Fish Farming in Greater Kibugu: A Livelihood Activity Inscribed in an Informal Value Chain

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Abstract

Embu County, Kenya, is not traditionally known for fish farming. However, this practice is gaining attention, especially with the large investments of the Government of Kenya/IFAD/FAO Aquaculture Business Development Programme (ABDP), totalling 144,5 million USD, between 2019 and 2026. As such, this research aims to investigate how fish farming is a livelihood activity, for both government and non-government supported farmers, taking the case of greater Kibugu, Embu County. This paper uses an interdisciplinary mixed-methods approach, consisting primarily of semi-structured interviews, pond water analysis and market surveys. The research finds that fish farming is a meaningful livelihood activity, for both government and non-government supported farmers. It is also found that farmers do not act as strict profit-maximising individuals and that the decision to start fish farming is not purely economic. Moreover, it's found that despite the governmental presence, the fish value chain is largely informal. Disjointed knowledge, limited access to good quality inputs and the absence of necessary infrastructure, create market friction. The findings are relevant for policymakers and can help inform the Kenyan Government as it plans future aquaculture projects, or other relevant agencies engaging with fish farming in similar contexts.

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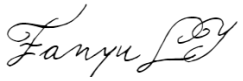
Signatures

Mikkel Schou Jensen



Fanyu Li

Camilla Cianfanelli

Noa E. Millman

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To close, we dedicate this work to all devoted Kenyan actors in the fish farming industry. Your silent contributions nourish both bodies and souls and drive society forward.

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Abbreviations and acronyms

ABDP	Aquaculture Business Development Programme
CGI	Common Interest Group
EO	Extension officer
ESP	Economic Stimulus Program
GoK	Government of Kenya

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IFAD	International Fund for Agricultural Development
FAO	Food and Agriculture Organization of the United Nations
FFEPP	Fish Farming Enterprise Productivity Program
KES	Kenyan shillings
MT	Metric tons
USD	US dollar

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1. Introduction

In Kibugu, Embu County, fish farming is not considered a traditional livelihood activity (Munguti et al., 2023). First promoted in the 1920s, fish farming was introduced as a sport by the colonial government (ibid.). In the 1950s, fish started to be seen as a food resource that could be cultivated through fish farming (Hishamunda & Ridler, 2006).

Currently, in Kibugu, most people’s livelihoods are inherently linked to agriculture, an activity that employs 70% of Kenya's rural population (Embu County Government, 2019). However, agricultural systems are particularly susceptible to the effects of climate change. Soil erosion, which can decrease soil fertility, and land degradation are expected to worsen (Embu County Government, 2019). Rising temperatures and more uncertain precipitation are also predicted in Embu County (Climate Knowledge Portal, 2024). Therefore, finding climate change adaptation strategies in Embu County, and more broadly in Kenya, has been included in development planning.

Introducing a new activity, such as fish farming, aims at diversifying livelihoods and mitigating the impacts of climate change. Fish farming is pegged by the Government of Kenya and international development agencies as a potential activity: it can reduce food insecurity, increase food diversity, and generate income (Hishamunda & Ridler, 2006). Fish farming is a sector that is developing, in fact, production in Kenya has almost doubled during

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the past decade (Cheserek et al., 2022). ‘Aquaculture’, the controlled cultivation of aquatic organisms, which will be henceforth used interchangeably with ‘fish farming’, which refers exclusively to the cultivation of fish.

As such, fish farming is part of the development programmes of several Sub-Saharan African countries, including Kenya (Hishamunda & Ridler, 2006). The most prominent Kenyan fish farming program is the Aquaculture Business Development Programme (ABDP), a partnership between the Government of Kenya (GoK), the International Fund for Agricultural Development (IFAD) and, to a lesser extent, the Food and Agriculture Organization of the United Nations (FAO). The ABDP is an active program, currently promoting fish farming in 17 counties, including Embu. The program is being implemented for an eight-year period, from 2018 to 2026, and envisages a total investment of USD 144.5 million (IFAD, 2023). Its main objective is "to increase the incomes, food security and nutritional status of the wider communities of poor rural households involved in aquaculture in the target counties” (ABDP, 2024). However, despite large investments in fish farming, there has been no research on this activity and its current status in Kibugu. The following report is the product of 12 days of field research into fish farming in Kibugu, to estimate the trends, challenges and possible socio-economic impacts of fish farming.

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1.1 Knowledge gap and research objectives

In Kenya, fish farming has been going on for an extended period and the government and international donors have launched large development projects to promote fish farming. Despite this, a limited amount of research can be found on fish farming in Embu County and specifically in Kibugu.

