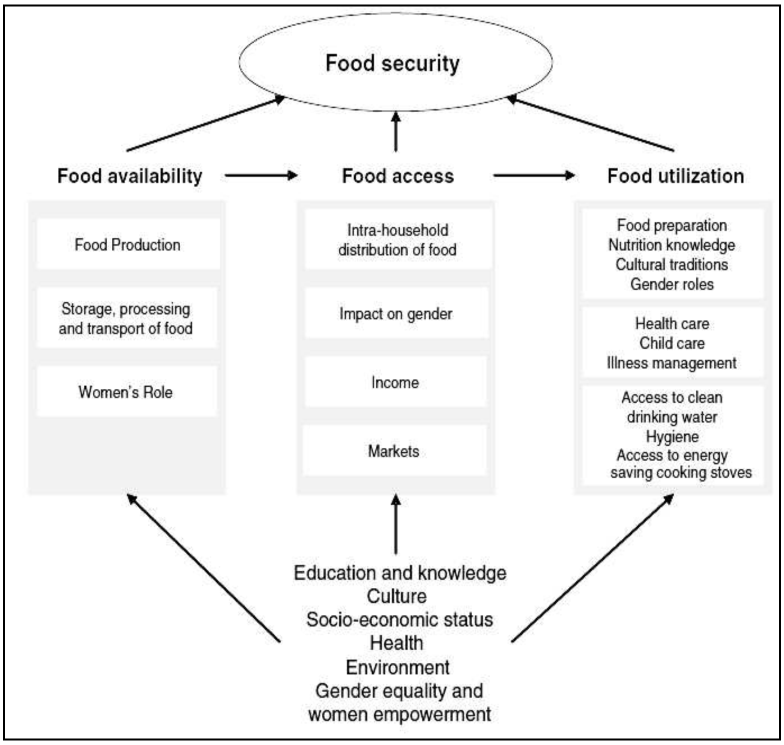
A further advantage of fish farmers in terms of food security results from the feature of aquaculture to diversify the sources of livelihood at farmers´ disposal. It is this diversification of production and income that reduces the risk suffering from consequences of crop failure [SATIA, 2011]. Fish farmers in Malawi, for instance, are reported to resist droughts and a resultant food shortage more easily than non-fish farming households through their additional income and prolonged crop growing conditions due to pond water [JAMU et al., 2002; PREIN & AHMED, 2000].

Efforts were made on behalf of the Food and Agriculture Organisation of the United Nations to assess the contribution of aquaculture to food security. The author proposes that the percentage of the total income a fish farmer can earn from aquaculture activities might be an accurate measurement of the role of aquaculture in hunger and poverty eradication. Another method would be the evaluation of the proportion of household income spent on fishery products compared to the proportion used to purchase other foodstuffs [CUNNINGHAM, 2005].

### *2.4.4. Aquaculture and women empowerment*

The way through which fish farming enhances household nutrition and health by empowering women represents an interesting consideration which is well acknowledged in recent relevant literature. Fig. 3 shows how the status of women is embedded in the framework of determinants of food security.

**Fig. 3: Food security and its determinants**




[NEGIN et al., 2009].

Several investigations argue that there is a strong relation between woman's status and her child's nutritional status [KAWARAZUKA, 2010; SMITH & HADDAD, 2000; SMITH et al., 2003; WORLD BANK, 2007]. In order to improve the high prevalence of child malnutrition in Sub-Sahara Africa it is necessary to provide women with education, income opportunities as well as to improve their access to and availability of food [SMITH & HADDAD, 2000].

The income earned by women is found to be invested in their children's health and well-being to a higher extent than that of men. The resources controlled by women have disproportionately stronger effects on general household health and nutrition outcome [WORLD BANK, 2007]. An improved status of women thus has considerable positive effects on their own nutritional status as well as on caring practices which are essential for the development and growth of their children [SMITH et al., 2003].

It has been recommended to incorporate the positive effects of women empowerment on child health and nutritional status into agricultural programmes through raising awareness of women in terms of nutritional issues. Such interventions appear to be substantially effective, particularly among low-income groups [WORLD BANK, 2007].

Aquaculture is stated to represent vital sources of employment and income for women and thus enhances their economic and social status [FAO, 2012a; JAHAN et al., 2009; KAWARAZUKA, 2010; SATIA, 2011]. The involvement of women in fish farming activities such as fish processing and marketing increases their control over resources and thereby initiates positive impacts on health and nutrition of household members, especially of children [KAWARAZUKA, 2010]. JAHAN et al. [2010], for instance, report about increased productivity and higher fish consumption on female-operated fish farms compared to male-operated ones.

In Kenya, the *Women in Fishing Industry Project* (WIFIP) was implemented which includes a training of women in pond construction and breeding of fish in order to provide them with additional income [AQUAFISH CRSP, 2010].

## 2.5. Aquaculture in Kenya

The previous chapters discussed literature on pathways which are supposed to enhance nutritional status, particularly in rural areas of developing countries and of children living in such environments. The dissemination of aquaculture and country-specific patterns of fish farming are outlined in the present chapter, pointing out a potential contribution to the reduction of undernutrition among Kenyan children.

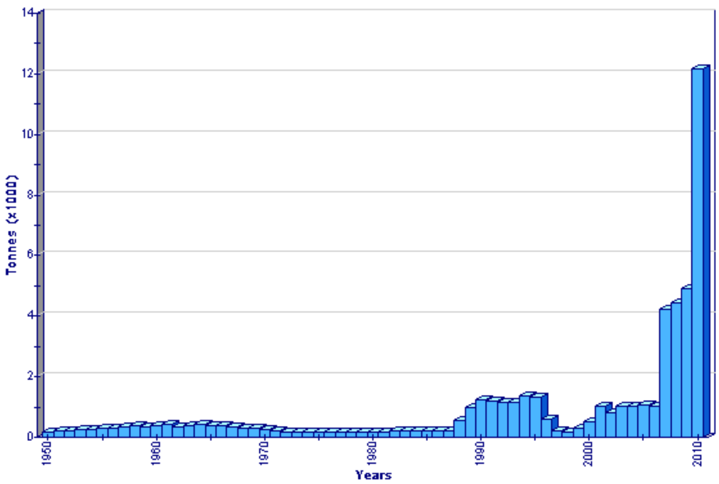
### 2.5.1. General overview

Kenya's history of fish farming which was first based on a pond culture of tilapia and later also common carp and catfish started in the 1920s. The "Eat More Fish

Campaign" implemented by the government in the 1960s and 1970s further promoted aquaculture within the country. A strategy for commercialisation of small-scale fisheries was launched with the support of the United States Agency for International Development (USAID) in the 1990s. The success of this intervention, which provided an enormous increase of productivity for farmers participating in the programme, led to a self-reinforcing process of dissemination of fish farming [REPUBLIC OF KENYA, 2012c].

Graph 3 illustrates the trend of Kenya's aquaculture production. The dramatic increase in production in 2010 might be due to the "Fish farming enterprise productivity programme" initiated in 2009 [MUSA et al., 2012] and will be discussed in the next chapter.

**Graph 3: Kenya aquaculture production 1950 – 2010 (FAO Fishery Statistic)**




[FAO, 2012b].

It is a commonly accepted opinion today that the aquaculture subsector in Kenya can contribute to reduce poverty and support food security. Rural areas in particular might profit from fish farming, as 46 % of the rural population which have access to perennial and seasonal water bodies live below the poverty line [MWANGI, 2008].

As the fastest growing sector in the country, the aquaculture subsector is assumed to hold a high potential to boost the development of the national economy through job creation and earnings from foreign exchange. The current production of aquaculture, however, represents only about 1 % of the entire national fish value, while about 95 % are derived from inland capture fisheries and the remaining part from marine capture fisheries [REPUBLIC OF KENYA, 2010].

With a great number of diverse water sources, natural preconditions for further dissemination of fish farming in Kenya exist. Various constraints hampering the development have been identified, however, which include inadequate infrastructure and investment, poor-quality fish seed and feed, limited knowledge of marketing as well as a lack of aquaculture research and policy [REPUBLIC OF KENYA, 2010].

Small-scale fish farming of tilapia (*Oreochromis niloticus* L.) represents the most frequent practice of aquaculture in poor rural areas of Kenya. Most ponds are operated as extensive or semi-intensive systems with low management levels and very low or no input of feed or other production promoters such as fertilisers. The most common farmed species after tilapia are catfish (*Clarias gariepinus* B.) and common carp (*Cyprinus carpio* L.). The most common fish holding units are earthen ponds and floating cages [FAO, 2005c].

The Kenyan government expects aquaculture to contribute to the reduction of the pressure on capture fisheries as natural fish stocks are declining [MWANGI, 2008; REPUBLIC OF KENYA, 2012d]. Furthermore, there is an increasing demand for fish due to the challenging rate of population growth [ASARECA, 2010]. In this respect, fish farming is deemed to be one vital alternative in maintaining the country's fish supply [ASARECA, 2010; MWANGI, 2008; REPUBLIC OF KENYA, 2012d].

### *2.5.2. Projects, programmes and governmental attempts concerning aquaculture development*

Within the *Agricultural Sector Development Strategy 2010 – 2020 (ASDS),* the Kenyan government formulated a strategic plan for the Fisheries Subsector. It aims at increasing aquaculture productivity and at supporting commercialisation and competitiveness in order to achieve improved livelihoods, higher income and better employment opportunities. Enhancing food security is stated as another issue approached by the programme [REPUBLIC OF KENYA, 2010].

While policy makers have given fish farming low priority as an economic activity in the past, the sector is now viewed as a chance to boost national economic development. Accordingly, the Ministry of Fisheries Development recommends treating and operating aquaculture as an enterprise, aiming at achieving economic gains for investors [REPUBLIC OF KENYA, 2012c].

The *Aquaculture Collaborative Research Support Programme* (ACRSP) and the subsequent *Aquaculture and Fisheries Collaborative Research Support Programme* (AquaFish CRSP) have been working towards sustainable aquaculture systems in Kenya since 1997. The programmes include trainings and supports of all kinds of stakeholders such as fishers, farmers, small entrepreneurs, researchers and policy makers and additionally, new technologies were brought to rural communities. These interventions led to a doubling of the number of Kenyan fish farmers (raising up to 4500) and a rise in fish production from 1 tonne in 1996 to 4 tonnes in 2006 [AQUAFISH CRSP, 2010].

Likewise, the *Fish Farming Enterprise Productivity Program* (FFEPP) which was implemented in the course of the *Economic Stimulus Program* (ESP) and was initiated by the Kenyan government in 2009 supports further dissemination of fish farming and increased fish production. After its implementation, numerous ponds were dug, some of which were filled with water and stocked with fingerlings – an effort which created huge capacities for aquaculture production and employment opportunities. The programme faces some constraints, however, such as poor infrastructure and delayed fund disbursement [MUSA et al., 2012].

The above mentioned efforts concerning the support of aquaculture principally focus on boosting Kenya's economy through increased fish production and enhanced economic viability in fish farming. In order to reduce the prevalence of undernutrition in children it would, however, be desirable to integrate definite fields of action for improving nutrition and health of the target group in these policies. It has already been mentioned in previous chapters that agricultural interventions are stated to affect the nutritional status more successfully if they are explicitly aiming at the improvement of this specific outcome [MASSET et al., 2011].

## *2.6. Using anthropometric measurements for determining child nutritional status*

Present thesis is dealing with research questions about the contribution of fish farming activities within farming households aimed at the reduction of undernutrition of Kenyan children in the Central Province. In order to address this issue, anthropometric measurements of children were conducted for comparing the nutritional status of children in fish farming households and those from non-fish farming backgrounds.

This chapter seeks to outline briefly the practicability of anthropometry and the suitability of the applied methods in order to discuss the subject (anthropometric measurement of children's height, weight and mid upper arm circumference).

Nutritional status of children under five years of age is reported to be most accurately defined by the assessment of their growth. Anthropometry thus represents the most frequently used method to describe the nutritional status of individuals or population groups. Inadequate nutrition as well as health problems such as infectious diseases are proven to consistently impede the growth of children. The unfavourable preconditions which lead to this impaired growth are also closely linked to general living standard within the children's personal background. A child's nutritional status can hence be used to gather information about the quality of life of a community or population such as the adequacy of available food [SHETTY, 2003].

The most commonly used indices of child nutritional status are "weight for height", "height for age" and "weight for age". "Weight for height" relates body mass to body height and represents an indicator for short-term nutritional history. Low values indicate a lack of adequate nutrition or a recent episode of illness at the particular time of the survey. "Height for age" gives information on the long-term performance of growth. Low values of this index represent cumulative growth deficits and reflect a long period of inadequate nutrition as well as chronic diseases. The index "weight for age" is influenced by both of the mentioned indices. The consequences of both acute and chronic malnutrition are forming this index [KNBS & ICF MACRO, 2010].

In order to reveal the occurrence of undernutrition in children, the three nutritional status indices are related to internationally accepted reference standards [SHETTY, 2003] which are provided by the World Health Organization (WHO). These standards are internationally applicable for comparing data of all children under the age of five and are based on growth data collected from children from six different ethnic backgrounds worldwide during the Multicentre Growth Reference Study (MGRS). All subjects included in the MGRS grew up under quasi optimal conditions including feeding according to recommendations of the WHO and the UNICEF (United Nations Children’s Fund), access to adequate health care and good health status during infancy and early childhood [VESEL et al., 2010].

Children whose values (Z-scores) for the above mentioned nutritional status indices lie below minus two standard deviations from the median of the WHO growth reference standards are deemed to suffer from undernutrition. Accordingly, children with problems in the “weight for height” index are termed *wasted*, children with inadequate “height for age” are *stunted* and children with too low values for “weight for age” are *underweight* [KNBS & ICF MACRO, 2010].

The mid upper arm circumference for age (MUAC) represents a further indicator for nutritional status and is ranked among the indicators included in the WHO growth reference standards [DE ONIS et al., 2004]. MUAC reflects muscle mass in children [TROWBRIDGE et al., 1982] which is reduced in malnourished individuals due to muscular atrophy [GOLDEN, 2009]. This indicator is therefore used to detect acute severe malnutrition in children which face an increased risk of death [WHO & UNICEF, 2009].

It is common in existent literature to evaluate the nutritional status by prevalence rates of stunting, wasting and underweight. Continuous indicators (Z-scores, percentiles), though, are stated to be a more ideal method of choice for assessing the impact of agricultural activities on nutritional status [MASSET et al., 2011] and are applied in present study.

# 3. Methodology

This chapter aims to illustrate the methods as well as the materials used for implementing this paper's research. Firstly, the design of the study as well as its sample size and the process of the sample selection will be discussed. Secondly, there will be a description of the location where the survey was conducted and of the training of the assistant who carried out the survey. Subsequently, the instruments of data collection and the statistical data analyses will be presented. Finally the study's limitations will be reviewed.

## *3.1. Study design*

The study was designed as a cross-sectional study which aims to describe the connections between agricultural activities – in particular those between aquacultural activities and the developmental performance of children under the age of five, which is closely linked to household food security.

With the intention of collecting necessary data for the above mentioned purpose, a questionnaire was adopted and anthropometric measurements were conducted. In order to enable the identification of potential predictors of the child nutritional status the study measures were applied to three categories of rural households: fish farming households, households which are situated in communities with fish farmers and households which are located in areas without any access to fish farming.

## *3.2. Sample size*

In order to meet the requirements for the application of commonly used statistical tests the size of the sample was set at a minimum of 150 subjects and accordingly, each of the three groups consisted of a minimum of 50 subjects (actual sizes of groups: children of fish farming households: N = 51; children of households with fish farmers in community: N = 50; children of households without access to fish farming: N = 51). The circumstance each group consisted of more than 30 participants (N > 30) allows for the adoption of an approximated normal distribution of data and thus also for the implementation of distribution dependent statistical methods [BORTZ & DÖRING, 2006].

## *3.3. Sample selection*

As no sampling frame for the observed households was available the selection was implemented as a quota sampling and consequently, the households were chosen according to the following preconditions:

All of the observed households show the following three characteristics:

- agricultural activities (as a crucial income source) on small-scale farms,
- child under 5 years of age who permanently lives in the observed household and is capable of standing freely (required for measurement of height and weight with the available devices) and
- residence of the Central Province.

Additional preconditions for fish farming households:

- aquaculture is integrated in farming activities (for a minimum of one year) as small-scale fish farming and
- operation of at least one fish pond, producing at least one kind of food fish, such as tilapia (*Oreochromis niloticus* L.), common carp (*Cyprinus carpio* L.) or catfish (*Clarias gariepinus* B.).

Additional preconditions for farming households with fish farmers in their community:

- fish farming household (defined as described above) within the proximate vicinity of a rural conglomeration.

The “District Fisheries Offices”, which have been visited upon the advice of the responsible “District Commissioner”, assisted in locating fish farming households within the different districts of the Central Province of Kenya.

## *3.4. The location of the study*

Current study was implemented in the Central Province of Kenya where, according to the Kenya Population and Housing Census 2009, 4,383,743 people, representing 11.35 % of Kenya’s total population [KNBS, 2010], live in an area of 13,191 $km^2$.

The Central Province is located north of Nairobi and southwest of Mount Kenya and covers the zone of the central highlands which is predominantly populated by the Kikuyu people. The area’s higher altitude causes a relatively cool climate. The distribution of the fairly reliable rainfall is typically bimodal with two distinct rainy seasons (long rains peak in April, short rains in November) [JAETZOLD et al., 2006].

With its unique agro-ecological zones with fertile volcanic soils and its favourable conditions for agriculture, the Central Province provides a better living standard than other parts of Kenya. Nevertheless, the province faces several problems which still lead to a high prevalence of poverty among its inhabitants. Among others, these issues include overpopulation, depletion of soils due to permanent cultivation and low prices for cash crops such as coffee and tea, which are cultivated throughout the region to the disadvantage of food production [JAETZOLD et al., 2006].

## *3.5. Study assistant training*

For the conduction of the survey, a local assistant was trained, who acted as interviewer and translator.

After a general instruction about the research project, the study purpose and its objectives, the assistant was charged with self-studying the questionnaire. Additional training meetings were arranged later on, in which each section of the questionnaire was individually addressed and difficulties (e. g. ethically challenging questions) were theoretically discussed. Finally, the implementation of the questionnaire and the anthropometric measurements were practically trained in three test households.

These procedures were applied in order to minimise the risk of bias (e. g. interviewer and measurement bias) and thus increase the quality of the data.

## *3.6. Instruments of data collection*

### *3.6.1. Questionnaire*

With the aim of collecting the required data for present research, a questionnaire was implemented. As the study had to be performed on the assumption that a great proportion of participants would not be able to speak English, the inquiry form was translated to Kikuyu language and the interviews were conducted by the study assistant who acted as a translator.

Any household member who assumed a vital role in child care was qualified to act as interviewee. Mothers represented the largest group who agreed to participate and answer the questionnaire, followed by fathers. In some cases grandmothers, grandfathers, sisters, brothers and other relatives were interviewed.

The applied questionnaire consisted of following sections:

- an introduction to the research's topic and its objectives as well as a brief information on the course of the survey,
- questions on household and socio-economic data (e. g. household size, household income, education, occupation),
- data about the child under five years of age (sex, date of birth),
- data on any agricultural activities (field crops, livestock, fish farming, irrigation),
- data on purchase of foodstuffs,
- a food frequency questionnaire (for the child under five) conducted as a semi-quantitative survey (enquiry on frequency of consumption of specific foodstuffs),
- nutritional knowledge (value of protein, fish as food) and the opinion about fish farming,
- the child's nutritional status[1)] and
- the child's health status

[1)] Collection of data on child nutritional status was derived from anthropometric measurements which are described in the following chapter.

### *3.6.2. Instruments for anthropometric measurements*

In order to evaluate the subject's nutritional status, following anthropometric data were collected: body weight, body height and mid upper arm circumference (MUAC). The devices used to fulfil this purpose are pictured in the appendices (10. 2. 1., 10. 2. 2., 10. 2. 3.) and will be explained in more detail in the following section.

In order for the anthropometric measurements to be taken, the children had to be capable of standing freely to be included in the study.

Weighing scales

The body weight was determined using a digital weighing scale (Ashton Meyers Electronic Personal Scales; International Distribution Centre: Clickstar Export Services Ltd., Dubai, UAE) which is accurate to one tenth of a kilo. As the loamy floor of many rural homes did not have a hard surface, the scale was placed on a flat wooden board before the subjects were weighed in order to increase data accuracy.

Stadiometer

No portable stadiometer was available at any specialised shop in Nairobi, which is why a local carpenter was charged with fabricating one: a measuring tape was pasted onto a stable wooden stick of an approximate length of 1,25 meters, at the zero-end of which a stabilising wedge was perpendicularly fixed which allowed for accurate measurement. Additionally, a measuring bar was flexibly attached so that it could be perpendicularly shifted in order to facilitate the reading of the child's height.