Even though literature suggests that fish farming can have positive impacts on the livelihood of involved households, there is limited information on this. Furthermore, little information details how existing governmental programs work in the area or how farmers are selected or involved in these programs.

From this, the following research objective has emerged:

How is fish farming a livelihood activity, for both government and non-government supported farmers?

This leads to the following research questions, which will form the basis of further analysis.

1) **How are fish farmers selected for government programs and characterised?**
2) **How does the fish value chain in greater Kibugu exist and operate?**

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3) **How does fish farming impact the wealth and livelihoods of involved fish farmers?**

This research can fill an important knowledge gap and offer insights into fish farming and its value chain, which are invaluable for the GoK and other policymakers who are making large investments. For communities involved, it is also essential that the impact of these policies are measured and analysed, to ensure that they are beneficial or, at the minimum, doing no harm. More broadly, knowledge learnt here can also span to other countries in Sub-Saharan Africa and beyond, who could learn from the experiences of the ABDP. With fish farming as a potential livelihood diversification activity, understanding it from a bottom-up perspective, rather than a top-down policy perspective, is key, should it be applied to other contexts.

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2. Background

Fish farming is a form of aquaculture where fish are raised in an enclosed environment to be consumed, sold or processed. In recent decades, fish farming has steadily increased. From 1961 to 2017, the average annual growth rate of global fish consumption was 3.1 per cent, higher than that of other animal protein foods (2.1%) (FAO, 2020). It is considered that fish could be a potential substitute for livestock as a source of animal protein and over the past two decades, aquaculture has achieved an important role in the global food system (Verdegem et al., 2023).

2.1 Promotion of fish farming in Kenya

Aquaculture, which includes fish farming, is seen as a system to improve nutrition, create wealth, diversify risks of agricultural failure, and create jobs in rural areas (Adeleke et al., 2020). FAO states that "as an economic source of highly nutritious animal protein, aquaculture has become an important factor in improving food security, raising nutritional standards and alleviating poverty, particularly in the world's poorest countries". In addition, creating economic growth enables investment in research, development, infrastructure and capacity-building initiatives (ibid.). For many decades, in Sub-Saharan Africa, small-scale aquaculture was promoted by investors and governments to increase food and nutrition security (Tran et al., 2019).

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Fish farming is also pegged as a livelihood diversification strategy, enabling rural people to not solely depend on agriculture. Livelihood refers to the utilisation of one's capabilities or assets in the activities to earn a living (Scoones, 1998). Livelihood diversification is "the process by which rural families construct a diverse portfolio of activities and social support capabilities in their struggle for survival and in order to improve their standards of living" (Ellis, 1998).

In Kenya there are environmental conditions for the development of fish farming, made possible by the presence of water on the land. Kenya is characterised by the presence of rivers, swamps, and wetlands, and is home to the largest freshwater lake in Africa (Lake Victoria). That makes it possible to invest in fish farming as an alternative livelihood.

The Government of Kenya has fish farming in their long term plan. In Kenya's Vision 2030 development plan, the fisheries and aquaculture subsector is recognised as a means to increase food security, reduce poverty and create employment (Schubert et al., 2021). The commitment to the development of fish farming is described as follows in the 2030 vision plan "This will be achieved through expanding the area of fish farming from the current high potential areas to Arid and Semi Arid Lands (ASALs) and developing fisheries related infrastructure and strengthening of monitoring, control and surveillance systems" (Government of Kenya, 2024).

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In Embu particularly, Vision 2030 includes the promotion of fish farming, meat safety, quality assurance and the establishment of cooling facilities. The strategies mentioned to achieve these goals are: “Develop the county's seed collection unit, develop the hatchery and trout farm, train farmers, create a fish storage and cooling facility, improve information and market linkages” (Embu County Government, 2019).

Through direct provision of food fish and indirect creation of employment and income, fish farming can contribute to both food security and poverty alleviation. Nevertheless, these contributions are relatively limited, in terms of total income, for small-scale rural fish farming.

However, fish farming is not always accessible to all. Fish farming has the potential to exacerbate social disparities, as one's starting position significantly influences their outcomes. High barriers to entry mean those with sufficient financial resources have greater opportunities for accumulation, while those unable to enter remain marginalised. A Marxist perspective highlights that social inequality plays a crucial role in determining the feasibility of upward mobility pathways (Ellingsen & Knorringa, 2022). Farmer-workers, small-scale fish traders, and farmers investing in poor-quality equipment cannot progress.