MUAC measurement tape

The mid upper arm circumference (MUAC) was determined using a commercially available MUAC measuring tape with a scale accurate to one millimetre. When measuring the MUAC, following procedure was applied in order to achieve accurate and thus comparable values:

- with the help of a string a middle point between the shoulder and the tip of the elbow was found at the bended left upper arm,
- the MUAC tape was wrapped around the upper arm, which was hanging down the side of the body in a relaxed manner and
- the MUAC was then read according to the indication of an arrow at the measuring tape.

## *3.7. Data analyses*

### *3.7.1. Calculation of anthropometric measurement indices*

The collected anthropometric measurement data were entered into the WHO Anthro computerised program (version 3.1.0), a software which was developed for the application of the WHO Child Growth Standards in order to assess growth and development of infants (0 to 60 months).

The standards were derived from data of the WHO Multicenter Growth Reference Study which was conducted between 1997 and 2003. Primary growth data from approximately 8500 children from various ethnic backgrounds were collected in order to generate growth curves, thus providing a single international standard, applicable for all children from their birth to the age of five [DE ONIS et al., 2004].

The WHO Anthro software offers means of comparing collected data with the WHO Child Growth Standards to subsequently calculate percentiles and Z-scores for the following anthropometric indices used in the present research for evaluation of the subjects' nutritional status: "weight for height", "weight for age", "height for age", BMI for age, MUAC for age. The thus calculated values were then entered into the accordant statistics software in order to conduct the planned statistical analyses which are explained below.

### *3.7.2. Statistical analyses*

Data derived from the questionnaire as well as from anthropometric indices calculated by the WHO Anthro software were entered into SPSS Statistics software (Version 19., IBM SPSS Inc.). Subsequently, suitable statistical tests were carried out in order to test the hypotheses which represent the basis of current research.

Utilised statistical tests

- *Chi square test*

The chi square test, according to Pearson, examines the null hypothesis which says that two nominal scaled variables are independent. It compares expected frequencies (calculated by assuming the null hypotheses is feasible) with observed frequencies [RUDOLF & KUHLISCH, 2008].

- *Fisher's exact test*

Like the chi square test, the fisher's exact test is a test of the null hypothesis saying that two nominal scaled variables are independent. It consists of a calculation of the actual probability of the observed contingency table with respect to all other possible contingency tables with the same column and row totals. This test can be used as an alternative to the chi square test if the precondition that all expected values of the frequencies lie above 1 and a maximum of 5 % of the expected values of frequencies lie above 5 is not realised [RUDOLF & KUHLISCH, 2008].

- *One-way analysis of variances (ANOVA)*

ANOVA is a statistical test which compares the amount of systematic variance in the data to the amount of unsystematic variance [FIELD, 2009]. As a result, statements about the similarity of (dependent) variable means of different groups (split according to an independent variable) can be made. According to this, the aim of a one-way ANOVA is to detect an effect of a multistage factor (independent variable) on the dependent variable [RUDOLF & KUHLISCH, 2008].

- *Welch test*

The Welch test is an alternative to the one-way ANOVA and is used when the assumption that variances are homogenous is not deemed feasible. Due to adjustments of the test statistic as well as to the degrees of freedom, the Welch test can be conducted if the homogeneity of the variances assumption is violated [FIELD, 2009].

- *Post-hoc test according to Tukey*

As no information can be drawn from the ANOVA concerning the actual relation between the variable means, the Tukey test can be applied as a post-hoc multiple comparison test to compare each possible pairing of means. The test procedure is based on the arithmetic means of the observed data values and includes the dependency between the mean values in the test decision [RUDOLF & KUHLISCH, 2008].

- *Lavene test* (testing homogeneity of variances)

A Lavene test is used for testing the homogeneity of variances which is a precondition for the application of several statistical tests such as ANOVAs. The test on significance is basically carried out through an analysis of variances. The values of the differences between each score and the mean of its group are subject of this method [RUDOLF & KUHLISCH, 2008].

- *U-test according to Mann and Whitney*

By looking at differences in ranked positions of scores in different groups the U-test investigates the hypothesis that the distribution of a variable among two (independent) populations differs from one to another. This is a non-parametric statistical test which assumes a continuous distribution [FIELD, 2009].

- *Nonparametric rank correlation according to Spearman*

Spearman's test is a non-parametric statistical correlation test. The application of this test is feasible if data are not normally distributed. It firstly ranks data and secondly utilises Pearson's product-moment correlation coefficient to interpret the connection between the ranked variables [FIELD, 2009].

## *3.8. Study limitations*

### *3.8.1. Limitations due to sampling method*

In accordance with the present survey, subject households were selected by the means of a quota sampling. Participants were included if they fulfilled the previously mentioned preconditions (chapter 3.3.), provided that they were available and agreed to willingly participate in the study.

This sampling method indicates a non-probability sampling which leads to a non-random sample. As a consequence results are not deemed to be representative for the entire population of Kenya. The implementation of the study was essential, nonetheless, in order to detect any potential interrelating factors between agricultural activities, aquaculture in particular, and children's nutritional status. From this point of view, the study was considered as a pilot study and was conducted with the aim of exposing details of the subject matter in order to provide initial suggestions for planning and designing further research.

### *3.8.2. Limitations concerning seasonal variations*

Seasonal climatic changes determine agricultural cropping patterns and thus dictate the availability of locally produced foodstuffs in countries located in tropical and sub-tropical zones [BROWN et al., 1982; HOORWEG et al., 1995; KIGUTHA, 1995]. As a consequence, household food security and nutritional status of pre-school children who represent one of the most neglected groups in times of food scarcity are influenced by this seasonal factor [BROWN et al., 1982; KIGUTHA, 1995]. The percentages for expected weight for height, arm circumference for age and triceps skinfold thickness for age in particular have proven to be sensitive indicators for seasonal change in a study carried out by BROWN et al. [1982] among 6 to 60 months old children in Bangladesh.

The present survey was implemented from the end of November 2010 to the end of February 2011, a period which falls into the post-harvest season in Central Kenya. During this time the availability of maize, which is the main staple food within the area of research, is advantageous and in addition to this, particularly good rainy season conditions in 2010 led to a favourable harvest in October and November 2010 [FAO, 2010a].

These circumstances may also influence the anthropometric data and its associations with agricultural activities and in particular aquaculture, as observed in the present research. Since the period of data collection coincided with a rather favourable season concerning food availability and hence child nutritional status, a distorted picture might be drawn from the results of the study. KIGUTHA [1997], who reviewed dietary assessment methods, underlined the fact that there are large seasonal differences in the intake of some nutrients. Consequently, data collected during only one season might lead to deceptive interpretations concerning overall dietary status, particularly in farming communities, where the availability of food strongly depends on weather conditions [KIGUTHA, 1997].

For this reason it is recommended that any further research, which should be conducted in order to investigate the present study's issues in more detail, considers these seasonal fluctuations. A longitudinal study design may help to tackle this difficulty.

# 4. Results

The first section of this chapter presents the characteristics of collected data and the study sample. It discusses the distribution of demographic and socio-economic values among the sample. Furthermore, it provides a report on the nutritional status indices derived from collected data compared to the WHO growth standards. Results of the inferential statistics carried out in order to test the central study hypothesis will be focused on in the second section. Outcomes concerning nutritional status, access to fish, fish consumption, health status, agricultural performance, quality of diet and nutritional knowledge will be considered.

## *4.1. Characteristics of data and sample*

### *4.1.1. The three categories*

In order to evaluate a potential contribution of aquaculture to the reduction of undernutrition in children of less than five years the sampled households were allocated to three categories, on which a vast proportion of the following calculations are based:

- fish farming households,
- households which are situated in communities with fish farmers and
- households which do not have any access to fish farming.

Distribution of sex among the three categories

Within the total of 152 subjects 53.3 % of the children are male and 46.7 % are female. The calculation of the test statistics of the chi$^2$ test indicates [with $\chi^2$ (2) = 1.294, $p$ = .524] that no significant difference of the distribution of sex among the three categories can be assumed.

**Tab 2.: Distribution of sex among the three categories**

| | | Sex of child | | |
|---|---|---|---|---|
| | | female | male | Total |
| Fish farmer | N | 23 | 28 | 51 |
| | Expected value | 23.8 | 27.2 | 51.0 |
| | % | 45.1% | 54.9% | 100.0% |
| | Standardised residuals | -.2 | .2 | |
| Fish farmer in community | N | 21 | 29 | 50 |
| | Expected value | 23.4 | 26.6 | 50.0 |
| | % | 42.0% | 58.0% | 100.0% |
| | Standardised residuals | -.5 | .5 | |
| No access to fish farming | N | 27 | 24 | 51 |
| | Expected value | 23.8 | 27.2 | 51.0 |
| | % | 52.9% | 47.1% | 100.0% |
| | Standardised residuals | .7 | -.6 | |
| Total | N | 71 | 81 | 152 |
| | % | 46.7% | 53.3% | 100.0% |

## Age in relation to sex and the three categories

The subjects' ages range from 10.35 months (= minimum) to 59.14 months (= maximum). While the mean age of female children is 34.74 (15.17) months, the age of male children averages at 33.68 (13.02) months. The mean ages within the three categories show the following values: children of fish farmers are on average 35.87 (14.51), children of farmers with fish farmers in their community are 31.83 (12.72) and children of farmers without access to fish farming are 34.75 (14.71) months old.

**Tab. 3: Age (months) in relation to sex and the three categories; *Mean (SD)***

| | Female | Male | Total |
|---|---|---|---|
| Fish farmer | 34.33 (15.48) | 37.17 (13.81) | 35.87 (14.51) |
| Fish farmer in community | 27.52 (12.09) | 34.96 (12.44) | 31.83 (12.72) |
| No access to fish farming | 40.70 (15.01) | 28.05 (11.27) | 34.75 (14.71) |
| Total | 34.74 (15.17) | 33.68 (13.02) | 34.17 (14.03) |

The number of children within households in relation to the three categories

The calculation carried out by means of a one-way ANOVA, leads to the assumption that no significant difference in the number of children exists between households in the three categories [$F(2, 149) = 0.055$, $p = .947$].

**Tab. 4: Number of children within households in relation to the three categories**

| | N | *Mean* | *SD* | Min | Max |
|---|---|---|---|---|---|
| Fish farmer | 51 | 2.35 | 1.51 | 1 | 9 |
| Fish farmer in community | 50 | 2.34 | 1.08 | 1 | 4 |
| No access to fish farming | 51 | 2.27 | 1.22 | 1 | 7 |
| Total | 152 | 2.32 | 1.27 | 1 | 9 |

The distribution of breastfeeding within the three categories

A $chi^2$ test did not show any difference in the distribution of breastfeeding among the three categories [$\chi^2(2) = 2.787$, $p = .248$].

**Tab. 5: Breastfeeding within the three categories**

| | | | Child is breastfed | | |
|---|---|---|---|---|---|
| | | | "yes" | "no" | Total |
| | Fish farmer | N | 5 | 46 | 51 |
| | | Expected value | 5.4 | 45.6 | 51.0 |
| | | % | 9.8% | 90.2% | 100.0% |
| | | Standardised residuals | -.2 | .1 | |
| | Fish farmer in community | N | 8 | 42 | 50 |
| | | Expected value | 5.3 | 44.7 | 50.0 |
| | | % | 16.0% | 84.0% | 100.0% |
| | | Standardised residuals | 1.2 | -.4 | |
| | No access to fish farming | N | 3 | 48 | 51 |
| | | Expected value | 5.4 | 45.6 | 51.0 |
| | | % | 5.9% | 94.1% | 100.0% |
| | | Standardised residuals | -1.0 | .4 | |
| Total | | N | 16 | 136 | 152 |
| | | % | 10.5% | 89.5% | 100.0% |

Concerning the distribution of gender, age, number of children in households and breastfeeding no differences between the three categories can be assumed. Hence, these characteristics are not suspected to lead to any confounding effects affecting the results of the hypothesis testing calculations of the study at hand.

### *4.1.2. Income*

To create variable values for comparing households of different sizes the amount of money individual households have at their disposal per day per person was examined.

Income in relation to education

A $chi^2$ test lead to a highly significant result [$\chi^2$ (3) = 22.699, $p < .001$] and a clear difference in the distribution of money is present in the groups of various educational levels.

**Tab.6 : Income in relation to highest education (household members)**

| | | | Money at disposal/day/person | | |
|---|---|---|---|---|---|
| | | | < 77 KSh | >= 77 KSh | Total |
| | No completed education | N | 13 | 1 | 14 |
| | | Expected value | 7.6 | 6.4 | 14.0 |
| | | % | 92.9% | 7.1% | 100.0% |
| | | Standardised residuals | 1.9 | -2.1 | |
| | Primary School | N | 41 | 19 | 60 |
| | | Expected value | 32.8 | 27.2 | 60.0 |
| | | % | 68.3% | 31.7% | 100.0% |
| | | Standardised residuals | 1.4 | -1.6 | |
| | Secondary School | N | 23 | 36 | 59 |
| | | Expected value | 32.2 | 26.8 | 59.0 |
| | | % | 39.0% | 61.0% | 100.0% |
| | | Standardised residuals | -1.6 | 1.8 | |
| | College | N | 6 | 13 | 19 |
| | | Expected value | 10.4 | 8.6 | 19.0 |
| | | % | 31.6% | 68.4% | 100.0% |
| | | Standardised residuals | -1.4 | 1.5 | |
| Total | | N | 83 | 69 | 152 |
| | | % | 54.6% | 45.4% | 100.0% |

Income in relation to the three categories

The calculation of the test statistics of chi² shows a significant result [$\chi^2$ (2) = 8.957, *p* = .011]: the major portion of fish farming households can be found in the higher income group, while households situated in communities with fish farmers and those who have no access to fish farming show higher shares in the lower income group.

**Tab. 7: Income in relation to the three categories**

| | | Money at disposal/day/person | | |
|---|---|---|---|---|
| | | < 77 KSh | >= 77 KSh | Total |
| Fish farmer | N | 20 | 31 | 51 |
| | Expected value | 27.8 | 23.2 | 51.0 |
| | % | 39.2% | 60.8% | 100.0% |
| | Standardised residuals | -1.5 | 1.6 | |
| Fish farmer in community | N | 28 | 22 | 50 |
| | Expected value | 27.3 | 22.7 | 50.0 |
| | % | 56.0% | 44.0% | 100.0% |
| | Standardised residuals | .1 | -.1 | |
| No access to fish farming | N | 35 | 16 | 51 |
| | Expected value | 27.8 | 23.2 | 51.0 |
| | % | 68.6% | 31.4% | 100.0% |
| | Standardised residuals | 1.4 | -1.5 | |
| Total | N | 83 | 69 | 152 |
| | % | 54.6% | 45.4% | 100.0% |

Income in relation to consumption of fresh fish

A chi² test was conducted in order to describe the distribution of income groups among those household groups whose children consume fresh fish weekly, monthly and never. The test statistics shows a significant result [$\chi^2$ (2) = 11.252, *p* = .004] which leads to the assumption that there is a difference in distribution of the frequency of fresh fish consumption by children among the groups of altering income level within households.

**Tab. 8: Money at disposal per day per person plotted against consumption of fresh fish**

| | | Fresh fish consumption of children | | | |
|---|---|---|---|---|---|
| | | weekly | monthly | never | Total |
| < 77 KSh | N | 8 | 30 | 45 | 83 |
| | Expected value | 14.7 | 31.7 | 36.6 | 83.0 |
| | % | 9.6% | 36.1% | 54.2% | 100.0% |
| | Standardised residuals | -1.8 | -.3 | 1.4 | |
| >= 77 KSh | N | 19 | 28 | 22 | 69 |
| | Expected value | 12.3 | 26.3 | 30.4 | 69.0 |
| | % | 27.5% | 40.6% | 31.9% | 100.0% |
| | Standardised residuals | 1.9 | .3 | -1.5 | |
| Total | N | 27 | 58 | 67 | 152 |
| | % | 17.8% | 38.2% | 44.1% | 100.0% |

Income in relation to frequency of fish consumption per month

The calculation of the test statistics of a U-test according to Mann and Whitney does not show any significant result [$Z$ = -1.232, $p$ = .218]. A difference of the frequency of fish consumption by children of households within the two income groups can therefore not be assumed.

**Tab. 9: Frequency of fish consumption per month in relation to income**

| | N | *Mean* | *SD* |
|---|---|---|---|
| < 77 KSh | 83 | 15.24 | 27.86 |
| >= 77 KSh | 69 | 11.36 | 22.72 |
| Total | 152 | | |

Income in relation to nutritional status

"Weight for height", "weight for age", "height for age", BMI, MUAC

One-way ANOVAs were conducted in order to determine differences in the values of percentiles of nutritional status indices related to the household's income. While homogeneity of variances can be assumed for the calculations [p ≥ .05], none of them show a significant outcome.

**Tab. 10: Results of the ANOVAs relating nutritional indices (children) and incomes (households)**

| Dependent variable | Income level | N | *Mean* | *SD* | *F* ($df_1/df_2$) | *p* |
|---|---|---|---|---|---|---|
| "Weight for height" | < 77 KSh | 83 | 49.64 | 26.93 | 0.037 (1, 150) | .848 |
| | >= 77 KSh | 69 | 50.45 | 24.94 | | |
| | Total | 152 | 50.01 | 25.96 | | |
| "Weight for age" | < 77 KSh | 83 | 34.54 | 27.14 | 1.547 (1,150) | .216 |
| | >= 77 KSh | 69 | 40.02 | 26.91 | | |
| | Total | 152 | 37.03 | 27.08 | | |
| "Height for age" | < 77 KSh | 82 | 24.05 | 24.80 | 1.797 (1, 149) | .182 |
| | >= 77 KSh | 69 | 29.85 | 28.36 | | |
| | Total | 151 | 26.70 | 26.56 | | |
| "BMI for age" | < 77 KSh | 83 | 53.16 | 26.37 | 0.003 (1, 150) | .957 |
| | >= 77 KSh | 69 | 53.39 | 25.10 | | |
| | Total | 152 | 53.26 | 25.72 | | |
| "MUAC for age" | < 77 KSh | 83 | 48.35 | 29.29 | 1.383 (1, 150) | .242 |
| | >= 77 KSh | 69 | 53.77 | 27.03 | | |
| | Total | 152 | 50.81 | 28.33 | | |

### *4.1.3. Education*

9.2 % (N = 14) of the 152 subjects live in households in which none of the members had completed any education, while 39.5 % (N = 60) of the highest educated household members had completed primary schools and 38.8 % (N = 59) secondary schools. 11.8 % (N = 18) had gone to college and 1 household member (= 0.7 %) had graduated from a university. In order to implement accurate statistical analyses the university graduate was added to the group of college alumni.

**Tab. 11: Distribution of highest completed education**

| | N | % |
|---|---|---|
| No completed education | 14 | 9.2 |
| Primary School | 60 | 39.5 |
| Secondary School | 59 | 38.8 |
| College | 18 | 11.8 |
| University | 1 | .7 |
| Total | 152 | 100.0 |

Education in relation to the three categories

The calculation of the test statistics of a chi$^2$ test corrected by means of a Fischer exact test does not show any significant differences in the distribution of the various levels of education within the three categories of households [$\chi^2$ (6) = 8.611, $p$ = .199].

**Tab. 12: Highest completed education plotted against the three categories**

| | | | Fish farmer | Fish farmer in community | No access to fish farming | Total |
|---|---|---|---|---|---|---|
| | No completed education | N | 4 | 6 | 4 | 14 |
| | | Expected value | 4.7 | 4.6 | 4.7 | 14.0 |
| | | % | 28.6% | 42.9% | 28.6% | 100.0% |
| | | Standardised residuals | -.3 | .6 | -.3 | |
| | Primary School | N | 15 | 20 | 25 | 60 |
| | | Expected value | 20.1 | 19.7 | 20.1 | 60.0 |
| | | % | 25.0% | 33.3% | 41.7% | 100.0% |
| | | Standardised residuals | -1.1 | .1 | 1.1 | |
| | Secondary School | N | 25 | 15 | 19 | 59 |
| | | Expected value | 19.8 | 19.4 | 19.8 | 59.0 |
| | | % | 42.4% | 25.4% | 32.2% | 100.0% |
| | | Standardised residuals | 1.2 | -1.0 | -.2 | |
| | College and University | N | 7 | 9 | 3 | 19 |
| | | Expected value | 6.4 | 6.3 | 6.4 | 19.0 |
| | | % | 36.8% | 47.4% | 15.8% | 100.0% |
| | | Standardised residuals | .2 | 1.1 | -1.3 | |
| Total | | N | 51 | 50 | 51 | 152 |
| | | % | 33.6% | 32.9% | 33.6% | 100.0% |

Education in relation to children's consumption of fresh fish

A chi$^2$ test shows a significant result [$\chi^2$ (6) = 14.863, $p$ = .021] which leads to the assumption that there is a difference in the distribution of frequencies of fish consumption by the observed children within the groups of different levels of education of the household members.