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2.2 Major government aquaculture initiatives: The Economic Stimulus Program (2009-2012) and the Aquaculture Business Development Plan (ABDP) (2019-2026)

Before 2008, the Kenyan aquaculture sector amounted to 4,452 MT. From 2009-2012, the Kenyan government launched an Economic Stimulus Program (ESP) (Nduku, 2015). The ESP included the establishment of the Fish Farming Enterprise Productivity Program (FFEPP). FFEPP was designed to increase production and commercialization of fish farming, through financial subsidies, financed by the Kenyan Government. ESP and FFEPP were important in increasing the number of fishing ponds in Kenya and in 2015 there were 60.277 ponds (Obwanga et al. 2020). FFEPP was split into two phases, which together attributed 12 million KES to each of 140 different constituencies and overall constructed 48.000 fishing ponds (ibid.).

In November 2016 the Aquaculture Business Development Programme (ABDP) was created as a follow-up to the FFEPP, but this time it was not only the Kenyan Government that financed the program, but also IFAD[1] and FAO (FAO, 2021). In 2019 the ABDP was launched. This program is effective in 15 Kenyan counties, including Embu. It is being executed by the State Department of Fisheries, Aquaculture and the Blue Economy. In terms

[1] IFAD is a fund made as a response to the food insecurity and famine in the 1970s and its primary task is to finance agricultural projects, whose purpose is to improve food production in a country (IFAD, 2023b)

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of financing, the program is said to blend both public and private funding. The total program cost is 144,5 million USD[2], of which IFAD is financing 67,9 million USD. The other domestic (Kenyan) co-financiers are the Ministry of Finance (31,4 million USD) and Beneficiaries (43,6 million USD). FAO is contributing 400,000 USD to the program.

2.3 Timeline of Kenyan aquaculture

In the 1920s, the colonial government introduced sport fishing in Kenya and with it fish farming (van Someren, 1960) (***Figure 1***). In 1948, under the colonial government, the Sagana Fish Farm and Kiganjo Trout Farm were created to produce fish seeds for stocking ponds, dams, and rivers (MoFD, 2010). After Kenya's independence, the new government established the Department of Fisheries, which promoted the fish industry through the "Eat More Fish" campaign, from which there was a rapid development of rural pond fish farming (Munguti et al., 2023). In 1989 there were 10.000 ponds nationally (Ngugi & Manyala, 2009) and by 1990 aquaculture was expected to produce 44.500 metric tonnes (MT) (Government of Kenya, 1982). Between 1970 and 2006, Kenyan aquaculture production varied between 1.000 and 4.000 MT. From 2006 to 2014, the aquaculture production in Kenya increased from 1.012 MT to 24.498 MT (***Figure 1***). Thereafter, the production decreased to 12.910 MT

[2] Note that this number was said to be 144,3 million USD, as of the most recent 2022 audit report.

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in 2017 and increased again the year after to 15.870 MT, in 2021 the aquaculture production reached 21.825 MT.

The reason for the increase in aquaculture production appears to be because of ESP FFEPP, even though the increase in production kept going after the programs ended. The end of the ESP is the reason for the decrease of aquaculture production after 2014 (Awuor et al. 2023; Obwanga et al. 2020). The increase of the aquaculture production from 2019 can be attributed to the implementation of the IFAD’s ABDP project but also the recent adoption of new production systems (cage farming and Recirculation Aquaculture Systems), which produced more fish per area, compared to ponds (Obwanga et al., 2020).

In Kenya, there is also a demand for fish, which pushes the industry. Under neoliberal theory, the development of the fish farming industry is driven by the economic demand for fish production in the market (Volpe, 2007). Efforts to maintain profits in a commodity-based market often result in the transfer of production costs to associated ecological and social systems. In other words, the industry's issues have impacts that manifest locally within the context of a domestic market; any relevant policy debates occur within this evident domestic framework. There is market demand for fish farming, which has been driving the development of the fish farming industry. Currently in Kenya, the fisheries sector, including fish farming and wild fisheries, cannot meet the national annual demand, which is equivalent to 550,000-1600,000 tons, when annual production is 180,000-240,000 tons (Obiero et al., 2019b). This difference between demand and fish production leads to the need for fish imports, but it also emphasises that this is a sector to invest in.