**Tab. 13: Highest completed education plotted against frequency of children´s fresh fish consumption**

| | | | Fresh fish consumption | | | |
|---|---|---|---|---|---|---|
| | | | weekly | monthly | never | Total |
| | No completed education | N | 1 | 4 | 9 | 14 |
| | | Expected value | 2.5 | 5.3 | 6.2 | 14.0 |
| | | % | 7.1% | 28.6% | 64.3% | 100.0% |
| | | Standardised residuals | -.9 | -.6 | 1.1 | |
| | Primary School | N | 5 | 24 | 31 | 60 |
| | | Expected value | 10.7 | 22.9 | 26.4 | 60.0 |
| | | % | 8.3% | 40.0% | 51.7% | 100.0% |
| | | Standardised residuals | -1.7 | .2 | .9 | |
| | Secondary School | N | 15 | 26 | 18 | 59 |
| | | Expected value | 10.5 | 22.5 | 26.0 | 59.0 |
| | | % | 25.4% | 44.1% | 30.5% | 100.0% |
| | | Standardised residuals | 1.4 | .7 | -1.6 | |
| | College | N | 6 | 4 | 9 | 19 |
| | | Expected value | 3.4 | 7.3 | 8.4 | 19.0 |
| | | % | 31.6% | 21.1% | 47.4% | 100.0% |
| | | Standardised residuals | 1.4 | -1.2 | .2 | |
| Total | | N | 27 | 58 | 67 | 152 |
| | | % | 17.8% | 38.2% | 44.1% | 100.0% |

Education in relation to the access to fresh fish

The calculation of the test statistics of a chi$^2$ test does not indicate any significant difference of distribution of access to fish within the groups of different levels of education of household members [$\chi^2$ (6) = 4.807, *p* = .569].

**Tab. 14: Highest completed education in relation to sources of fresh fish supply**

| | | | No fish got from any source | Fish got from community, village, others | Fish farmer | Total |
|---|---|---|---|---|---|---|
| | No completed education | N | 5 | 5 | 4 | 14 |
| | | Expected value | 4.7 | 4.8 | 4.5 | 14.0 |
| | | % | 35.7% | 35.7% | 28.6% | 100.0% |
| | | Standardised residuals | .1 | .1 | -.2 | |
| | Primary School | N | 24 | 22 | 14 | 60 |
| | | Expected value | 20.1 | 20.5 | 19.3 | 60.0 |
| | | % | 40.0% | 36.7% | 23.3% | 100.0% |
| | | Standardised residuals | .9 | .3 | -1.2 | |
| | Secondary School | N | 17 | 18 | 24 | 59 |
| | | Expected value | 19.8 | 20.2 | 19.0 | 59.0 |
| | | % | 28.8% | 30.5% | 40.7% | 100.0% |
| | | Standardised residuals | -.6 | -.5 | 1.1 | |
| | College | N | 5 | 7 | 7 | 19 |
| | | Expected value | 6.4 | 6.5 | 6.1 | 19.0 |
| | | % | 26.3% | 36.8% | 36.8% | 100.0% |
| | | Standardised residuals | -.5 | .2 | .4 | |
| Total | | N | 51 | 52 | 49 | 152 |
| | | % | 33.6% | 34.2% | 32.2% | 100.0% |

Education in relation to frequency of fish consumption per month

Due to the inhomogeneity of variances [*p* = .001] a Welch test was conducted, but does not show a significant result [*F* (3, 45.753) = 1.788, *p* = .163]. This outcome leads to the assumption that among the groups of different degrees of education there is no difference in the frequency of fish consumption by children per month.

**Tab. 15: Frequency of fish consumption per month (children) within highest levels of education (households)**

| | N | *Mean* | *SD* |
|---|---|---|---|
| No completed education | 14 | 8.79 | 24.65 |
| Primary School | 60 | 11.00 | 21.21 |
| Secondary School | 59 | 19.17 | 31.63 |
| College or University | 19 | 7.11 | 13.97 |
| Total | 152 | 13.48 | 25.65 |

### *4.1.4. Nutritional status indices*

The following tables indicate mean values of Z-scores of nutritional status indices which result from a comparison of the collected anthropometric data and the WHO growth standards. While tab. 16 presents the values of the total of 152 subjects, tab. 17 and tab. 18 demonstrate the corresponding data allocated according to the child's gender.

The most distinct deviations from the WHO growth standards can be found in the mean values for the indicators "weight for age" (-.48) and "height for age" (-.87). The remaining indicators do not greatly differ from the ones of the standard population. The differences between male and female subjects appear to be marginal. BMI values, however, show the highest dissimilarities between sexes (.20), followed by values for "weight for age" (.17). The distribution curves in graphs 4 to 8 illustrate the sample characteristics explained above.

**Tab. 16: Nutritional status indices (Z-scores) of all children related to the WHO growth standards**

| | N | Min | Max | *Mean* | *SD* |
|---|---|---|---|---|---|
| Weight for height | 152 | -2.42 | 2.58 | -.01 | .87 |
| Weight for age | 152 | -2.67 | 2.01 | -.48 | .95 |
| Height for age | 152 | -3.08 | 2.80 | -.87 | 1.08 |
| BMI for age | 152 | -2.37 | 2.79 | .11 | .86 |
| MUAC for age | 152 | -2.21 | 2.83 | .04 | .95 |

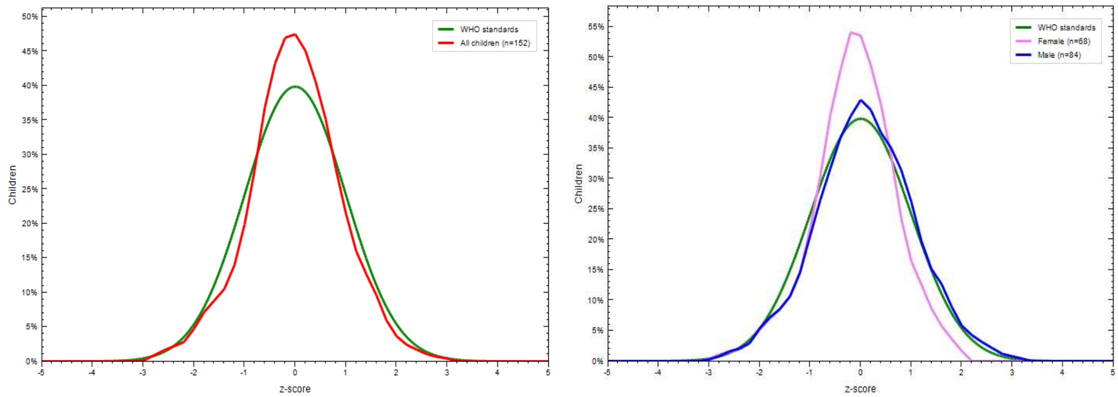
**Tab. 17: Nutritional status indices (Z-scores) of female children related to the WHO growth standards**

| | N | Min | Max | *Mean* | *SD* |
|---|---|---|---|---|---|
| Weight for height | 71 | -2.42 | 1.54 | -.09 | .78 |
| Weight for age | 71 | -2.45 | 2.01 | -.57 | .89 |
| Height for age | 71 | -3.08 | 1.83 | -.90 | .98 |
| BMI for age | 71 | -2.37 | 1.68 | .00 | .79 |
| MUAC for age | 71 | -2.21 | 1.95 | .04 | .96 |

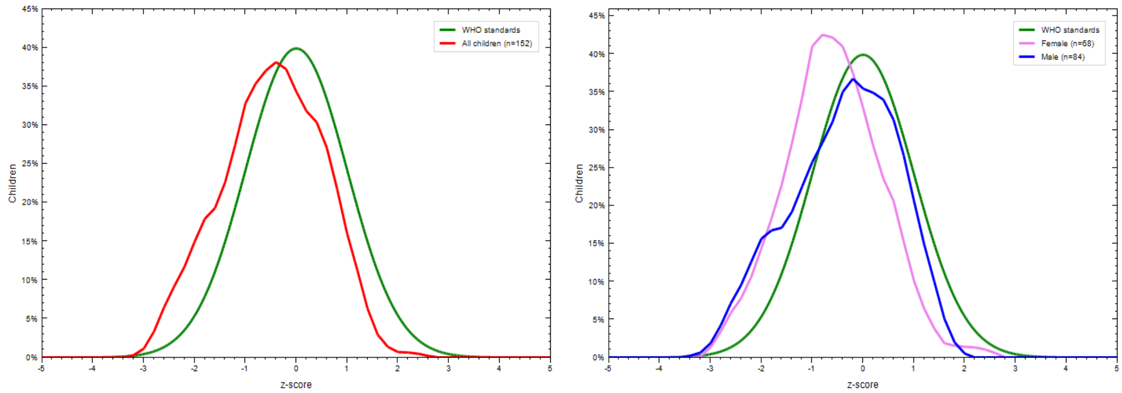
**Tab. 18: Nutritional status indices (Z-scores) of male children related to the WHO growth standards**

| | N | Min | Max | *Mean* | *SD* |
|---|---|---|---|---|---|
| Weight for height | 81 | -2.33 | 2.58 | .06 | .94 |
| Weight for age | 81 | -2.67 | 1.30 | -.40 | 1.01 |
| Height for age | 81 | -2.81 | 2.80 | -.85 | 1.16 |
| BMI for age | 81 | -2.01 | 2.79 | .20 | .91 |
| MUAC for age | 81 | -2.06 | 2.83 | .03 | .94 |

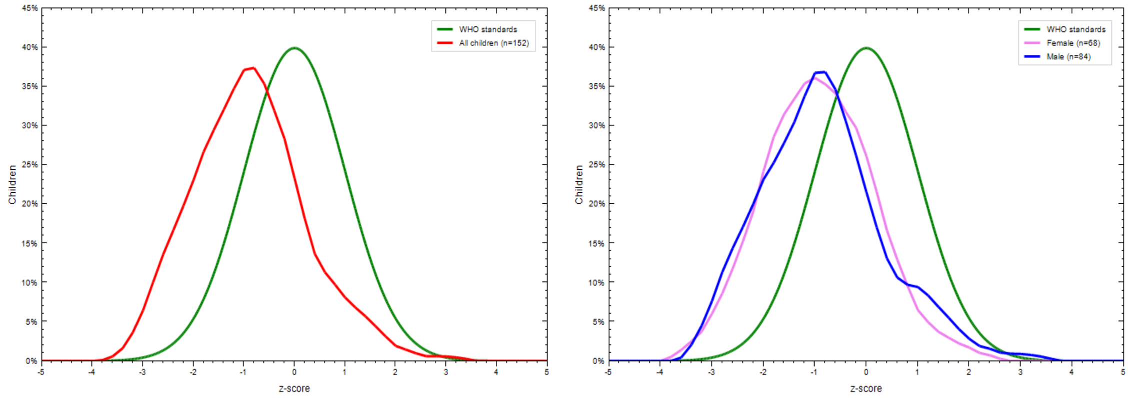
**Graph 4: "Weight for height" related to the WHO growth standards**



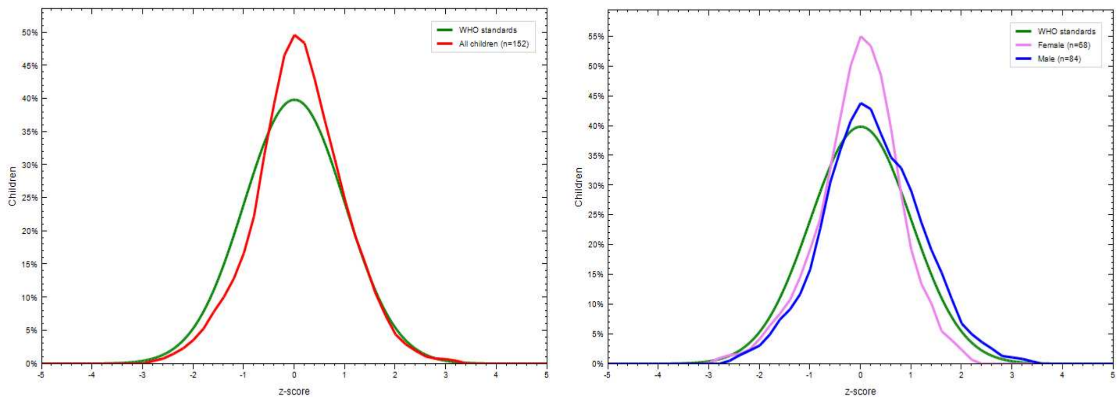

**Graph 5: "Weight for age" compared to the WHO growth standards**



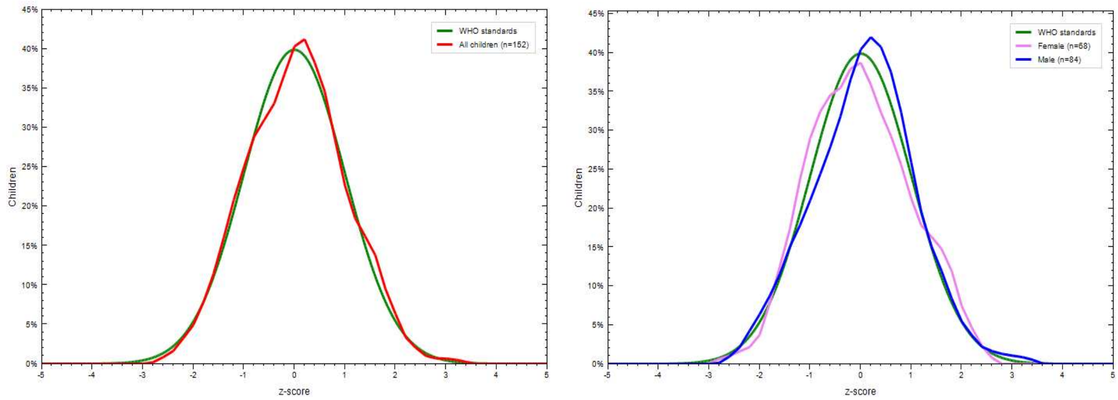
**Graph 6: "Height for age" compared to the WHO growth standards**




**Graph 7: BMI for age compared to the WHO growth standards**




**Graph 8: MUAC for age compared to the WHO growth standards**



## *4.2. Results of the hypothesis testing analyses*

### *4.2.1. Nutritional status indices among the three categories – testing of the central hypothesis*

“Weight for height” (percentiles) in relation to the three categories

The calculation of the test statistics of a one-way ANOVA (the homogeneity of variances can be assumed [*p* = .344]) does not show any significant difference between the values of “weight for height” (percentiles) within the three categories [$F$ (2, 149) = 0756, $p$ = .417], whereas the partial eta$^2$ ($\eta^2$= .01) indicates a small effect. This circumstance suggests that “weight for height” percentiles in children of fish farmers are slightly higher than those of the children in the group of farmers who live in communities of fish farmers. Those “weight for height” percentiles of the latter group are, in contrast to this, slightly higher than those of children of farmers without any access to fish farming. An overview of a classification of effect sizes can be found in a work of BORTZ and DÖRING [2006].

**Tab. 19: “Weight for height” percentiles among the three categories**

| | *Mean* | *SD* | N |
|---|---|---|---|
| Fish farmer | 52.66 | 23.92 | 51 |
| Fish farmer in community | 50.88 | 27.36 | 50 |
| No access to fish farming | 46.51 | 26.63 | 51 |
| Total | 50.01 | 25.96 | 152 |

“Weight for age” (percentiles) in relation to the three categories

A one-way ANOVA was conducted in order to reveal a potential difference in the index “weight for age” between children who live on fish farms, those who live in households with fish farmers in their community and those who live in households without any access to fish farming. The calculation of the test statistics shows a trend [$F$ (2, 149) = 3.008, $p$ = .052]. A post-hoc test according to Tukey supports this result, as it indicates a significant difference in “weight for age” values between children of fish farming households and those who live on farms without any access to fish farming [$p$ = .047].

**Tab. 20: "Weight for age" percentiles among the three categories**

| | N | *Mean* | *SD* |
|---|---|---|---|
| Fish farmer | 51 | 44.17 | 26.47 |
| Fish farmer in community | 50 | 35.39 | 26.28 |
| No access to fish farming | 51 | 31.49 | 27.42 |
| Total | 152 | 37.03 | 27.08 |

"Height for age" (percentiles) in relation to the three categories

The homogeneity of variances cannot be assumed [*p* = .015]. Thus, a robust statistical test was conducted. The calculation of the test statistics of a Welch test leads to a significant result [*F* (2, 97.443) = 3.353, *p* = .039]. The post hoc test according to Tukey indicates a significant difference of "height for age" percentiles of children of fish farmers and children of farmers without access to fish farming [*p* = .025]. "Height for age" percentiles of children who live in households with fish farming communities do by trend differ from those of children of fish farming families [*p* = .069].

**Tab. 21: "Height for age" percentiles among the three categories**

| | *Mean* | *SD* | N |
|---|---|---|---|
| Fish farmer | 35.06 | 31.10 | 51 |
| Fish farmer in community | 23.48 | 22.91 | 50 |
| No access to fish farming | 21.40 | 23.13 | 50 |
| Total | 26.70 | 26.56 | 151 |

BMI (percentiles) in relation to the three categories

The calculation of the test statistics of a one-way ANOVA does not detect any significant difference within the percentiles of BMI between the three categories [*F* (2, 149) = 0.583, *p* = .559]. Homogeneity of variances can be assumed [*p* = .267].

**Tab. 22: BMI percentiles among the three categories**

| | *Mean* | *SD* | N |
|---|---|---|---|
| Fish farmer | 55.09 | 23.13 | 51 |
| Fish farmer in community | 54.63 | 27.69 | 50 |
| No access to fish farming | 50.10 | 26.36 | 51 |
| Total | 53.26 | 25.72 | 152 |

MUAC (percentiles) in relation to the three categories

A one-way ANOVA was conducted. The calculation of the test statistics does not show any significant result [$F$ (2, 149) = 1.313, $p$ = .272]. The percentiles of MUAC do not significantly differ from each other within the three categories. Homogeneity of variances can be assumed [$p$ = .932]. The partial eta$^2$ ($\eta^2$ = .017), however, indicates a small effect [BORTZ & DÖRING, 2006].

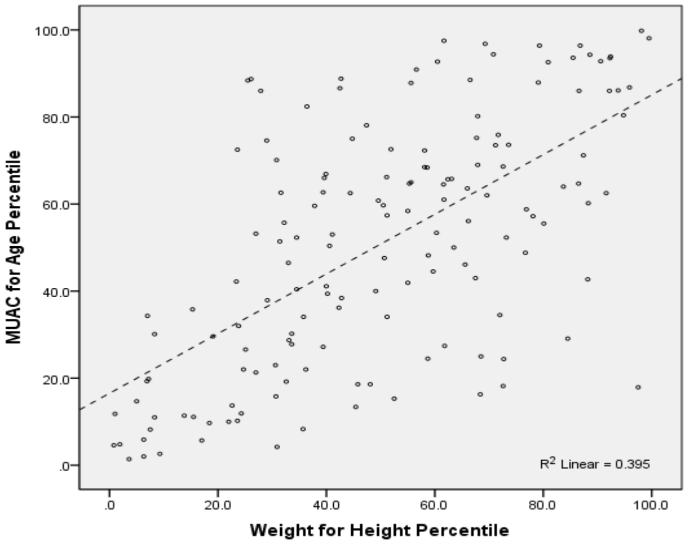
**Tab. 23: MUAC percentiles among the three categories**

| | *Mean* | *SD* | N |
|---|---|---|---|
| Fish farmer | 54.33 | 27.71 | 51 |
| Fish farmer in community | 52.44 | 28.98 | 50 |
| No access to fish farming | 45.70 | 28.11 | 51 |
| Total | 50.81 | 28.33 | 152 |

Correlation between MUAC (percentiles) and “weight for height” (percentiles)

The link between MUAC percentiles and “weight for height” percentiles was determined by the means of a nonparametric rank correlation according to Spearman. The calculation of the test statistics shows [$r_s$ = .611, $p \leq .01$] a highly significant result which may be interpreted as follows: the higher the percentiles of “weight for height”, the higher the values for corresponding MUAC percentiles of children. These findings are supported by literature which states that MUAC may be used as a proxy of “wasting” [SCN, 2012], which is described by the index “weight for height” [FAO, 2003]. The following scatterplot (graph 9) illustrates the correlation between MUAC percentiles and “weight for height” percentiles.

**Graph 9: Correlation between MUAC (percentiles) and "weight for height" (percentiles)**




## *<u>4.2.2. Analysis of assumed determining factors of child nutritional status</u>*

### *4.2.2.1. Access to fresh fish*

<u>Actual sources of fresh fish supply</u>

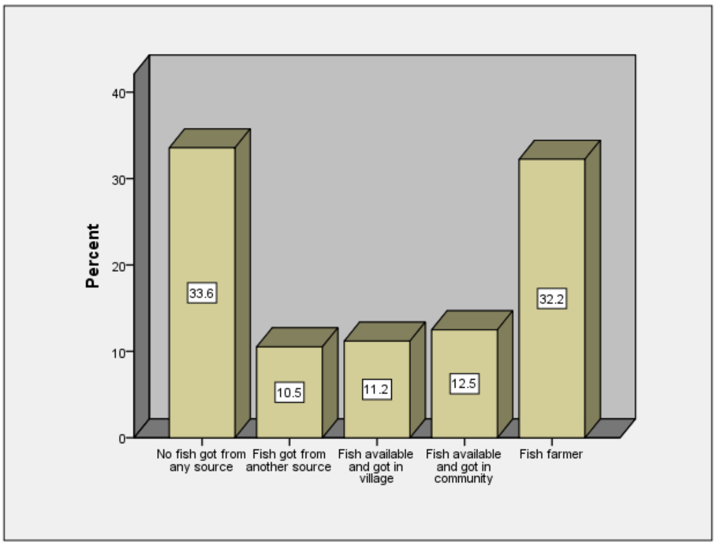
Among the households of the 152 observed children, 51 are ranked as fish farmers. 46 interviewees stated that they use at least 25 % of their fish for their own consumption, while the other shares are sold and/or lost. One interviewee stated that he sold 50 % and lost the other share, another respondent answered that 100 % of his fish harvest was lost. Both of them do not get any fish from other sources. Three of the household members who are part of the group of fish farmers did not make any statement about the usage of their harvested fish.

19 of the 50 households ranked as living in communities with fish farmers stated that they purchase fish from their communities, seven answered that they obtain fish from village markets and three said that they get fish from other sources. 21 households do not receive any fish from the enquired sources and therefore belong to the group of "no fish got from any source" in the bar chart below (graph 10).

51 children live in households which have no access to fish farming. Ten interviewed household members of this group stated that they obtain fish from village markets, while 13 households purchase fish from other sources and 28 belong to the group “no fish got from any source” as they do not get any fish from the enquired sources.

The discussed circumstances lead to the following case numbers, which are indicated as percentages in the bar chart shown below (graph 10): 51 “no fish got from any source, 16 “fish got from another sources”, 17 “fish available and got in village”, 19 “fish available and got in community”, 49 fish farmers (who used at least 25 % for own consumption).

**Graph 10: Different sources of fresh fish supply (in % of total)**




<u>Indices for nutritional status plotted against different sources of fresh fish supply</u>

Homogeneity of variances can be assumed for the following calculations [p > .05].

<u>“Weight for height”</u>

No significant result was found in the calculation of the one-way ANOVA which was conducted in order to identify a potential difference between “weight for height” percentiles among children of fish farming families, children who live in families who purchase fish from other sources and those whose families do not obtain fish from any source [*F* (2, 149) = 0.329, *p* = .720].

**Tab. 24: "Weight for height" (percentiles) plotted against sources of fresh fish supply**

| | N | *Mean* | *SD* |
|---|---|---|---|
| No fish got from any source | 51 | 49.50 | 28.13 |
| Fish got from community, village, others | 52 | 48.27 | 25.59 |
| Fish farmer | 49 | 52.39 | 24.31 |
| Total | 152 | 50.01 | 25.96 |

<u>"Weight for age"</u>

The test statistics of this one-way ANOVA indicates a significant result [*F* (2, 149) = 3.281, *p* = .040] and a considerable difference of the index "weight for age" among the three groups concerning access to fresh fish was detected. A post-hoc test according to Tukey shows that children who live in households which are involved in fish farming show significantly higher values for "weight for age" percentiles than children who live in households which obtain fish from other sources [*p* = .035]. "Weight for age" percentiles of children from families who do not get fish from any source, however, do not differ significantly from the two other groups.

**Tab. 25: "Weight for age" (percentiles) plotted against sources of fresh fish supply**

| | N | *Mean* | *SD* |
|---|---|---|---|
| No fish got from any source | 51 | 35.48 | 26.16 |
| Fish got from community, village, others | 52 | 31.33 | 27.10 |
| Fish farmer | 49 | 44.67 | 26.78 |
| Total | 152 | 37.03 | 27.08 |

<u>BMI and MUAC</u>

There are no significant results for the calculation of the test statistics of one-way ANOVAs, which were conducted in order to describe potential differences in the values for BMI and MUAC percentiles among children from fish farming families, children who obtain fish from other sources and those who do not get fish from any source [BMI: *F* (2, 149) = 0.121, *p* = .886; MUAC: *F* (2, 149) = 1.206, *p* = .302].

**Tab. 26: BMI (percentiles) plotted against sources of fresh fish supply**

| | N | *Mean* | *SD* |
|---|---|---|---|
| No fish got from any source | 51 | 53.07 | 27.97 |
| Fish got from community, village, others | 52 | 52.15 | 25.89 |
| Fish farmer | 49 | 54.66 | 23.46 |
| Total | 152 | 53.26 | 25.72 |

**Tab. 27: MUAC (percentiles) plotted against sources of fresh fish supply**

| | N | *Mean* | *SD* |
|---|---|---|---|
| No fish got from any source | 51 | 52.36 | 28.14 |
| Fish got from community, village, others | 52 | 46.00 | 28.72 |
| Fish farmer | 49 | 54.32 | 27.97 |
| Total | 152 | 50.81 | 28.33 |

“Height for age”

Homogeneity of variances cannot be assumed [*p* = .002]. Therefore a Welch test, which is robust against this kind of condition, was conducted in order to detect a potential significant difference of “height for age” percentiles between the three categories. The results of the Welch test [*F* (2, 94.359) = 3.760, *p* = .027] and a post-hoc test according to Tukey [*p* = .028] lead to the assumption that children who live on fish farms show significantly higher values for “height for age” percentiles than children whose households obtain fresh fish from other sources and children who live in families which do not get fish from any source.

**Tab. 28: “Height for age” (percentiles) plotted against sources of fresh fish supply**

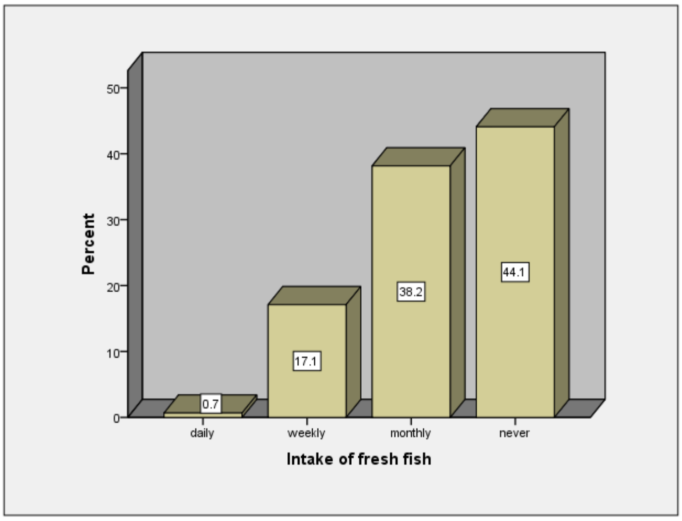
| | N | *Mean* | *SD* |
|---|---|---|---|
| No fish got from any source | 51 | 22.58 | 19.63 |
| Fish got from community, village, others | 51 | 21.88 | 25.72 |
| Fish farmer | 49 | 36.01 | 31.34 |
| Total | 151 | 26.70 | 26.56 |

### *4.2.2.2. Fresh fish consumption*

Actual consumption of fresh fish by observed children

The household members of 44.1 % of the children (N = 67) stated that their child never eats fresh fish. This share consists of 9 children of fish farmers, 24 children who live in households with fish farmers in their community and 34 children of families without any access to fish farming. 38.2 % of the households (N= 58) noted that their children consume fresh fish at least once per month (this percentage is distributed as follows: 24 children of the group of fish farmers, 21 children who live in communities with fish farmers and 13 children who do not have any access to fish farming). 17.1 % of the household members remarked that their children (N = 26) eat fresh fish at least once per week (18 fish farmer children, 5 children of fish farming communities and 3 children of families without access to fish farming). One household of the last category stated that the observed child (= 0.7 %) eats fresh fish daily. The bar chart (graph 11) below indicates the shares of subjects (in %) who consume fish daily, weekly, monthly and never.

**Graph 11: Frequencies of fresh fish consumption (in % of total)**



The conditions mentioned above were taken as the subject of a chi$^2$ test. The calculation of the test statistics shows a significant association between the consumption of fresh fish by observed children and their affiliation to a certain category [$\chi^2$ (4) = 30.904, $p$ < .001].

**Tab. 29: Consumption of fresh fish by children in relation to the three categories**

| | | | Consumption of fresh fish | | | |
|---|---|---|---|---|---|---|
| | | | weekly | monthly | never | Total |
| | Fish farmer | N | 18 | 24 | 9 | 51 |
| | | Expected value | 9.1 | 19.5 | 22.5 | 51.0 |
| | | % | 35.3% | 47.1% | 17.6% | 100.0% |
| | | Standardised residuals | 3.0 | 1.0 | -2.8 | |
| | Fish farmer in community | N | 5 | 21 | 24 | 50 |
| | | Expected value | 8.9 | 19.1 | 22.0 | 50.0 |
| | | % | 10.0% | 42.0% | 48.0% | 100.0% |
| | | Standardised residuals | -1.3 | .4 | .4 | |
| | No access to fish farming | N | 4 | 13 | 34 | 51 |
| | | Expected value | 9.1 | 19.5 | 22.5 | 51.0 |
| | | % | 7.8% | 25.5% | 66.7% | 100.0% |
| | | Standardised residuals | -1.7 | -1.5 | 2.4 | |
| Total | | N | 27 | 58 | 67 | 152 |
| | | % | 17.8% | 38.2% | 44.1% | 100.0% |

Indices for nutritional status plotted against the frequency of fresh fish consumption

“Weight for height”

The calculation of the test statistics of a one-way ANOVA does not show any significant result [$F$ (2,149) = 1.168, $p$ = .314]. Assumption of homogeneity of variances is feasible [$p$ = .844]. A difference in the “weight for height” percentiles of children who eat fresh fish at least once per week, those who consume fresh fish at least once a month and those who do not eat any fresh fish at all cannot be assumed.

**Tab. 30: "Weight for height" (percentiles) plotted against frequency of fresh fish consumption**

| | N | *Mean* | *SD* |
|---|---|---|---|
| weekly | 27 | 56.31 | 25.21 |
| monthly | 58 | 47.08 | 25.22 |
| never | 67 | 50.01 | 26.81 |
| Total | 152 | 50.01 | 25.96 |

"Weight for age"

A significant difference in "weight for age" percentiles was detected in children who eat fresh fish at least once per week and those who consume fresh fish only monthly or never. These findings result from a calculation of a one-way ANOVA [$F$ (2, 149) = 4.045, $p$ = .019] for which the homogeneity of variances can be assumed [$p$ = .367] and a post-hoc test according to Tukey [weekly compared to monthly: $p$ = .018; weekly compared to never: $p$ = .043].

**Tab. 31: "Weight for age" (percentiles) plotted against frequency of fresh fish consumption**

| | N | *Mean* | *SD* |
|---|---|---|---|
| weekly | 27 | 50.02 | 27.63 |
| monthly | 58 | 32.98 | 24.92 |
| never | 67 | 35.29 | 27.48 |
| Total | 152 | 37.03 | 27.08 |

"Height for age"

Since variances are not homogenous for this calculation [p < .001], a Welch test was implemented in order to detect a potential alteration in "height for age" percentiles of children, depending on how often they consume fresh fish. The robust statistical test indicates a significant result [$F$ (2, 63.732) = 3.389, $p$ = .040]. A post-hoc test according to Tukey reveals that children who eat fresh fish weekly show higher "height for age" percentiles than children who consume fresh fish monthly [$p$ = .006] and those who do not eat any fresh fish [$p$ = .007].

**Tab. 32: "Height for age" (percentiles) plotted against frequency of fresh fish consumption**

| | N | *Mean* | *SD* |
|---|---|---|---|
| weekly | 27 | 41.89 | 35.21 |
| monthly | 58 | 23.01 | 22.78 |
| never | 66 | 23.73 | 23.66 |
| Total | 151 | 26.70 | 26.6 |

BMI and MUAC

The test statistics of one-way ANOVAs which were conducted in order to evaluate any potential differences in BMI and MUAC percentiles between children who consume fresh fish weekly, monthly and never do not show any significant result [BMI: $F$ (2,149) = 0.743, $p$ = .477; MUAC: $F$ (2, 149) = 0.589, $p$ = .556]. Homogeneity can be assumed in both calculations [BMI: $p$ = .896; MUAC: $p$ = .703].

**Tab. 33: BMI (percentiles) plotted against frequency of fresh fish consumption**

| | N | *Mean* | *SD* |
|---|---|---|---|
| weekly | 27 | 57.97 | 25.89 |
| monthly | 58 | 50.70 | 25.19 |
| never | 67 | 53.58 | 26.19 |
| Total | 152 | 53.26 | 25.72 |

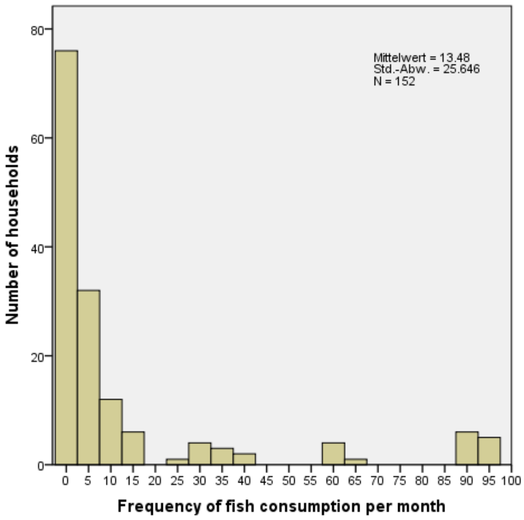
**Tab. 34: MUAC (percentiles) plotted against frequency of fresh fish consumption**

| | N | *Mean* | *SD* |
|---|---|---|---|
| weekly | 27 | 52.44 | 27.27 |
| monthly | 58 | 47.63 | 27.56 |
| never | 67 | 52.91 | 29.54 |
| Total | 152 | 50.81 | 28.33 |

### *4.2.2.3. Frequency of fish consumption*

20.4 % of the total of 152 subjects do habitually not consume any fish. 50 % normally eat fish less than three times per month and 8.6 % of interviewees stated that the observed child eats fish two to three times per day (= 60 and more times per month). The bar chart in graph 12 demonstrates the before mentioned conditions.

**Graph 12: Frequency of fish consumption per month**




<u>Indices for nutritional status plotted against frequency of fish consumption per month</u>

<u>“Weight for height”</u>

A nonparametric rank correlation according to Spearman was conducted. The test statistics does not show any significant result [$r_s$ = .125, $p$ = .063 one-tailed]. A link between “weight for height” percentiles and frequency of fish consumption per month cannot be assumed.

<u>“Weight for age”</u>

The calculation of the test statistics of a nonparametric rank correlation according to Spearman leads to a significant result [$r_s$ = .190, $p$ = .010 one-tailed]. The assumption that there is a significant correlation between the values for "weight for age" and the frequency of fish consumption per month is deemed to be feasible.

"Height for age"

A significant correlation was found between "height for age" and the frequency of fish consumption per month [$r_s$ = .148, $p$ = .035 one-tailed] as a result of a nonparametric rank correlation according to Spearman.

BMI

The test statistics of a nonparametric rank correlation according to Spearman does not show any significant value [$r_s$ = .124, $p$ = .064 one tailed] for the link between BMI percentiles and the frequency of fish consumption per month.

MUAC

A significant correlation can be assumed between the values for MUAC percentiles and the frequency of fish consumption per month. This assumption was made as a consequence of the calculation of the test statistics of a nonparametric rank correlation according to Spearman [$r_s$ = .152, $p$ = .031 one-tailed].

### *4.2.2.4. Health status*

Diarrhoea in relation to the three categories

The calculation of the test statistics of a chi$^2$ test does not indicate any significant result [$\chi^2$ (2) = 5.530, $p$ = .063] in this respect. No difference of distribution of the frequency of diarrhoea within the three categories can be assumed.

**Tab. 35: Frequency of diarrhoea within to the three categories**

| | | | never | sometimes or often | Total |
|---|---|---|---|---|---|
| | Fish farmer | N | 41 | 9 | 50 |
| | | Expected value | 35.4 | 14.6 | 50.0 |
| | | % | 82.0% | 18.0% | 100.0% |
| | | Standardised residuals | .9 | -1.5 | |
| | Fish farmer in community | N | 35 | 15 | 50 |
| | | Expected value | 35.4 | 14.6 | 50.0 |
| | | % | 70.0% | 30.0% | 100.0% |
| | | Standardised residuals | -.1 | .1 | |
| | No access to fish farming | N | 31 | 20 | 51 |
| | | Expected value | 36.1 | 14.9 | 51.0 |
| | | % | 60.8% | 39.2% | 100.0% |
| | | Standardised residuals | -.9 | 1.3 | |
| Total | | N | 107 | 44 | 151 |
| | | % | 70.9% | 29.1% | 100.0% |

## Cough in relation to the three categories

According to the result of a chi[2] test [$\chi^2$ (2) = 4.556, *p* = .103], no significant difference of the distribution of frequency of cough within the three categories was detected.

**Tab. 36: Frequency of cough within the three categories**

| | | | never | sometimes or often | Total |
|---|---|---|---|---|---|
| | Fish farmer | N | 28 | 22 | 50 |
| | | Expected value | 22.2 | 27.8 | 50.0 |
| | | % | 56.0% | 44.0% | 100.0% |
| | | Standardised residuals | 1.2 | -1.1 | |
| | fish farmer in community | N | 21 | 29 | 50 |
| | | Expected value | 22.2 | 27.8 | 50.0 |
| | | % | 42.0% | 58.0% | 100.0% |
| | | Standardised residuals | -.3 | .2 | |
| | No access to fish farming | N | 18 | 33 | 51 |
| | | Expected value | 22.6 | 28.4 | 51.0 |
| | | % | 35.3% | 64.7% | 100.0% |
| | | Standardised residuals | -1.0 | .9 | |
| Total | | N | 67 | 84 | 151 |
| | | % | 44.4% | 55.6% | 100.0% |

Fever in relation to the three categories

No significant result was derived from the calculation of the test statistics of a chi$^2$ test [$\chi^2$ (2) = 0.454, *p* = .797]. A difference of distribution of fever between the three categories can thus not be assumed.

**Tab. 37: Frequency of fever within the three categories**

| | | | never | sometimes or often | Total |
|---|---|---|---|---|---|
| | Fish farmer | N | 30 | 20 | 50 |
| | | Expected value | 31.1 | 18.9 | 50.0 |
| | | % | 60.0% | 40.0% | 100.0% |
| | | Standardised residuals | -.2 | .3 | |
| | Fish farmer in community | N | 33 | 17 | 50 |
| | | Expected value | 31.1 | 18.9 | 50.0 |
| | | % | 66.0% | 34.0% | 100.0% |
| | | Standardised residuals | .3 | -.4 | |
| | No access to fish farming | N | 31 | 20 | 51 |
| | | Expected value | 31.7 | 19.3 | 51.0 |
| | | % | 60.8% | 39.2% | 100.0% |
| | | Standardised residuals | -.1 | .2 | |
| Total | | Count | 94 | 57 | 151 |
| | | % | 62.3% | 37.7% | 100.0% |

### *4.2.2.5. Farm productivity*

Diversity of crops in relation to the three categories

The calculation of the test statistics of a one-way ANOVA shows a significant result [*F* (2,149) = 4.250, *p* = .016]. Homogeneity of variances can be assumed [*p* = .087]. According to this, it can be assumed that farms that integrate aquaculture yield higher numbers of different kinds of planted crops than farms with fish farming in their community and those who do not have any access to fish farming.

**Tab. 38: Diversity of crops within the three categories**

| | N | *Mean* | *SD* |
|---|---|---|---|
| Fish farmer | 51 | 7.78 | 2.63 |
| Fish farmer in community | 50 | 6.52 | 2.51 |
| No access to fish farming | 51 | 6.65 | 2.04 |
| Total | 152 | 6.99 | 2.46 |

Diversity of livestock in relation to the three categories

A one-way ANOVA was conducted in order to determine a potential change between the numbers of different types of livestock within the households of the three categories [$F$ (2, 149) = 6.811, $p$ = .001]. The calculation of the test statistics leads to the assumption that farmers who integrate aquaculture own a greater variety of livestock than those who live in communities with fish farmers and those who do not have any access to fish farming. Homogeneity of variances can be assumed [$p$ = .529].

**Tab. 39: Diversity of livestock within three categories**

| | N | *Mean* | *SD* |
|---|---|---|---|
| Fish farmer | 51 | 2.75 | 1.04 |
| Fish farmer in community | 50 | 1.96 | 1.26 |
| No access to fish farming | 51 | 2.04 | 1.23 |
| Total | 152 | 2.25 | 1.23 |

Diversity of livestock products in relation to the three categories

The test statistics of a one-way ANOVA indicates a significant difference in the number of different types of livestock products among the three categories [$F$ (1, 149) = 7.341, $p$ = .001]. Homogeneity of variances can be assumed [$p$ = .157]. Thus, fish farming households are able to produce a greater variety of livestock products than families who live in communities with fish farmers and those which do not have any access to fish farming.