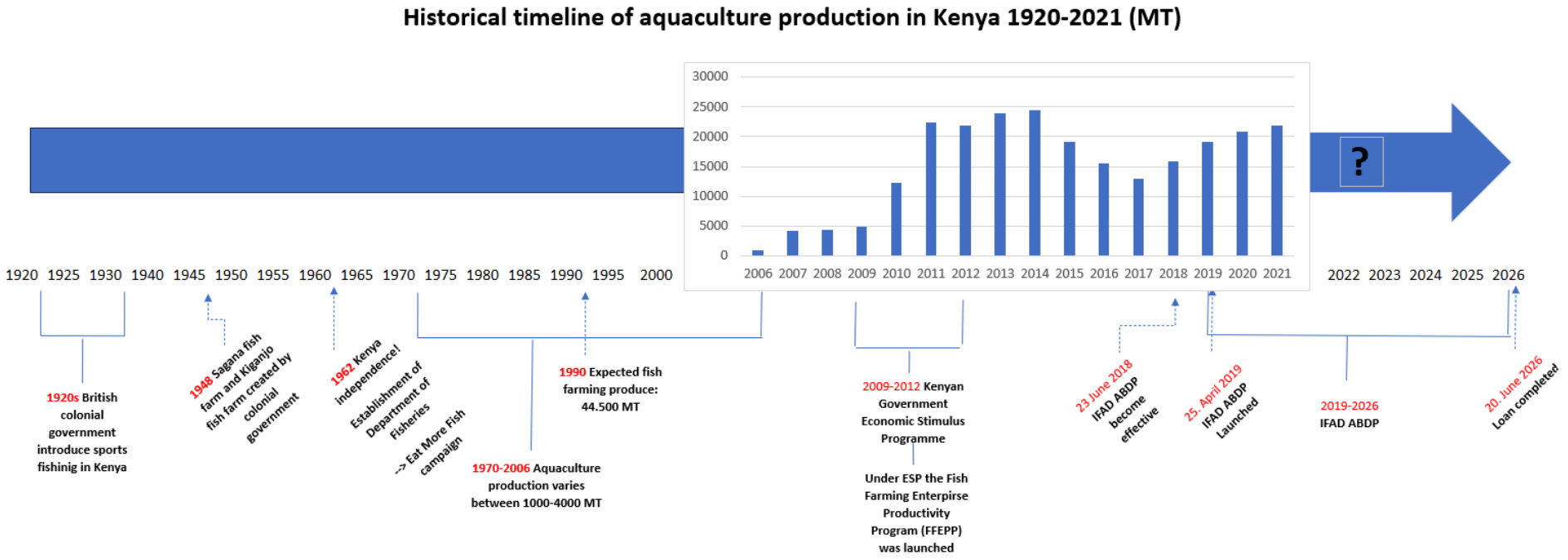

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Figure 1 Timeline of aquaculture in Kenya. Total aquaculture production taken from The World Bank, only accessible in a specific form from the year 2006-2021 (World Bank, 2021). Historical information: (B. Obwanga et al., 2020; Munguti et al., 2023). Numbers are calculated in MT.

2.4 Factors influencing the fish farming activity

Despite large investments in the industry, fish farming is not without challenges. Fish farmers must consider the different impacting factors and anticipate the challenges they could face (Ngugi et al., 2007). Firstly, the farmer must identify a suitable site for the pond construction, here, the physical characteristics, such as soil suitability should be assessed, as well as water quality and availability (Banerjea, 1967). The soil should be of high clay content and impervious, so it can retain water, if the soil is not impervious the farmers can use a pond liner. In fish farming the pond's water quality is essential for the production of fish, because the pond is where the fish live, feed and breed. The fish farmer must therefore understand how to keep a clean pond and know the requirements of good water quality as different fish species require different water quality aspects (temperature, pH, oxygen concentration, salinity, nitrate, turbidity) (See appendix 8.2 for more information). Within these different ranges each species has the best conditions to grow and breed. Secondly, other factors to take in consideration are the quality of fingerlings, fish feed, and other inputs. The quality of the fingerlings influences the size of the fish and the time of growth, affecting the production and economic return. This importance of fingerlings, and difficulties with acquiring them and distributing them have been raised in the latest ABDP report (IFAD, 2023). Lastly, for the farmers to have economic success they must consider the market demand for fish and the proximity to the market if available. It is from these aspects above that the study was structured, which then tries to give a perspective on these factors influencing fish farming.

2.5 Description of study area

2.5.1 Geographic location

Kenya is divided into 47 counties. These counties are divided into sub-counties or constituencies, which are in turn divided into wards. The study site was located in Embu county, Manyatta constituency[3]. The study was centred around Kibugu, which is located in Nginda ward. However, data was also taken from locations located in Ruguri-Ngandori and Kirimaki (***Figure 2***). The study area is therefore considered to be that of greater Kibugu.