**Tab. 40: Diversity of livestock products within the three categories**

| | N | *Mean* | *SD* |
|---|---|---|---|
| Fish farmer | 51 | 2.88 | 1.28 |
| Fish farmer in community | 50 | 1.94 | 1.57 |
| No access to fish farming | 51 | 1.88 | 1.57 |
| Total | 152 | 2.24 | 1.54 |

### *4.2.2.6. Farm economy*

Usage of harvested crops

**Tab. 41: Usage of harvested crops by category (%)**

| | Fish farmer | Fish farmer in community | No access to fish farming | *Mean* | *SD* |
|---|---|---|---|---|---|
| Consumed | 66.39 | 69.97 | 69.46 | 68.61 | 1.58 |
| Sold | 27.85 | 22.14 | 23.95 | 24.65 | 2.38 |
| Lost | 5.76 | 7.89 | 6.59 | 6.75 | 0.88 |
| Total | 100.00 | 100.00 | 100.00 | | |

About two thirds of the harvested crops are on average consumed by the household members themselves. Almost a quarter of their crops is sold. These findings apply to all of the three categories. The remaining harvest (6.75 %) is lost, wasted or others than consumed or sold (e. g. given to neighbours). No remarkable differences between the three categories were observed.

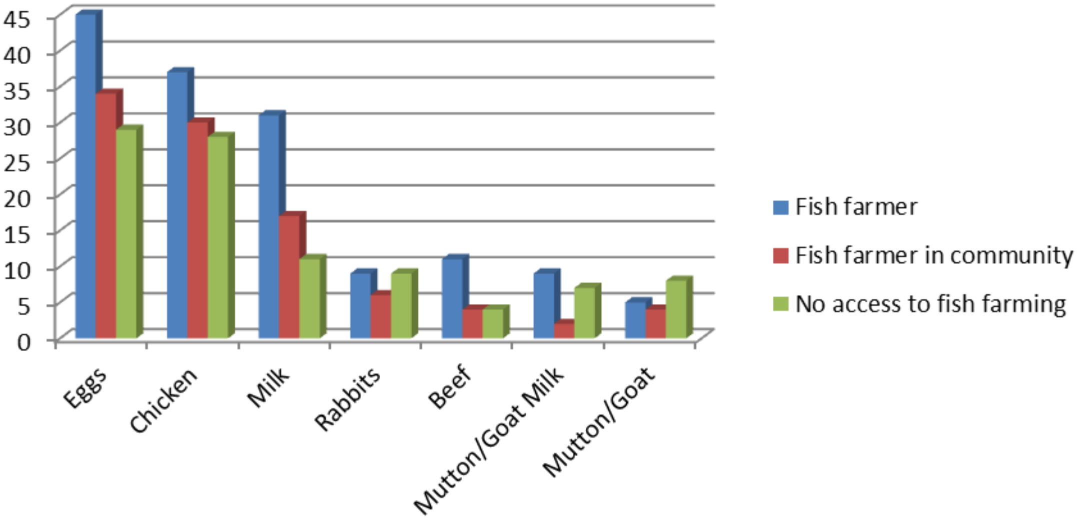
Production and usage of different livestock products

**Tab. 42: Usage of livestock products by category (%)**

| | Fish farmer | Fish farmer in community | No access to fish farming | *Mean* | *SD* |
|---|---|---|---|---|---|
| Consumed | 54.59 | 53.32 | 58.51 | 55.47 | 2.21 |
| Sold | 22.96 | 23.72 | 20.88 | 22.52 | 1.20 |
| Lost | 22.45 | 22.96 | 20.62 | 22.01 | 1.00 |
| Total | 100.00 | 100.00 | 100.00 | | |

55.47 % of livestock foodstuffs produced by the households of the three categories are on average consumed by the household members themselves, while 22.52 % are sold and 22.01 % are lost, wasted or others than consumed and sold (e. g. given away to neighbours). No significant differences between the three categories can be seen, except that households without any access to fish farming consume a slightly higher share of livestock products themselves as compared to the other two categories.

**Graph 13: Production of livestock foodstuffs by category (households)**

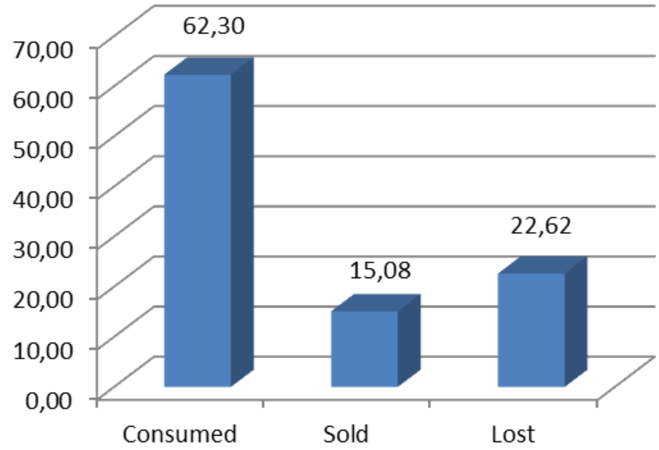



Graph 13 illustrates the frequencies of production of different livestock foodstuffs within the three categories. Accordingly, fish farmers produce eggs, chicken, cow milk, beef and mutton and/or goat milk more frequently as compared to the other two categories. Nevertheless, farmers without access to fish farming yield mutton and/or goat meat more frequently than fish farmers and households with fish farmers in their community. Rabbit meat is produced by the same number of farmers without access to fish farming as fish farmers. Households with fish farmers in their community come second in the frequency of producing the three most common livestock foodstuffs (eggs, chicken and cow milk).

Usage of harvested fish

Following bar chart (graph 14) shows the usage of fish harvested by fish farmers. According to the evaluation of current survey almost two thirds (62.30 %) of the fish is consumed by the fish farmer´s household members themselves. 15.08 % are sold and 22.62 % are lost, wasted or others than consumed and sold (e. g. given away to neighbours).

**Graph 14: Usage of harvested fish (%)**




48 of the fish farmers grow only one kind of fish, 13 grow two kinds and two fish farmers grow three different kinds of fish (three fish farmers did not make any statement about the number of their harvested fish).

### *4.2.2.7. Irrigation*

Irrigation within the three categories

A chi[2] test does not show any significant results [$\chi^2$ (2] = 4.180, *p* = .124], which allows for the assumption that there is no difference in distribution of the frequency of irrigation of field crops between the three categories.

**Tab. 43: Irrigation within the three categories**

| | | | Irrigation | | |
|---|---|---|---|---|---|
| | | | "yes" | "no" | Total |
| | Fish farmer | N | 42 | 9 | 51 |
| | | Expected value | 36.9 | 14.1 | 51.0 |
| | | % | 82.4% | 17.6% | 100.0% |
| | | Standardised residuals | .8 | -1.4 | |
| | Fish farmer in community | N | 35 | 15 | 50 |
| | | Expected value | 36.2 | 13.8 | 50.0 |
| | | % | 70.0% | 30.0% | 100.0% |
| | | Standardised residuals | -.2 | .3 | |
| | No access to fish farming | N | 33 | 18 | 51 |
| | | Expected value | 36.9 | 14.1 | 51.0 |
| | | % | 64.7% | 35.3% | 100.0% |
| | | Standardised residuals | -.6 | 1.0 | |
| Total | | N | 110 | 42 | 152 |
| | | % | 72.4% | 27.6% | 100.0% |

Duration of irrigation in relation to the three categories

A one-way ANOVA indicates that there is no significant difference in the duration of irrigation among the three categories [*F* (2,108) = 0.349, *p* = .706]. Homogeneity of variances can be assumed [*p* = .725].

**Tab. 44: Duration of irrigation (in months) within the three categories**

| | N | *Mean* | *SD* |
|---|---|---|---|
| Fish farmer | 42 | 2.69 | 0.95 |
| Fish farmer in community | 35 | 2.63 | 0.97 |
| No access to fish farming | 34 | 2.82 | 1.06 |
| Total | 111 | 2.71 | 0.99 |

#### *4.2.2.8. Quality of diet*

Diversity of consumed foodstuffs by children

In order to evaluate the quality of the subjects' diet and to determine the link between the diversity of consumed foodstuffs and its connection to a certain category a one-way ANOVA was conducted. The calculation of the test statistics shows a significant difference [*F* (2, 149) = 5.899, *p* = .003] in the number of habitually consumed foodstuffs of children who live on fish farms compared to children of the two non-fish farming categories.

**Tab. 45: Number of consumed foodstuffs**

| | N | *Mean* | *SD* |
|---|---|---|---|
| Fish farmer | 51 | 34.12 | 7.75 |
| Fish farmer in community | 50 | 30.78 | 6.19 |
| No access to fish farming | 51 | 29.76 | 5.99 |
| Total | 152 | 31.56 | 6.91 |

Children's consumption of animal protein

Since homogeneity of variances cannot be assumed [*p* = .002], a robust statistical test was applied in order to evaluate a potential difference in the frequency of consumption of foodstuffs containing animal protein within the three categories. The calculation of the test statistics of a Welch test leads to a significant result [*F* (2, 94.629) = 5.938, *p* = .004]. According to a post-hoc test (Tukey), a significant difference can be assumed in the frequency of consumption of foodstuffs containing animal protein between children who live on fish farms and those who do not have any access to fish farming [*p* = .002].

**Tab. 46: Frequency of consumption of foodstuffs containing animal protein***

| | N | *Mean* | *SD* |
|---|---|---|---|
| Fish farmer | 51 | 92.49 | 55.61 |
| Fish farmer in community | 50 | 72.50 | 40.77 |
| No access to fish farming | 51 | 61.86 | 31.35 |
| Total | 152 | 75.64 | 45.30 |

* Milk and dairy products, eggs, meat, fish

Children's consumption of animal protein (except fish)

Homogeneity of variances cannot be assumed [*p* = .017]. Consequently a robust statistical test was conducted. A Welch test, which was used in order to determine a potential difference in the frequency of the consumption of foodstuffs containing animal protein (except fish) among the three categories leads to a significant result [*F* = (2, 94.172) = 6.284, *p* = .003]. A post-hoc test according to Tukey indicates that children who live on fish farms consume foodstuffs containing animal protein (other than fish) significantly more frequently during the period of investigation than children who live on farms which do not have any access to fish farming [*p* = .006].

**Tab. 47: Frequency of consumption of foodstuffs containing animal protein (except fish)***

| | N | *Mean* | *SD* |
|---|---|---|---|
| Fish farmer | 51 | 70.96 | 38.14 |
| Fish farmer in community | 50 | 64.64 | 33.59 |
| No access to fish farming | 51 | 50.92 | 22.98 |
| Total | 152 | 62.16 | 33.07 |

* Milk and dairy products, eggs, meat

Diversity of purchased foodstuffs (households)

The calculation of a one-way ANOVA indicates that there is no significant difference in the number of foodstuffs which are purchased by the observed households among the three categories [*F* (2, 149) = 2.459, *p* = .089]. Variances can be assumed as homogenous [*p* = .173].

**Tab. 48: Number of purchased foodstuffs (households)**

| | N | *Mean* | *SD* |
|---|---|---|---|
| Fish farmer | 51 | 24.47 | 5.76 |
| Fish farmer in community | 50 | 26.82 | 7.26 |
| No access to fish farming | 51 | 24.29 | 6.03 |
| Total | 152 | 25.18 | 6.44 |

A one-way ANOVA was conducted in order to reveal a potential difference in the frequency of purchased animal source foodstuffs between the three categories.

Homogeneity of variances can be assumed for the three calculations concerning differences in meat purchase [*p* = .343], in dairy products/egg purchase [*p* = .485] and in fish purchase [*p* = .150]. A significant difference was solely revealed in terms of the frequency of dairy product and egg purchase. According to a post-hoc test according to Tukey, fish farmers bought these products significantly less frequently than households with fish farmers in their community [*p* = .001] and households without access to fish farming [*p* = .004].

**Tab. 49: Number of purchased animal source foods (households)**

| | | N | *Mean* | *SD* |
|---|---|---|---|---|
| Meat | fish farmer | 51 | 9.39 | 10.960 |
| | fish farmer in community | 50 | 7.68 | 7.011 |
| | no access to fish farming | 51 | 7.27 | 8.547 |
| | Total | 152 | 8.12 | 8.987 |
| Dairy products and eggs | fish farmer | 51 | 15.78 | 18.526 |
| | fish farmer in community | 50 | 30.30 | 20.103 |
| | no access to fish farming | 51 | 28.27 | 19.099 |
| | Total | 152 | 24.75 | 20.177 |
| Fish | fish farmer | 51 | 3.57 | 5.467 |
| | fish farmer in community | 50 | 2.84 | 3.460 |
| | no access to fish farming | 51 | 2.63 | 4.845 |
| | Total | 152 | 3.01 | 4.661 |

#### *4.2.2.9. Nutrition knowledge and opinion about fish farming*

Knowledge about the nutritional value of protein

The calculation of the test statistics of a one-way ANOVA reveals a significant result [$F$ (2,149) = 3.064, $p$ = .050]. A post-hoc test according to Tukey indicates that a difference in scores for the correct appraisal of statements about protein between households situated in communities with fish farmers and those who do not have any access to fish farming can be assumed. Variances are supposed to be homogenous [*p* = .139].

**Tab. 50: Scores reached for correct answers of 8 questions about protein**

| | N | *Mean* | *SD* |
|---|---|---|---|
| Fish farmer | 51 | 5.16 | 1.12 |
| Fish farmer in community | 50 | 5.62 | 1.19 |
| No access to fish farming | 51 | 5.00 | 1.56 |
| Total | 152 | 5.26 | 1.33 |

Five out of eight statements were judged correctly by the same proportion of informants in each category, while fish farmers and farmers which live in communities with fish farmers gave a correct answer to one of the statements[1] with a higher frequency than farmers without access to fish farming. Two declarations[2] were assessed correctly more often by members of families which live in communities with fish farmers. These findings result from calculations of test statistics of chi$^2$ tests. In order to fulfil the preconditions for this kind of statistical test, cases in which interviewees answered "I don't know" were excluded. The results are shown in tab. 51.

**Tab. 51: Chi$^2$ tests for evaluation of nutritional knowledge about protein within the three categories**

| Statements on questionnaire | Test statistic of $\chi^2$ (df) | *p* |
|---|---|---|
| "Protein is essential for human nutrition." | 3.581 (2) | .167 |
| **"Proteins of plant sources are of higher quality than proteins from animal sources."** [1] | **8.489 (2)** | **.014** |
| "Proteins are important for growth and development of children." | 2.121 (2) | .346 |
| "A lack of protein in the diet does not affect human health." | 0.628 (2) | .731 |
| "Parents should avoid that children consume too much of protein." | 0.864 (2) | .649 |
| **"Fruits normally contain a high amount of protein."** [2] | **7.383 (2)** | **.025** |
| "Pulses normally contain a high amount of protein." | 4.917 (2) | .086 |
| **"Animal source foods (meat, eggs, dairy products) normally contain a high amount of protein."** [2] | **7.740 (2)** | **.021** |

Knowledge about fish consumption and its value for the human diet

Homogeneity of variances can be assumed [*p* = .074]. By the means of a one-way ANOVA a tendency was detected [*F* (2, 149) = 2.735, .068]. A post-hoc test according to Tukey shows that interviewees of fish farms reached higher scores by trend than those who live on farms without any access to fish farming [*p* = .055].

**Tab. 52: Scores reached for correct answers of four questions about fish**

| | N | *Mean* | *SD* |
|---|---|---|---|
| Fish farmer | 51 | 3.51 | 0.73 |
| Fish farmer in community | 50 | 3.32 | 1.04 |
| No access to fish farming | 51 | 3.06 | 1.12 |
| Total | 152 | 3.30 | 0.99 |

Opinion about fish farming

- *Wish to integrate fish farming?*

81.63 % of households with fish farmers in their community and 94.12 % of members of households which do not have any access to fish farming expressed their wish to integrate fish farming into their own farms. While 8.13 % of the first and 3.92 % of the second group do not wish to integrate fish farming, the rest does not know if they wish to establish a fish farm (10.20 % of the first group, 1.96 % of the second group).

- *Fish farming too expensive?*

72 % of household members with fish farmers in their community find fish farming too expensive to integrate it into their own farms, 8 % think that it is not too expensive and 20 % do not know if it is too expensive for them or not. Within the group of farmers who do not have any access to fish farming, the shares were observed as follows: 74 % stated that fish farming is too expensive; it is not too expensive for 12 % of them and 14 % do not know whether it is too expensive.

- *Fish farming brings financial benefits?*

94.12 % of fish farmers stated that they have financial benefits through fish farming (5.88 %: “no financial benefits”). 88 % of household members with fish farmers in their community think that fish farming would bring financial benefits to their families, while 12 % of this group do not know if they would achieve these welfares. 82.35 % of household members whose families do not have any access to fish farming would expect financial benefits from fish farming, while 17.65 % are not sure about this possibility.

- *Fish farming brings health benefits?*

The following shares of interviewees think that fish farming brings health benefits to their households: 98.04 % of household members of fish farms, 96 % of members of farms with fish farmers in their community and 94.12 % of interviewees of households without any access to fish farming held this opinion. The rest of interviewed household members do not know whether fish farming brings or could bring health benefits to their families.

# 5. Discussion

This chapter deals with the discussion of the results gathered in chapter 4. Outcomes of the statistical analyses are commented on as well as compared with and related to the existing relevant literature. The tested hypotheses are assessed according to the results and reviewed separately. In addition to this, connections to practical advisements are established. Finally potential impacts of fish farming on food security at community level will be discussed.

## *5.1. Fish farming and socioeconomic aspects*

### *5.1.1. Income*

In the course of present research the assumption was made that the household income (measured as money at disposal per day per person) of fish farmers is higher than that of farmers with fish farmers in their community and households, who do not have any access to fish farming.

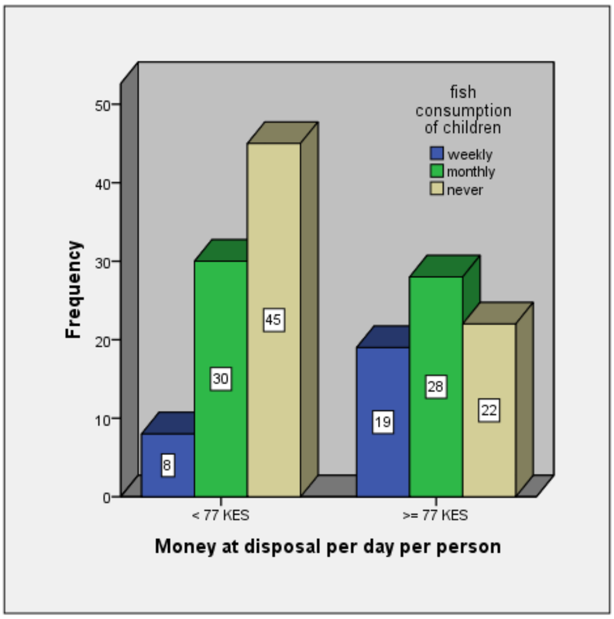
Analysis of the sample shows that education is a strong predictor for income. Furthermore, income is associated with the affiliation to a certain category because fish farmers may considerably more frequently have higher incomes than households belonging to the other two categories.

This outcome is supported by preliminary research. KAWARAZUKA [2010] reviewed literature regarding the contribution of fish intake, aquaculture and small-scale fisheries to the improvement of food and nutrition security. The author stated that nutritional status is improved by additional income derived from the sale of fish produced by aquaculture. According to several other studies, carried out in Malawi and Bangladesh, the integration of aquaculture in farming activities leads to an increased household income [AIGA et al., 2009; DEY et al., 2006; JAHAN et al., 2010; JAMU et al., 2002; NAGOLI et al., 2009; THOMPSON et al., 2002].

The benefits in household income of families operating aquaculture on their farms can lead to improved dietary intake such as increased consumption of staple foods as well as of animal source foods including fish [KAWARAZUKA, 2010]. KAWARAZUKA's research work [2010] reports that fish consumption in low income households is less frequent compared to that of high income households according to some reviewed studies from Asia.

Additionally, within the sample of current study, children of farmers with higher incomes do significantly more often consume fresh fish. The bar chart in graph 15 illustrates the sizes of the groups of different frequencies of fish consumption divided into a lower and a higher household income group.

**Graph 15: Money at disposal per day per person plotted against consumption of fresh fish**




Overall fish consumption, however, does not seem to depend on household income. This may be due to the utilisation of "omena", a fish meal which is added to children's diets in order to increase the nutritional value such as the amount of protein

[ONIANG'O, 1988]. This meal represents an important and cheap protein source which is accessible also to low-income families [KRAIN et al., 2012].

In the present sample, the values for nutritional status indices in the category of the higher income level lie consistently above the ones of the lower income group. The statistical analysis, though, does not indicate any significant differences in the percentiles of "weight for height", "weight for age", "height for age", BMI and MUAC for age between the two groups.

### *5.1.2. Education*

The affiliation to a certain category seems to be independent from the highest level of education within households. Likewise, the source of fresh fish supply, i.e. self-production, purchase from any other source or no fish supply, is, according to the statistical analyses, not associated with the households' highest education level.

The outcomes do, however, lead to the assumption that the actual consumption of fresh fish is higher among children who live in households with higher educated household members. The children's overall fish consumption, though, does not appear to be linked to the level of highest education within households.

## *5.2. Nutritional status indices*

### *5.2.1. Comparison of present data with the Kenya Demographic and Health Survey*

Rather large disparities were observed when comparing the prevalence rates of stunting ("height for age" < -2 *SD*), underweight ("weight for age" < -2 *SD*) and wasting ("weight for height" < -2 *SD*) in the sample of the present study and in the data collected in the course of the Kenya Demographic and Health Survey 2008/2009 [KNBS & ICF MACRO, 2010]. Tab. 53 shows the magnitude of the mentioned disparities.

**Tab. 53: Prevalence rates of stunting, underweight and wasting (in % of total) of current sample and according to the Kenya Demographic and Health Survey 2008/2009 (KDHS)**

| | *Current sample* | *Kenya* | *Central Province* |
|---|---|---|---|
| *Stunting* | 16.4 | 35.2* | 31.6* |
| *Underweight* | 8.6 | 16.4* | 12.1* |
| *Wasting* | 2.0 | 7.0* | 4.9* |

*[KNBS & ICF MACRO, 2010].

Several reasons are suspected to be responsible for the considerable differences of rates of undernutrition:

- sampling frames of both studies are of different sizes and unequal levels of representativeness,
- the data of present research were exclusively collected in the Central Province of Kenya were prevalence rates of undernutrition are disproportionately low compared to Kenya in total (which is shown in Tab. 53) [KNBS & ICF MACRO, 2010],
- as only one child per family was measured, it is likely that the best nourished child within the household was chosen by the respondent,
- as already documented before, the present study was conducted during a season of favourable food availability which might influence short term indicators of undernutrition such as “weight for height” and thus the prevalence of wasting and
- systematic errors might have occurred due to low quality of measuring resulting from inadequate measuring devices and difficult natural preconditions such as uneven floor of inappropriate texture.

Due to these reasons and the resulting disparities the informative value of the data in present research may be limited when relating them to data of other research.

Nonetheless, the research at hand investigates differences in indices for nutritional status between subpopulations of a total sample within which all subjects were measured under the same conditions. Therefore, despite of potential weaknesses, the comparability of data is still valuable and thus feasible to answer the research question of current thesis.

Above all, for the statistical analyses which are applied in order to assess the differences in nutritional status indices among three subpopulations of the sample, continuous data (percentiles) of the indicators of undernutrition were used instead of prevalence rates. This approach is stated to be ideally chosen when assessing the impact of agricultural activities on nutritional status in scientific studies [MASSET et al., 2011].

### *5.2.2. Fish farming and child nutritional status*

Nutritional status indices among the three categories

The following hypothesis, which represents the central issue of this thesis, was tested to investigate the association between nutritional status and the affiliation of children to a certain category:

*There is a significant difference ($p \le .05$) between the nutritional status of children (measured as mean values of percentiles for nutritional status indices such as "weight for height", "weight for age", "height for age", BMI for age and MUAC for age) who live in households or communities of fish farming families and those without any access to fish farming.*

The results of the hypothesis testing analyses reveal that the indices "weight for age" and "height for age" might depend on the affiliation of children to a certain category. Accordingly, it appears that children who live in fish farming families show more favourable outcomes concerning these two indices than children belonging the other two categories. Nevertheless, the other nutritional status indices such as "weight for height", BMI for age and MUAC for age did not differ significantly among the three groups.

“Height for age” represents an index for past nutritional history [TORUN, 2006] and low values are associated with long-term nutritional deprivation [REINHARD & WIJAYARATNE, 2002] whereas the index “weight for height” reflects the current nutritional status [TORUN, 2006] with low values indicating acute malnutrition [REINHARD & WIJAYARATNE, 2002].

Higher values in the “height for age” index in children of families operating an aquaculture may therefore be linked with a more reliable and/or constant food supply of increased quality and/or quantity. This circumstance may be encouraged by several benefits fish farming is supposed to offer besides enhanced availability of a high quality foodstuff. These benefits include improved household food security through increased household income, reduced seasonal vulnerability concerning food shortages, since the seasonal availability of fish is often different from that of crops, and the empowerment of women resulting in better child care [KAWARAZUKA, 2010].

“Weight for height” values, though, did not appear to differ between the three categories. The period of data collection coincided with the post-harvest season of Kenya’s main staple food, maize. Since food supply is usually sufficiently available during that time, a distinct difference in the indicator for acute malnutrition, which might persist during lean seasons, was not likely to be observed among the three categories, as “weight for height” is reported to represent a sensitive indicator for seasonal change [BROWN et al., 1982].

Literature linking aquaculture and child nutritional status remain rather scarce [KAWARAZUKA, 2010]. However, some little evidence regarding the subject matter exists. AIGA et al. [2009], for instance, conducted a cross sectional study comparing the nutritional status of children between 6 and 59 months of age living in fish farming and non-fish-farming households in Malawi. This study’s outcomes support the above mentioned results as they exposed a lower prevalence of stunting (“height for age” values below -2 *SD*) and underweight (“weight for age” values below -2 *SD*) among children of fish farming households than of non-fish-farming households. In contrast to the present research, a difference was found for the malnutrition indicator wasting ("weight for height" values below -2 *SD*) between fish farming and non-fish-farming households [AIGA et. al, 2009].

Another research was presented by JAMU et al. [2002] who reviewed two studies conducted in order to assess the contribution of aquaculture to nutritional status of young children (under 6 years) in Malawi. In one of the studies, no differences were found in underweight and wasting, but rates of stunting appeared to be lower in children of fish farming families than in those without fish ponds. The second study, however, revealed higher levels of underweight, wasting and stunting in children of non-fish farming households compared to those living on fish farms [JAMU et al., 2002].

MASSET et al. [2011] found very little evidence on an impact of agricultural interventions including aquaculture and small-scale fisheries on child nutritional status when reviewing research concerning the subject matter conducted since 1990. The authors, though, attribute the small effect to several methodological weaknesses of the reviewed studies rather than to the lack of effectiveness of the interventions.

KAWARAZUKA [2010], reviewing studies about the contribution of aquacultural activities on food and nutrition security, argues that a certain limitation exists concerning the role of aquaculture as a means of improving nutritional status. Accordingly, there are various important determinants of nutritional and health statuses such as breastfeeding practices and diseases. Aquaculture may hence only have a partly positive impact on nutritional and health statuses [KAWARAZUKA, 2010].

<u>Nutritional status indices among groups of different sources of fresh fish supply</u>

Children who live on fish farms appear to be advantaged in terms of the nutritional status indices "weight for age" as well as "height for age" compared to their age mates of the other two categories as discussed before. This research furthermore examines the relation between child nutritional status and the actual sources of fresh fish supply of households.

According to present results children of fish farming families (who consume at least 25 % of their harvested fish themselves) show as well higher values for “weight for age” and “height for age” than children whose families get fresh fish from their communities, villages and/or other sources or those whose families do not obtain fresh fish from any source.

The calculations for the other indices (“weight for height”, BMI and MUAC for age) do not lead to any significant results and are therefore not assumed to differ among the children of the three groups of families with different sources of fresh fish supply.

## *5.3. Fish farming and health aspects*

Since the nutritional status of children is supposed to be closely linked to their health status the frequency of specific health problems (such as diarrhoea, cough and fever) was examined within the subjects of the three categories under investigation.

The results of present research, however, do not indicate any significant difference in the distribution of children of the three categories within the group who suffered from diarrhoea, cough or fever during the three months before survey conduction and the group of children who did not have these health problems over the same period of time. The shares of children of fish farming families, though, appear to be higher in the group who never had diarrhoea and cough during the enquired time period than the shares of children of the other two categories. This circumstance should be taken as a hint for further investigations and a more detailed evaluation of the correlation between common health problems and aquaculture should be incorporated in future research.

Anyway, a study from western Kenya reveals that the introduction of Tilapia (*Oreochromis niloticus* L.), a commonly farmed fish in Kenya, led to a tremendous reduction of mosquito larvae. Growing this fish species might thus represent an ecologically sustainable tool of malaria control within the vicinity of the ponds [HOWARD et al., 2007; ROOS et al., 2006]. Control of snails that bear schistosomiasis parasites through aquaculture is reported to have another positive effect on health [ROOS et al., 2006].

Adverse health effects might result from environmental contaminants such as polychlorinated biphenyls (PCBs) and fish borne zoonotic parasites which are promoted by water pollution, population pressure and dams. Parasites particularly become health threads when raw or inadequately cooked fish is consumed [ROOS et al., 2006].

## *5.4. Fish farming and diet related factors*

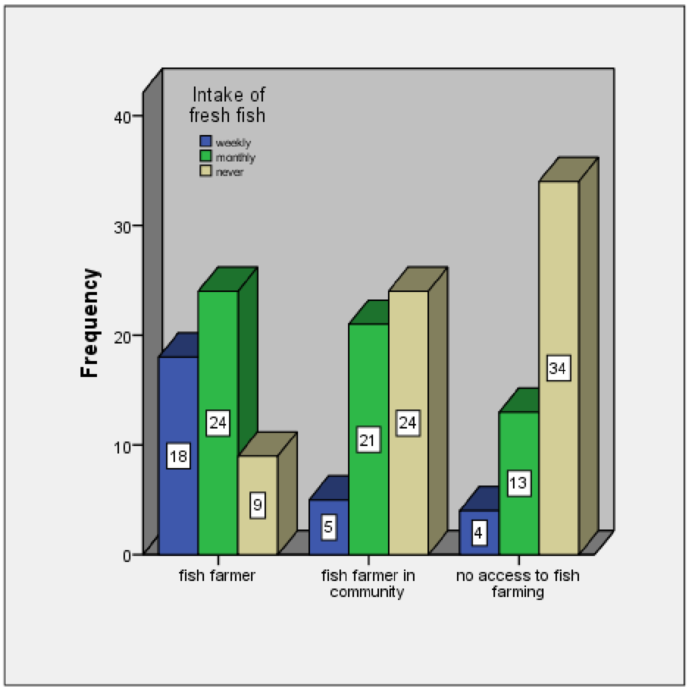
### *5.4.1. Fish consumption*

Frequency of fresh fish consumption among the three categories

A significantly different distribution of children of the three categories can be found in the groups who consume fresh fish weekly, monthly or not at all. The share of fish farmer’s children in the group of weekly fresh fish consumption is higher than the share of children of the other two categories. On the contrary children of farmers without any access to fish farming are found more frequently in the group of subjects who never consume fresh fish. The bar chart in graph 16 illustrates the conditions explained above.

Fresh fish additionally eaten by Kenyan children may raise the quality of their diet. After all, consumption of animal protein is currently known to be inadequate in Kenyan children [BWIBO & NEUMANN, 2003] and fish represents a more efficient source of protein than plant foods do. Furthermore, fish intake may contribute to optimise micronutrient status due to its favourable nutrient content [KAWARAZUKA, 2010].

**Graph 16: Frequency of fresh fish consumption according to the three categories**




Some previous research as well revealed an increased fish intake in fish producing households compared to non-fish farming households [DEY et al., 2006; JAHAN et al., 2010; NAGOLI et al., 2009; THOMPSON et al., 2002]. Moreover, a recently published systematic review concerning the effectiveness of agricultural interventions on the improvement of child nutritional status reports increased fish consumption after aquaculture and small-scale fishery interventions. Nevertheless, the authors state that due to substitution effects this might not necessarily improve the overall diet [MASSET et al, 2011].

Nutritional status indices and frequency of fresh fish consumption

Due to the favourable nutritional value of fresh fish advantages concerning nutritional status in children with more frequent fresh fish consumption is assumed within this study compared to those who eat fresh fish rarely and those who do not consume any fresh fish.

According to current results the values of the indices “weight for age” and “height for age” differ significantly between children who eat fresh fish weekly, those who consume fresh fish monthly and those who never eat fresh fish. Children with weekly fresh fish consumption are heavier and taller than their age mates who eat fresh fish only monthly. No fish consumption, though, leads to the most unfavourable values for weight and height for the respective age. These results suggest that constant consumption of fresh fish and the associated nutritional benefits such as high quality protein, better energy and micronutrient supply result in long-term benefits concerning children’s nutritional status. These advantages obviously become manifest in higher values for “height for age” and the associated values for “weight for age”. No significant differences were observed for the indices “weight for height”, BMI and MUAC for age between children with frequent, rare and no fresh fish intake.

Nutritional status indices plotted against frequency of overall fish consumption

Furthermore, the overall fish consumption (including dried, smoked and frozen fish) of children is investigated in the course of this study in order to clarify a potential link between nutritional status and frequency of fish consumption in general.

The results show that the frequency of overall fish consumption is associated with the values for “weight for age” and “height for age”. According to this, the more frequently a child consumes fish, the higher the values are for these two indices. This justifies the consideration that fish consumption may protect children from being “underweight” and “stunted”. Moreover, the values of MUAC for age are higher the more frequently a child eats fish. MUAC represents an indicator for muscle mass and protein supply [TROWBRIDGE et al., 1982]. Thus, the results indicate that a higher frequency of fish intake is associated with a more advantageous body composition of children. “Weight for height” and BMI for age indices do not show any significant correlation with the frequency of fish consumption within this research.

*5.4.2. Quality of children’s diets*

Within this research the diversity of habitually consumed foodstuffs and the frequency of the children´s consumption of foodstuffs containing animal protein was observed. Consequently it was examined whether potential advantages in the nutritional status of children living on fish farms may arise from a better quality of their diets.

In order to evaluate the impact of interventions which aim to improve nutritional status it is recommended to use diet diversity indicators to estimate diet composition. This strategy is suggested according to a recently implemented systematic review and is as well adopted in present research to assess diet quality of the observed children [MASSET et al., 2011].

The analyses of data reveal an advantage of children of fish farming households concerning quality of their diet compared to children of other farmers. According to this, fish farmer’s children consume a greater variety of foodstuffs. Diversity in this context serves as a predictor for food security [IFPRI, 2002]. One strategy to improve nutritional status might be realised by improving dietary intake through diversifying the diet [KAWARAZUKA, 2010]. Besides, strategies to increase dietary diversification are recommended in order to improve micronutrient intake [RUEL, 2001]. Moreover, ONYANGO et al. [1998] implemented a study in order to investigate the impact of dietary diversity on the anthropometric status of Kenyan toddlers. They found that the number of foods consumed is positively associated with the indices “weight for age”, “height for age”, “weight for height”, triceps skinfold and MUAC (mid upper arm circumference) of the observed children [ONYANGO et al., 1998]. The Department of

Child and Adolescent Health and Development of the WHO established indicators to assess infant and young child feeding practices. Minimum dietary diversity represents one of these indicators. Accordingly, children who receive foods from a higher number of food groups are considered to be supplied with diets of better quality compared to children with a less diversified diet [WHO, 2007b].

Furthermore, within the sample children from fish farms eat animal protein containing foodstuffs more frequently, such as milk, dairy products, eggs and meat. Likewise, an increased consumption of animal protein, (apart from fish) in fish farming households compared to non-aquaculture households was reported in Malawi by DEY et al. [2006]. Fish, farmer's children in general consume fresh fish more often than their age mates of the other two categories according to the data of current study.

To significantly and positively impact the growth of moderately undernourished children, a minimum of one third of their protein should be provided by animal sources, especially if the diet is low in protein content in general [MICHAELSEN et al., 2009].

The more diversified diet of fish farmer's children which contains more high quality foodstuffs such as animal source foods might not be attributed to the additional purchase of foodstuffs within households. The diversity of purchased foodstuffs is assumed to be equal among the three categories according to the results of current research. Moreover, dairy products and eggs are purchased even less frequently by fish farmers than by household members of the other two categories, although the consumption in fish farming households is higher. Thus, the higher quality of diets might rather be explained by the more diversified assortment of foodstuffs produced on the fish farmers' own farms.

## *5.5. Fish farming and other agricultural activities*

### *5.5.1. Farm productivity*

In the course of current study it is assumed that fish farms are more productive than non-aquaculture farms. Accordingly the diversity of planted crops, of different kind of livestock and of livestock products is examined in this thesis. The availability of farm products within households may be linked to children´s diet quality and hence to their nutritional status.

The conducted calculations lead to results which confirm this assumption. The diversity of planted crops, of livestock and of livestock products appeared to be significantly higher in fish farms than in the other two categories.

This result is supported by relevant literature. A socio-economic study conducted in Malawi discovered that fish farming encourages farmers to diversify the production of small ruminants and poultry. Additionally, the productivity of the farm was increased by a rise of the number of harvested crops. As a consequence, fish farmer's household food security was enhanced as they showed better supply rates concerning staple foods throughout the season than non-fish farming households [JAMU et al., 2002].

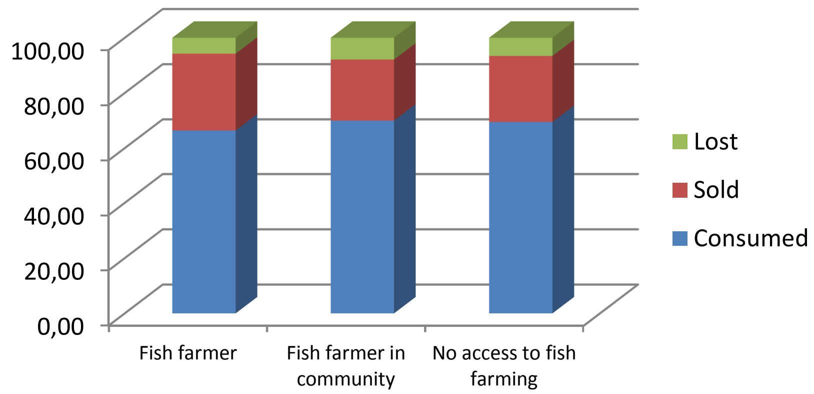
An analysis of the benefits that HIV and AIDS-affected households in Malawi experience from adapting aquaculture supports the outcomes of present study, as the investigators revealed increased farm productivity among households which adopt fish farming. As a consequence of the higher production of crops and fish, the authors mentioned improved food security on household level [NAGOLI et al., 2009].

All these findings make the assumption feasible that farmers who integrate aquaculture may be able to offer their children a greater variety of farm products and thus a more diversified diet which might bring nutritional benefits.

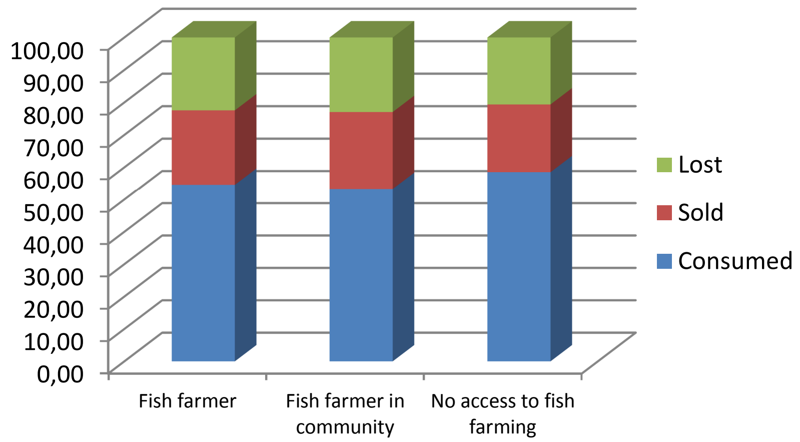
## *5.5.2. Farm economy*

Almost the same shares of farm products are consumed by household members themselves within the three categories: two thirds in the case of harvested crops and more than half of the livestock products. Nearly a quarter of all farm products are sold. The rest is lost, wasted or others than consumed or sold (e. g. given to neighbours). Graphs 17 and 18 show the usage of farm products related to the three categories.

**Graph 17: Usage of harvested crops by category (%)**




**Graph 18: Usage of livestock products by category (%)**



Furthermore, fish farmers produce five of seven enquired livestock foodstuffs more frequently than other farmers; these products are: eggs, chicken, milk, beef and mutton/goat milk. Solely mutton/goat meat is a more frequent product at farms without any access to fish farming. Rabbit meat is produced by the same number of households of the latter category as by fish farming households.

Considering that fish farmers plant a greater variety of crops and produce a larger diversity of livestock products, they are obviously able to offer a more diversified foodstuff assortment at the markets. This might bring economic advantages and thus financial benefits to the fish farming households.

In addition to the advantages in farm economy mentioned above, fish farmers can actually harvest fish from their ponds. Two thirds of these aquatic products are consumed by household members themselves, while almost a quarter is lost, wasted or other than consumed or sold, such as used as barter or gifts. At least about 15 % of the fish is sold, which might present a further source of income for fish farming families.

### *5.5.3. Irrigation*

The irrigation of field crops is supposed to be associated with advantages in farm productivity, which might bring benefits for child nutrition, as discussed herein. Within present study it is assumed that fish farmers might be able to irrigate their crops to a higher extent than non-aquaculture farmers due to the availability of water resources from fish ponds.

This assumption could not be confirmed by the statistical analyses of data which shows that the group of farmers who irrigate their field crops consists by a higher share of fish farmers than farmers of the other two categories. The applied statistical test, however, did not lead to any significant result, hence, no difference in the frequency of irrigation of crops can be assumed among the three categories. According to the analyses of data, it appeared that, on average, farmers of all three categories irrigate their crops for the same amount of months per year.

Literature reports that fish ponds on smallholder farms might play an important role in water management since they serve as water storage for the farms and are used for watering crops. Consequently, that may help to resist droughts [MILLER, 2009]. An investigation on the benefits of adapting aquaculture in HIV and AIDS-affected households in Malawi led to following findings: crop and vegetable production could be increased through additional water from fish ponds which seeped into the surrounding soil and kept plants thriving. Additionally, crop production was improved by using sediment dredged from the bottom of the ponds as an effective fertiliser [NAGOLI et al., 2009]. An earlier research from Malawi also highlighted the advantages of fish farming in terms of water management, as it increased the length of the crop-growing season with the help of pond water to combat droughts [JAMU et al., 2002].

It still seems, however, that fish farmers in Central Kenya do not yet really benefit from the integration of aquaculture into their farms in terms of water management or irrigation. This might be a topic for awareness training of farmers in order to raise farm productivity through the use of pond water resources which allows farmers to overcome periods of food shortages. Further research might help to clarify this opportunity with taking ecological and social sustainability into account.

## *5.6. Fish farming and nutritional knowledge*

Since the nutritional knowledge of a person who is involved in the upbringing of a child is suspected to impact child nutritional status this study includes analyses on the nutritional knowledge of household members of the three categories under investigation.

No difference in the number of correctly assessed statements about the value of protein in the diet was found between the group of fish farmers and the other two categories. Nevertheless, the statement about the quality of animal protein, which is superior to that of plant sources, was more often assessed correctly by household members of fish farms than by members of households without access to fish farming. Two other statements, in contrast, were more often appraised correctly by members of households with fish farmers in their community.

An inhomogeneity in categories concerning the correct assessment of single statements about the value of protein as well as a negligible difference of average scores for correct answers among the three categories was found. Likewise, the difference in scores for correct assessments of statements about fish as food between the three categories is hardly worth to be mentioned. Due to these results the informative value of the analyses concerning the knowledge about the value of protein as well as about the value of fish consumption for the human diet stays questionable.

In any case, these findings lead to the assumption that the decision to implement aquaculture on farms was obviously not influenced by the farmers' nutritional knowledge and the associated wish to enhance the quality of their diet through fish production. Awareness-raising about the connection between fish consumption and increased diet quality might support the effect of already existing fish farms on health matters. Moreover, it is recommendable to include education regarding this subject in future interventions which aim to implement aquaculture on small-scale farms.

## *5.7. Opinion about fish farming*

The vast majority of interviewees in households which do not integrate aquaculture in their agricultural activities expressed their wish to implement fish farming in future. However, about two thirds of the respondents state that it was too expensive for them to establish a fish pond at their farms.

85 % of non-fish farming households on average assume increased income through fish farming. Whereas, nearly all enquired household members living at a fish farm declare that their families actually benefited financially from aquaculture.

Almost all interviewees, irrespective of the category they belong, associate fish farming with health benefits.

## *5.8. The impact of aquaculture on food security at community level*

More than half of the households which are situated in communities with fish farmers within the sample of present study are allocated to the lower income level group. This is considerably more than the share of fish farmers, but also clearly less than the share of farmers which do not have any access to fish farming. The mean values of nutritional status indices of children living in fish farmer's communities also lie consistently between the means of the other two categories. While "weight for height", BMI and MUAC for age indices appear to be more similar to the ones of children of fish farmers, "weight for age" and "height for age" indices are more comparable with the ones of children who live in households without access to fish farming. No significant results were found for these interrelations, however.

Concerning the quality of the diet of children from households who live in fish farmers' communities, the following statements can be derived from current investigation: children's consumption of fresh fish and of foodstuffs containing animal protein (apart from fish) is higher than in the category of households without access to fish farming, however not as high as of children living on fish farms. The diversity of consumed foodstuffs is significantly lower than that of fish farmer's children and appears to be only slightly higher than that of children who live in households which are far from fish farming.

Diversity of planted crops and livestock products of farms which are located near fish farms are more comparable to the one of farmers without access to fish farming than to that of fish farmers. This finding reflects once again the potentially underutilised resources resulting from aquaculture such as pond water for irrigation or sediments for fertilisation, which could also bring benefits to farm productivity of the fish farmer's neighbours.

In terms of children's health status and nutritional knowledge, no relevant results regarding food security on community level were discovered by this survey.

Evaluations of the effects of aquaculture on food security and nutritional status of children are generally rare [MASSET et al., 2011]. Hence, evidence about the impact on fish farmer's communities hardly exists. However, a screening of the existent literature only provides the information that a remarkable share of fish produced on small-scale farms in Malawi [PREIN & AHMED, 2000] and Bangladesh [JAHAN et al., 2010] is usually sold or donated to neighbours.

Further research is necessary in order to clarify the effects of fish farming on communities. Projects and policies which aim to support the establishment of fish ponds in rural areas should incorporate considerations at community level. Aquaculture may even bear the potential to enhance the living standards and thus food security of farmers situated in the vicinity of ponds through supply of water, fertilizer and high quality food.

## 6. Conclusions

Present research deals with the question in which ways aquaculture and in particular small-scale fish farming in rural areas in Central Kenya contributes to the reduction of undernutrition in Kenyan children under the age of five. Conclusions which can be drawn from field work, from subsequent analyses of the gathered data on nutritional status and on farming activities as well as from relevant reviewed literature will be examined in this chapter.

It has to be mentioned that investigations on child nutritional status as well as on agricultural activities and their impact on socio-economic and health outcomes proved to be challenging due to their complex character. Despite of this, the thesis at hand succeeded in revealing some interesting interrelations. When interpreting the outcomes, however, certain limitations due to the sampling method have to be kept in mind. Representativeness for the entire population of Kenya can consequently not be deduced from this thesis´ results. Nevertheless, current findings might include meaningful advice for both future research and practical application in form of all kinds of projects which aim at supporting small-scale fish farming in Kenya. Reasonable implementation of such projects might contribute to raise the living standard of fish farming households as well as to escape from poverty and thus ensure better nutrition and health for Kenyan children. These positive effects might lead to a raise of popularity of aquaculture and thus to an increase in the number of fish farming households. Additionally, even households in fish farmers' communities might indirectly benefit from wealth and food production gained from small-scale fish farming.

One fundamental outcome of present research is that children living in fish farming households show more favourable values for the nutritional status index "height for age" and the dependent index "weight for age". These indices reflect long-term nutritional history with inadequate values indicating long periods of poor nutrition and/or chronic diseases. The nutritional status represents an absolutely complex concept depending on numerous determinant factors. Hence, these advantages in child growth cannot entirely and causally be attributed to the existence of aquaculture at farms. However, several additional findings concerning enhanced socio-economic and nutrition-related preconditions on fish farms are supposed to impact the nutritional status of children in such settings in a positive manner.

In this respect, aquaculture on small-scale farms is found to boost household income and diversify livelihoods. Moreover, it increases farm productivity through diversifying crop harvests and the output of animal products. These advantages, with which fish farming households are endowed, obviously give them the opportunity to offer their children a higher quality of diet compared to non-fish farming households. Accordingly, fish farmer's children enjoy a significantly more diversified diet and consume foodstuffs containing animal protein (even meat, eggs and milk in addition to fish) significantly more often.

With these improvements of diets, aquaculture holds a realistic potential to play a crucial role in the eradication of two major problems of child nutrition in Kenya: the lack of animal protein in children's diet on the one hand, which might be tackled by an increased consumption of animal source foods and the widespread public health problem of micronutrient deficiencies on the other hand, which might find a remedy by diversification of diets and enrichment through high quality foodstuffs such as fish and other animal source foods.

The more diversified assortment of foods of higher quality which is present in fish farming households is obviously formed by their own on-farm production, as the analyses of the diversity of purchased foodstuffs did not show any differences between fish farming and non-fish farming families. Even though fish farmers buy animal source foods less frequently than other farmers, their children consume these foods more often. Increased farm productivity, hence, seems to play a vital role in the association between aquaculture and the reduction of undernutrition in Kenyan children. Fish farmers should therefore be encouraged to invest in diversifying and increasing their farm output. Informing them on their enhanced opportunities has to be recommended for incorporation into policies and projects which aim at supporting small-scale fish farming.

Besides an improved nutrition, increased farm productivity enables better market chances and thus leads to economic advantages. The latter are extended by an enhanced ability to barter for goods. Sharing products as gifts may further raise the social capacity of fish farmers, which might facilitate the achievement of a favourable position in the community and thereby benefit their children.

Child health is another aspect which is hypothesised in present study to show connections to aquacultural activities. This specific assumption could, however, currently not be verified, as no significant advantages were detected concerning the occurrence of major public health problems in fish farmer's children. Present study, though, was not designed to evaluate this association in detail. Anyway, marginal differences in the frequencies of diarrhoea and cough between fish farmers' and non-fish farmers' children justify the request for future research. Further studies should be planned in order to reveal a potential impact of fish farming on child health status, since an impact seems to be obvious due to a better nutrition of fish farmers' children.

Aquaculture holds a certain potential of enhancing on-farm water management which, however, seems to be yet unexploited in Kenya. This assumption is based on the findings suggesting that fish farmers do not irrigate their field crops to a higher extent than non-fish farmers. Aquaculture projects should include this issue so as to make fish farmers aware of the obviously underutilised water resources derived from ponds. They may profit from extended periods of water availability and the remaining moisture in dried ponds during dry seasons as well as from the use of pond sediments as crop fertiliser. Further research is indicated to clarify the interrelations between aquaculture and irrigation potential.

Current study did not consider seasonal variations in food availability and child nutritional status. Yet, natural fluctuations due to climate and the according harvest periods lead to cyclic episodes of inadequate food availability and access in Kenya. Fish farming could provide resources which may help to overcome such periods more easily. Resources in this regard may include water from fish ponds, an increased and more diversified farm outcome and even financial and health related factors. Future investigations should include aspects of seasonal food security and its consequences. Longitudinal studies covering at least one agrarian annual growth cycle are required for taking seasonal deviations in food security and its potential effects on child nutritional status into account.

Additional factors related to aquaculture, which are supposed to enhance child nutritional status, are present in relevant literature, but have not been evaluated in present study. There are reports on how fish farming leads to an empowerment of women, as they are often integrated in the processing and marketing of fish. Women´s status is known to be closely linked to child care and thus child nutritional status. This consideration is very well in accordance with recent times and is essential to be regarded in aquaculture projects and research in order to support the empowerment of Kenyan women and thus nutrition and health of their children. Even unborn children could indirectly profit from aquaculture in terms of better food availability as fish consumption during pregnancy may have advantageous effects on pregnancy outcome due to the beneficial nutrient content of this high quality foodstuff.

Nutrient contents of farmed fish represent another topic which may be linked to child nutrition, but could not be covered by present investigation. The potential association should therefore be subject of further research. Establishing polyculture systems of traditionally farmed large fish with nutrient-dense small fish species could potentially favour the nutritional status of Kenyan children as it has been shown in other countries. The eradication of micronutrient deficiencies might be pushed forward with the help of this approach.

Another important point to mention is that Kenya's aquaculture sector generally faces some basic constraints which need to be tackled in order to facilitate the introduction of fish farming on small-scale farms as well as to enhance the sector's contribution to economic growth. The Kenyan government's *Fishery Strategic Plan* represents one first step towards tackling these constraints which include inadequate infrastructure as well as investment and policy decisions. As a consequence, the next step has to be the effective implementation of policies defined in the strategic plan.

Awareness training and education on aquaculture issues, based on well-founded results of research and practical experiences, would further increase the quality and self-determination of all stakeholders within the sector. Raising the awareness of different involved groups of people such as policy makers, project leaders but also fish farmers themselves, is essential concerning child nutritional status and its various determinant factors.

The most important step towards initiating a positive effect on child nutritional status through small-scale fish farming has to be done by meaningful implementation of well-elaborated projects. These projects have to be previously evaluated and assessed as socially, economically and environmentally sustainable. By taking action in consideration of the previously mentioned advice, a reduction of undernutrition in children in the Central Province of Kenya by means of aquaculture is deemed to be a realistic and achievable goal.

## 7. Summary

According to previous research conducted in various parts of the world, fish farming at small-scale farms has shown a certain potential to enhance food security. Several attempts have been initiated in Kenya to support the aquacultural sector with the target of boosting the economy as well as tackling the problem of food insecurity in the country. Present study, implemented in rural areas of the Central Province of Kenya, seeks to examine various ways through which aquacultural activities on small-scale farms impact child nutritional status. Current findings should represent indications for further research as well as suggestions for projects which aim at fighting undernutrition in children through agricultural activities. Certain limitations concerning representativeness have to be kept in mind when adopting this study´s results.

Within the framework of present cross-sectional study, anthropometric data of 152 children under the age of five were collected in order to assess their nutritional status. Additionally, information on farming activities as well as on socio-economic, diet- and health related facts of the children's households were enquired by the means of a questionnaire. By comparing anthropometric data with a widely recognised standard population and by applying suitable statistical calculations, the following evidence was drawn from the survey.

Children living in fish farming households are found to be privileged concerning diet quality. Such children show more adequate values for long-term indicators of nutritional status. Accordingly, height and body weight are more appropriate for their age compared to those of children of non-fish farming families as low levels in these indicators are associated with chronic undernutrition. Households who adopt aquaculture on their farms achieve better outcomes concerning farm productivity and household income. These favourable conditions on fish farms are assumed to be partly responsible for the benefits in nutritional status of their children.

No significant differences were revealed between fish farming and non-fish farming households in terms of the extent of crop irrigation and health status of their children,

even though links were hypothesised at first. Further research is suggested in order to focus on these connections in detail, as resources gained from fish farming are still assumed to be beneficial concerning these issues. Future investigations are also required to clarify the potential role of aquaculture in fighting micronutrient deficiencies, in overcoming seasonal food insecurity and in empowering women. Present pilot study could not examine these aspects. However, to a certain extent, all these factors also support positive outcomes in child nutritional status.

It will be vital to implement awareness training and education of all stakeholders in the aquacultural sector concerning nutrition-related issues. Well-founded results of research and practical experiences have to represent the basis for well-elaborated projects which aim to enhance child nutritional status. Solely the incorporation of specific strategies regarding the enhancement of food security in aquaculture policies and projects will distinctly increase the contribution of fish farming to a reduction of the prevalence of undernutrition in Kenyan children.

## 8. Zusammenfassung

Gemäß vorangegangener Forschung, die in verschiedenen Teilen der Welt durchgeführt wurde, zeigt die Fischzucht auf Kleinfarmen ein gewisses Potential, die Ernährungssicherheit zu verbessern. Auch in Kenia wurden Bestrebungen initiiert, die den Aquakultursektor fördern, um damit die Wirtschaft anzukurbeln und das Problem der Ernährungsunsicherheit, die im Land herrscht, in Angriff zu nehmen. Die vorliegende Studie, die in ländlichen Gebieten der „Central Province" in Kenia durchgeführt wurde, hat zum Ziel, diverse Wege zu erforschen, durch die Aquakulturaktivitäten auf Kleinfarmen den Ernährungsstatus von Kindern beeinflussen können. Die Ergebnisse sollen sowohl Anhaltspunkte für zukünftige Forschung als auch Empfehlungen für Projekte darstellen, die darauf abzielen, die Unterernährung bei Kindern durch landwirtschaftliche Maßnahmen zu bekämpfen. Gewisse Einschränkungen bezüglich Repräsentativität müssen bei der Anwendung der Resultate dieser Studie jedoch berücksichtigt werden.

Im Rahmen dieser Querschnittstudie wurden anthropometrische Daten von 152 Kindern unter fünf Jahren erhoben, um damit ihren Ernährungsstatus zu ermitteln. Des Weiteren wurden sowohl Informationen über landwirtschaftliche Aktivitäten als auch über sozioökonomische, ernährungs- und gesundheitsbezogene Fakten in den Haushalten der Kinder mittels eines Fragebogen erhoben. Durch den Vergleich der anthropometrischen Daten mit einer allgemein anerkannten Standardpopulation und nach Durchführung geeigneter statistischer Verfahren konnten folgende Erkenntnisse aus der Studie abgeleitet werden.

Es wurde beobachtet, dass Kinder, die auf Farmen mit Fischzucht leben, bezüglich der Nahrungsqualität begünstigt sind. Diese Kinder weisen adäquatere Werte für Langzeitindikatoren ihres Ernährungsstatus auf; ihre Körpergröße und ihr Körpergewicht entsprechen in höherem Ausmaß ihrem Alter, verglichen mit Kindern aus Haushalten ohne Fischzucht. Niedrige Werte dieser Indikatoren werden mit chronischer Unterernährung in Verbindung gebracht. Zudem erzielen Farmen, die Fischzucht betreiben, bessere Resultate hinsichtlich Produktivität und Haushaltseinkommen. Es wird vermutet, dass diese günstigen Bedingungen auf Fischfarmen den vorteiligen Ernährungsstatus ihrer Kinder zum Teil mitbewirken.

In Bezug auf das Bewässerungsausmaß und den Gesundheitszustand der Kinder haben sich keine Unterschiede zwischen Haushalten mit und solchen ohne Fischzucht gezeigt, obwohl Zusammenhänge im Vorfeld angenommen wurden. Weitere Studien, die sich auf diese Themen konzentrieren, sind hier nötig, da dennoch angenommen wird, dass Ressourcen, die aus der Fischzucht hervorgehen, einen Nutzen für die eben genannten Punkte bringen. Zukünftig wären außerdem Untersuchungen erforderlich, um eine mögliche Rolle der Aquakultur im Hinblick auf den Kampf gegen Mikronährstoffmangel sowie auf die Überwindung saisonaler Ernährungsunsicherheit und auf das Empowerment von Frauen zu analysieren. Die vorliegende Pilotstudie konnte diese Aspekte nicht untersuchen. All diese Faktoren haben jedoch zu einem gewissen Teil auch eine positive Wirkung auf den Ernährungsstatus von Kindern.

Darüber hinaus wird es entscheidend sein, Aufklärungsarbeit und Bildung für alle Beteiligten im Aquakultursektor bezüglich ernährungsbezogener Themen zu implementieren. Fundierte Ergebnisse von wissenschaftlichen Untersuchungen und praktische Erfahrungen müssen die Grundlage für sorgfältig ausgearbeitete Projekte darstellen, die die Verbesserung des Ernährungsstatus von Kindern zum Ziel haben. Nur durch die Eingliederung spezifischer Strategien betreffend einer Steigerung der Ernährungssicherheit in Aquakulturpolitik und -projekten wird es gelingen, den Beitrag, den Fischzucht zur Reduktion der Prävalenz von Unterernährung von Kindern in Kenia beitragen kann merklich zu steigern.

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# 10. Appendices

## *10.1. Questionnaire*

### *Influence of agricultural activity on child nutritional status*

*This survey is being conducted in the name of Kornelia Hammerl (MSc; Department of Nutritional Sciences, University of Vienna, Austria) in cooperation with the Great Lakes University of Kisumu (GLUK) in course of the write-up of her dissertation to finish her Doctoral Program of Nutritional Sciences.*

***CONVEY THE FOLLOWING INFORMATION TO THE RESPONDENT:***

*In order to identify a correlation between child nutritional status and certain agricultural activities in the children´s households and communities this survey seeks to interview members of about 150 households in the Central Province of Kenya and Mount Kenya Region. The responses provided by the households may help to evaluate positive consequences of efforts to support certain agricultural activities. This evaluation may help to increase such supports which may lead to improvements in children´s nutritional status and thus to welfare of Kenyan communities.*

*I therefore, would like to ask you some questions as a responsible member of this household. I will also need your assistance in asking some questions to other members of your household if necessary; weighing and measuring the height and weight of any children under age 5 years who live in your household. These questions will take some time to complete and therefore I would appreciate your patience. I want to assure you that under no circumstance will the information be used for any purpose other than meeting the objectives of the survey. All the information given is strictly confidential.*

*Before I start, do you have any questions or is there anything which I have said on which you would like any further clarification? Otherwise, may I proceed with interviewing you?*

---

Date:

Place:

ID:

---

1) Household Data:

1.1) Interviewed family member (relation to children < 5 years in the household):

Father O Mother O Sister/Brother O

Others O => Who? __________________

Household size: __________

Probe Questions for establishing a comprehensive list of individuals of the household (household size):
Number of all the members of your immediate family who normally live and eat their meals together here:
Number of any other persons related to you who normally live and eat their meals together here:
Are there any other persons who normally live and eat their meals here? Number:

1.2) Children: How many? __________ Under 5 years: __________

Birth dates (< 5 years; month/year): A)__________B)__________C)__________

D)__________E)__________F)__________

1

1.3) Household Income: How much money does your household have at disposal per day/person (all the people who are listed above – household size)?

⇨ Total amount divided by household size = per capita amount

| | | | | | |
|---|---|---|---|---|---|
| < 77 KES (≈ 1 USD) | O | 77 – 310 KES (≈ 4 USD ≈ average daily income) | O | > 310 KES | O |

1.4) What kind of occupation do family members have who contribute to the household´s livelihood?

| Who? | Occupation |
|---|---|
| a)________________________ | ________________________ |
| b)________________________ | ________________________ |
| c)________________________ | ________________________ |
| d)________________________ | ________________________ |
| e)________________________ | ________________________ |
| f)________________________ | ________________________ |

1.5) How many years of school did family members finish who contribute to the household´s livelihood and what is their highest completed education?

| Years | Highest completed education |
|---|---|
| a) ________ | ________________________ |
| b) ________ | ________________________ |
| c) ________ | ________________________ |
| d) ________ | ________________________ |
| e) ________ | ________________________ |
| f) ________ | ________________________ |

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2a) Agricultural activities: PLANTED CROPS

2a.1) What kind of crops were grown on your household´s farm during the past 12 months?

a)_____________________ b)_____________________ c)_____________________

d)_____________________ e)_____________________ f)_____________________

g)_____________________ h)_____________________ i)_____________________ j)____________________ k)____________________ l)____________________

2a.2) Was there irrigation practiced on your farm during the past 12 months?

Yes O => How many months? ___________

No O

2a.3) Which amount of the crops planted on your own farm was consumed, sold, lost/wasted/others (e.g. given away) during the last 12 months within the household (in %)?

| | Consumed | | | | | Sold | | | | | Lost/wasted/others | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 25 | 50 | 75 | 100 | 0 | 25 | 50 | 75 | 100 | 0 | 25 | 50 | 75 | 100 |
| a) | | | | | | | | | | | | | | | |
| b) | | | | | | | | | | | | | | | |
| c) | | | | | | | | | | | | | | | |
| d) | | | | | | | | | | | | | | | |
| e) | | | | | | | | | | | | | | | |
| f) | | | | | | | | | | | | | | | |
| g) | | | | | | | | | | | | | | | |
| h) | | | | | | | | | | | | | | | |
| i): | | | | | | | | | | | | | | | |
| j) | | | | | | | | | | | | | | | |
| k) | | | | | | | | | | | | | | | |
| l) | | | | | | | | | | | | | | | |

(Note: each line has to equal 100 %!)

<u>2b) Agricultural activities:</u> LIVESTOCK

2b.1) Have any of your household members raised or owned livestock, poultry, etc. during the past 12 months?

Yes O

No O

2b.2) Please give me the types and the amount of all animals that any of your household members raised during the last 12 months:

Quantity

O Cattle ________

O Pig ________

O Mutton/goat ________

O Poultry ________

O Others => ________________ ________

________________ ________

________________ ________

3

2b.3) What kind and what quantity of livestock products did you obtain during the last month?

Quantity

O Beef ____________
O Milk ____________
O Pork ____________
O Mutton/goat meat ____________
O Mutton/goat milk ____________
O Chicken ____________
O Eggs ____________
O Others => _________________ ____________

2b.4) How much of these livestock products produced on your household´s farm were consumed, sold, lost/wasted/others (e.g. given away) during the last month in %?

| | Consumed | | | | | Sold | | | | | Lost/wasted/others | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 25 | 50 | 75 | 100 | 0 | 25 | 50 | 75 | 100 | 0 | 25 | 50 | 75 | 100 |
| Beef | | | | | | | | | | | | | | | |
| Milk | | | | | | | | | | | | | | | |
| Pork | | | | | | | | | | | | | | | |
| Mutton/goat meat | | | | | | | | | | | | | | | |
| Mutton/goat milk | | | | | | | | | | | | | | | |
| Chicken | | | | | | | | | | | | | | | |
| Eggs | | | | | | | | | | | | | | | |
| Others: | | | | | | | | | | | | | | | |

(Note: each line has to equal 100 %)

2c) Agricultural activities: FISH FARMING

2c.1) Has any of your household members grown fish in ponds on your household´s farm during the last 12 months?

Yes O
No O

2c.2) Which type of fish and how much was produced on your own farm during the last 12 months?

Type Quantity
a)_________________ ___________
b)_________________ ___________
c)_________________ ___________
d)_________________ ___________

4

2c.3) How much of the fish grown on your farm was consumed, sold, lost/wasted/others (e.g. given away) during the last 12 months (in %)?

| | Consumed | | | | | Sold | | | | | Lost/wasted/others | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 25 | 50 | 75 | 100 | 0 | 25 | 50 | 75 | 100 | 0 | 25 | 50 | 75 | 100 |
| a) | | | | | | | | | | | | | | | |
| b) | | | | | | | | | | | | | | | |
| c) | | | | | | | | | | | | | | | |
| d) | | | | | | | | | | | | | | | |

(Note: each line has to equal 100 %)

2c.4) Have any of the households in your community grown fish in ponds during the last 12 months?

Yes O
No O

2c.5) Did you buy/get/obtain fish from this source (community) during the last 12 months?

Yes O
No O

2c.6) Did you have access to fish grown in ponds in your village or sold in a nearby market during the last 12 months?

Yes O
No O

2c.7) Did you buy/get/obtain fish from this source (village/market) during the last 12 months?

Yes O
No O

2c.8) Did you have access to fish from other sources during the last 12 months (supermarket, markets in other communities/parts of the country, brought from family members, friends, neighbors, …)?

Yes O What kind of sources? _______________________________________
No O

---

3) Purchase of food stuffs and Food Frequency Questionnaire

3a) How often do your household members normally purchase following food stuffs for usage in your own household?

(Note: Ask for numbers! Start with asking "how often daily", if less than daily then proceed with asking "how often weekly", etc.!)

| Food Stuff | daily | weekly | monthly | never |
|---|---|---|---|---|
| ***Cereals*** | | | | |
| Rice | | | | |
| Maize | | | | |
| Wheat | | | | |
| Millet | | | | |
| Sorghum | | | | |
| Bread | | | | |
| Others: | | | | |
| ***Roots and Tubers*** | | | | |
| Potatoes | | | | |
| Sweet potatoes | | | | |
| Arrow roots | | | | |
| Cassava | | | | |
| Yams | | | | |
| Plantains | | | | |
| Others: | | | | |
| ***Pulses*** | | | | |
| Beans | | | | |
| Grams (all kinds) | | | | |
| Peas | | | | |
| Groundnuts | | | | |
| Cowpeas | | | | |
| Others: | | | | |
| ***Vegetables*** | | | | |
| Onion/Leeks | | | | |
| Cabbage/Lettuce | | | | |
| Carrots | | | | |
| Tomatoes | | | | |
| Spinach | | | | |
| Sukuma wiki | | | | |
| Courgette | | | | |
| Cucumber | | | | |
| French beans | | | | |
| celery | | | | |
| Cauliflower | | | | |
| Egg plant | | | | |
| Pumpkins | | | | |
| Okra | | | | |
| Others: | | | | |
| ***Meat*** | | | | |
| Beef | | | | |
| Pork | | | | |
| Mutton/Goat meat | | | | |
| Chicken | | | | |
| Others: | | | | |

| | | | | |
|---|---|---|---|---|
| ***Fish*** | | | | |
| Fresh Fish | | | | |
| Frozen Fish | | | | |
| Dried/Smoked Fish | | | | |
| Others: | | | | |
| ***Dairy products and eggs*** | | | | |
| Milk (all kinds) | | | | |
| Yoghurt | | | | |
| Cheese | | | | |
| Eggs | | | | |
| Others: | | | | |
| ***Oils and Fats*** | | | | |
| Butter | | | | |
| Margarine | | | | |
| Cooking fat | | | | |
| Cooking oil | | | | |
| Peanut butter | | | | |
| Others: | | | | |
| ***Fruits*** | | | | |
| Banana | | | | |
| Oranges | | | | |
| Pawpaw | | | | |
| Avocado | | | | |
| Mangoes | | | | |
| Pineapples | | | | |
| Passion fruit | | | | |
| Pears | | | | |
| Peaches | | | | |
| Apples | | | | |
| Lemons | | | | |
| Grape fruits | | | | |
| Melons | | | | |
| Sugar cane | | | | |
| Others: | | | | |

3b) How often does subject A) (section 1.2) normally consume following food stuffs?

(Note: Ask for numbers! Start with asking "how often daily", if less than daily then proceed with asking "how often monthly", etc.!)

| Food Stuff | daily | weekly | monthly | never |
|---|---|---|---|---|
| ***Cereals*** | | | | |
| Rice | | | | |
| Maize | | | | |
| Wheat | | | | |
| Millet | | | | |
| Sorghum | | | | |
| Bread | | | | |
| Others: | | | | |

| | | | | |
|---|---|---|---|---|
| ***Roots and Tubers*** | | | | |
| Potatoes | | | | |
| Sweet potatoes | | | | |
| Arrow roots | | | | |
| Cassava | | | | |
| Yams | | | | |
| Plantains | | | | |
| Others: | | | | |
| ***Pulses*** | | | | |
| Beans | | | | |
| Grams (all kinds) | | | | |
| Peas | | | | |
| Groundnuts | | | | |
| Cowpeas | | | | |
| Others: | | | | |
| ***Vegetables*** | | | | |
| Onion/Leeks | | | | |
| Cabbage/Lettuce | | | | |
| Carrots | | | | |
| Tomatoes | | | | |
| Spinach | | | | |
| Sukuma wiki | | | | |
| Courgette | | | | |
| Cucumber | | | | |
| French beans | | | | |
| celery | | | | |
| Cauliflower | | | | |
| Egg plant | | | | |
| Pumpkins | | | | |
| Okra | | | | |
| Others: | | | | |
| ***Meat*** | | | | |
| Beef | | | | |
| Pork | | | | |
| Mutton/Goat meat | | | | |
| Chicken | | | | |
| Others: | | | | |
| ***Fish*** | | | | |
| Fresh Fish | | | | |
| Frozen Fish | | | | |
| Dried/Smoked Fish | | | | |
| Others: | | | | |
| ***Dairy products and eggs*** | | | | |
| Milk (all kinds) | | | | |
| Yoghurt | | | | |
| Cheese | | | | |
| Eggs | | | | |
| Others: | | | | |
| ***Oils and Fats*** | | | | |
| Butter | | | | |

| | | | | |
|---|---|---|---|---|
| Margarine | | | | |
| Cooking fat | | | | |
| Cooking oil | | | | |
| Peanut butter | | | | |
| Others: | | | | |
| ***Fruits*** | | | | |
| Banana | | | | |
| Oranges | | | | |
| Pawpaw | | | | |
| Avocado | | | | |
| Mangoes | | | | |
| Pineapples | | | | |
| Passion fruit | | | | |
| Pears | | | | |
| Peaches | | | | |
| Apples | | | | |
| Lemons | | | | |
| Grape fruits | | | | |
| Melons | | | | |
| Sugar cane | | | | |
| Others: | | | | |

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## 4a) Nutritional Knowledge: VALUE OF PROTEIN

(Note: Do not suggest "don´t know" as an answer, cross only if no answer is/can be given!)

| | totally agree | totally disagree | don´t know |
|---|---|---|---|
| Protein is essential for human nutrition. | | | |
| Proteins from plant sources are of higher quality than proteins from animal sources. | | | |
| Proteins are important for growth and development of children. | | | |
| A lack of proteins in the diet does not affect human health. | | | |
| Parents should avoid that children consume too much of protein. | | | |
| Fruits normally contain a high amount of proteins. | | | |
| Pulses normally contain a high amount of proteins. | | | |
| Animal source foods (meat, eggs, dairy products) normally contain a high amount of proteins. | | | |

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## 4b) Nutritional Knowledge: FISH AS FOOD/OPINION ABOUT FISH FARMING

(Note: Do not suggest "don´t know" as an answer, cross only if no answer is/can be given!)

| | totally agree | totally disagree | don´t know |
|---|---|---|---|
| Fish contain a high amount of proteins. | | | |
| Fish ranks as healthy food stuff. | | | |
| Fish consumption endangers health. | | | |
| Children should avoid eating fish, as it is not good for their health. | | | |
| If I/we had the opportunity I/we would integrate fish farming on my/our farm.* | | | |
| Fish farming would bring/brings financial benefits to my/our household. | | | |
| Fish farming would bring/brings benefits concerning health and nutrition to my household. | | | |
| Fish farming would be/is too expensive to integrate in my/our farm. | | | |

* If fish farming has already been integrated in the respective farm cross "totally agree"

5) Child health and anthropometry

5a) Anthropometry of subject A) (section 1.2):

Weight: ___________kg Height: ___________m

Head circumference: ____________cm

BMI: __________kg/m$^2$

Wasting: % weight for height = observed weight/reference weight for patient´s height** x 100

Stunting: % height for age = observed height/reference height for patient´s age** x 100

(** references according to The WHO Child Growth Standards http://www.who.int/childgrowth/standards/en/)

Subject A) (section 1.2) is assigned to following category:

Normal O

Wasted but not stunted O

Wasted and stunted O

Stunted but not wasted O

5b) Child health of subject A) (section 1.2):

5b.1) How often during the past 3 months subject A (section 1.2) suffered from following health problems?

| | never | once – two times * | constantly |
|---|---|---|---|
| diarrhea | | | |
| cough | | | |
| fever | | | |

* When was the last: Diarrhea: _____________

Cough: _____________

Fever: _____________

5b.2) Does subject A (section 1.2) suffer from HIV/AIDS?

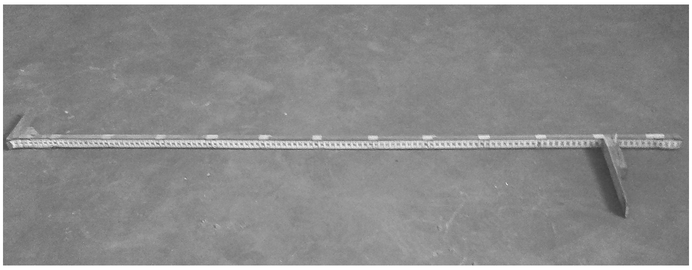
Yes O No O No specification O

5b.3) Loss of developmental milestones of subject A:

Yes O No O

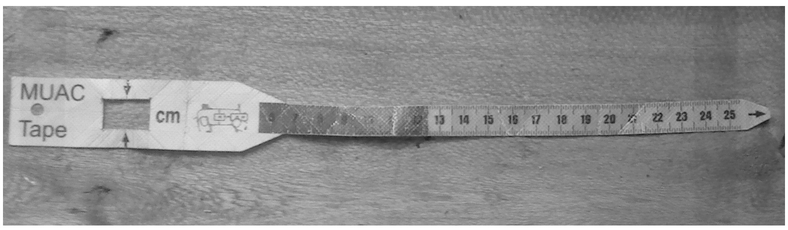
## *10.2. Anthropometric measurement devices*

Stadiometer



Weighing scale


MUAC tape



## 11. Curriculum vitae

# K o r n e l i a   H a m m e r l

### Persönliche Daten

| | |
|---|---|
| Akademischer Titel: | Mag. rer. nat. |
| Geboren am: | 16. 12. 1979 |
| Geburtsort: | Wien |
| Staatsbürgerschaft: | Österreich |
| Wohnsitz: | Wienerstrasse 67b<br>3032 Eichgraben<br>Niederösterreich |
| Telefon: | +43 676 709 3660 |
| E-Mail: | konnihammerl@hotmail.com |

### Universität Wien:

2009 – 2013: Doktoratsstudium der Naturwissenschaften/Ernährungswissenschaften

*Dissertation*: *„The potential of fish farming to contribute to the reduction of undernutrition in children (< 5 years); a pilot study at household level in the Central Province of Kenya"*

Feldforschung in Kenia (10/10 – 03/11):

- Ernährungsepidemiologische Querschnittstudie über den Zusammenhang zwischen Unterernährung bei Kindern und Aquakultur in Zentralkenia
- Finanziert durch das Marietta Blau Stipendium (des BMWF, vergeben durch den ÖAD)

*Studienleistungen:* Nutritional Epidemiology, Trials and Meta-Analysis in Nutritional Epidemiology, Ermittlung des Ernährungsstatus in ernährungsepidemiologischen Studien, Übungen zur Ermittlung des Ernährungsstatus, Specifics of English as academic language: writing proficiency, Interdisziplinäre Forschung, Globales Lernen

1999 – 2007: Diplomstudium der Ernährungswissenschaften

*Wahlschwerpunkt*: „Ernährung und Umwelt“
Human- und Ernährungsökologie, Umweltschutz und -recht, Umweltbelastung und –analytik, Hygiene, neuartige Lebensmittel, alternative Ernährungsformen, Welternährungssituation, Ernährung in Entwicklungsländern

*Diplomarbeit*: *„Availability and feeding value of selected potential feedstuffs for a sustainable fish production system in Kenya“*

Forschungsaufenthalt in Kenia (03/07 – 06/07):
- ⇨ Analyse der Hauptnährstoffe von einheimischen Pflanzenteilen um die Eignung als Verwendung für Fischfutter einzuschätzen
- ⇨ Finanziert durch das Top-Stipendium Niederösterreich und das Stipendium für kurzfristige wissenschaftliche Arbeiten im Ausland (KWA) des DLE Forschungsservice und Internationale Beziehungen der Universität Wien

*Wahlfächer:* Soziologie der Ernährung, Ernährungsökonomie in Entwicklungsländern, Ernährungsepidemiologie, Ernährungswirtschaft, Sporternährung/Leistungsphysiologie, Wissenschaftstheorie und Theoriendynamik, Verbraucher-beratung

*Zusätzliche Prüfungen:* Methoden und Konzepte der Ernährungsaufklärung, Writing and Speaking Scientific English

## Universitäts-Praktika:

07/08 – 08/08: Durchführung von Ernährungsworkshops und des Sportprogramms im Feriencamp „Durch dick und dünn“ für übergewichtige und adipöse Kinder
- ⇨ Kinderfreunde Steiermark

05/08 – 07/08: Projektassistenz Projekt „Gesundes Essen von Anfang an“: Ist-Analyse der österreichischen Ernährungsempfehlungen für Kinder, Recherche und Beurteilung von guten Praxisbeispielen der Gesundheitsförderung, Miterstellung eines Grobentwurfs für Handlungsempfehlungen und eines Detailentwurfs für Handlungsfelder
- ⇨ AGES (Agentur für Gesundheits- und Ernährungssicherheit Österreich)

03/07 – 06/07: Analyse der Hauptnährstoffe von Pflanzenteilen im Forschungslabor der „Aquaculture Research Station“, Sagana, Kenia, im Rahmen eines Projektes zur Optimierung der Wirtschaftlichkeit von Aquakultur auf Kleinfarmen unter Berücksichtigung sozio-ökonomischer Faktoren und des ökologischen Gleichgewichtes in Kenia, Uganda und Äthiopien
- ⇨ In Zusammenarbeit mit der BOKU (Universität für Bodenkultur)

| | |
|---|---|
| 06/06 – 09/06: | Betreuung von Flüchtlingen: Beratung und Unterstützung in Ernährungsfragen, Durchführung von Ernährungsworkshops, Gemeinsames Kochen und Einkaufen von Lebensmitteln mit den Bewohnern, Gesundheitsmanagement, Durchführung von sportlichen Aktivitäten, Begleitung zu Behörden und Ämtern, Durchführung von Deutschkursen<br>⇨ Verein Projekt Integrationshaus |

## Publikationen:

Munguti, J., Liti, D., Asaminew, K., Mwanja, W., Mwanja, M., Waidbacher, H., Drexler, S.-S., Straif, M., Heimberger, B., **Hammerl, K.**, Nalwanga, R., Zollitsch, W.. (2009): *Nutrient content of selected potential feed ingredients for inclusion in fish feeds in Eastern Africa region.* In: Drexler, S.-S., Waidbacher, H. (Eds.), Book of abstracts. BOMOSA; INCO-CT-2006- 032103. Integrating BOMOSA cage fish farming system in reservoirs, ponds and temporary water bodies in Eastern Africa. Final Conference., S. 53-54

Zollitsch, W., Liti, D., **Hammerl, K.**, Heimberger, B., Gabler, R., Munguti, J., Waidbacher, H.. (2009): *Nutritional value of selected potential feedstuffs for sustainable aquaculture of Nile Tilapia Oreochromis niloticus L.* In: Drexler, S.-S., Waidbacher, H. (Eds.), Book of abstracts. BOMOSA; INCO-CT-2006- 032103. Integrating BOMOSA cage fish farming system in reservoirs, ponds and temporary water bodies in Eastern Africa. Final Conference., S. 51-52

## Sprachenkenntnisse:

| | |
|---|---|
| Deutsch: | Muttersprache |
| Englisch: | Universitäts-Lehrveranstaltungen: The specifics of English as academic language“, „Writing and Speaking Scientific English“<br>Verfassen von wissenschaftlichen Arbeiten (Diplomarbeit, Dissertation)<br>verhandlungsfähig |
| Spanisch: | 2 Semester Oberstufen-Wahlfach<br>1 Semester Latein-Amerika-Institut<br>1 Semester privater Unterricht |
| Französisch: | Maturaniveau |