[3] Manyatta constituency has six wards: Nginda, Kirimaki, Mbeti North, Kithimu, Gaturi South and Ruguri-Ngandori.

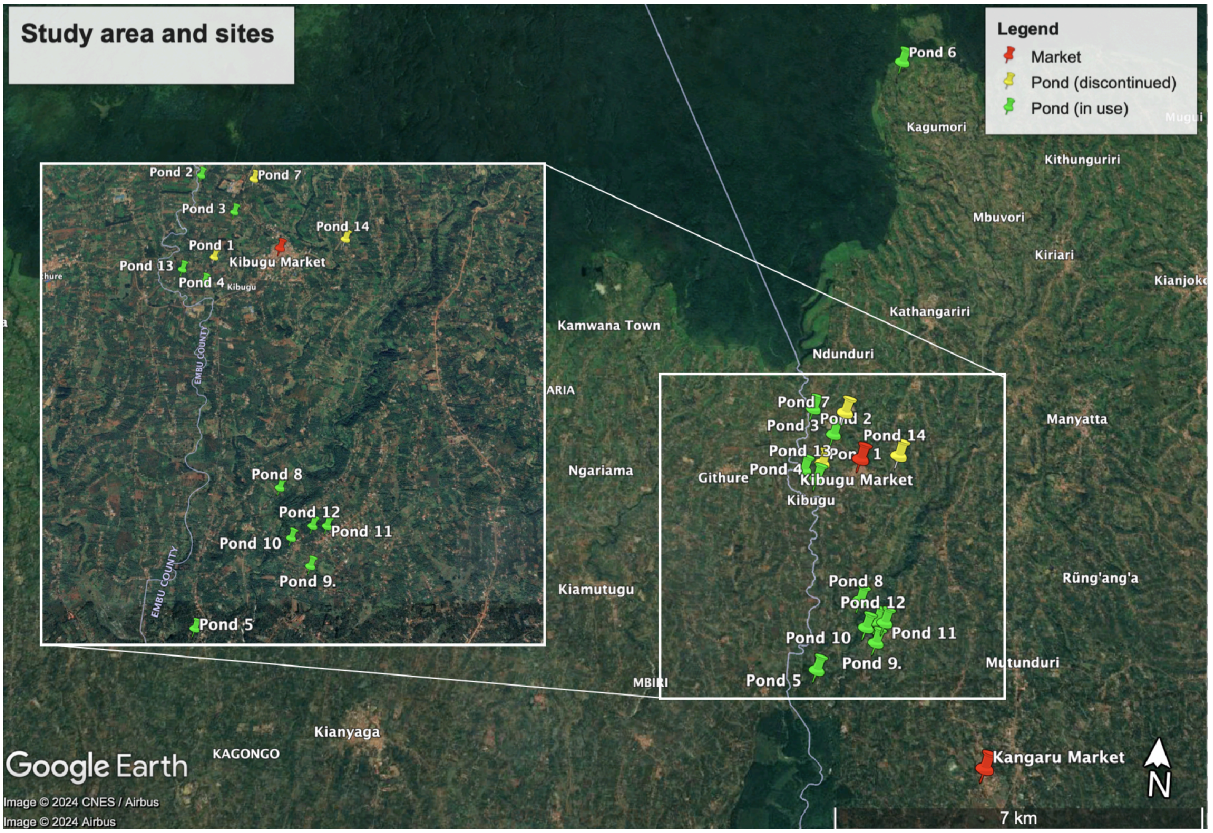

Figure 2 Map of study area and sites. Red pins denote the markets (Kibugu market and Kangaru market). Yellow pins denote the discontinued ponds (Pond 1, Pond 7 and Pond 14). Green pins denote pons that are still in use (Pond 2, Pond 3, Pond 4, Pond 5, Pond 6, Pond 8, Pond 9, Pond 10, Pond 11, Pond 12 and Pond 13). Figure made using Google Earth Pro.

2.5.2 Topography, climate and demographic

The most granular climate data available is for Embu County. Most recent data (1991-2020) indicates a climate marked by two distinct rainy seasons, one between October and December, where average precipitations reach just below 250mm, and one between March and May, where average precipitations reach just over 200mm (***Figure 3, A***). The average mean temperature is 25ºC. Mean surface air temperatures have increased since 1901 (***Figure 3, B***).

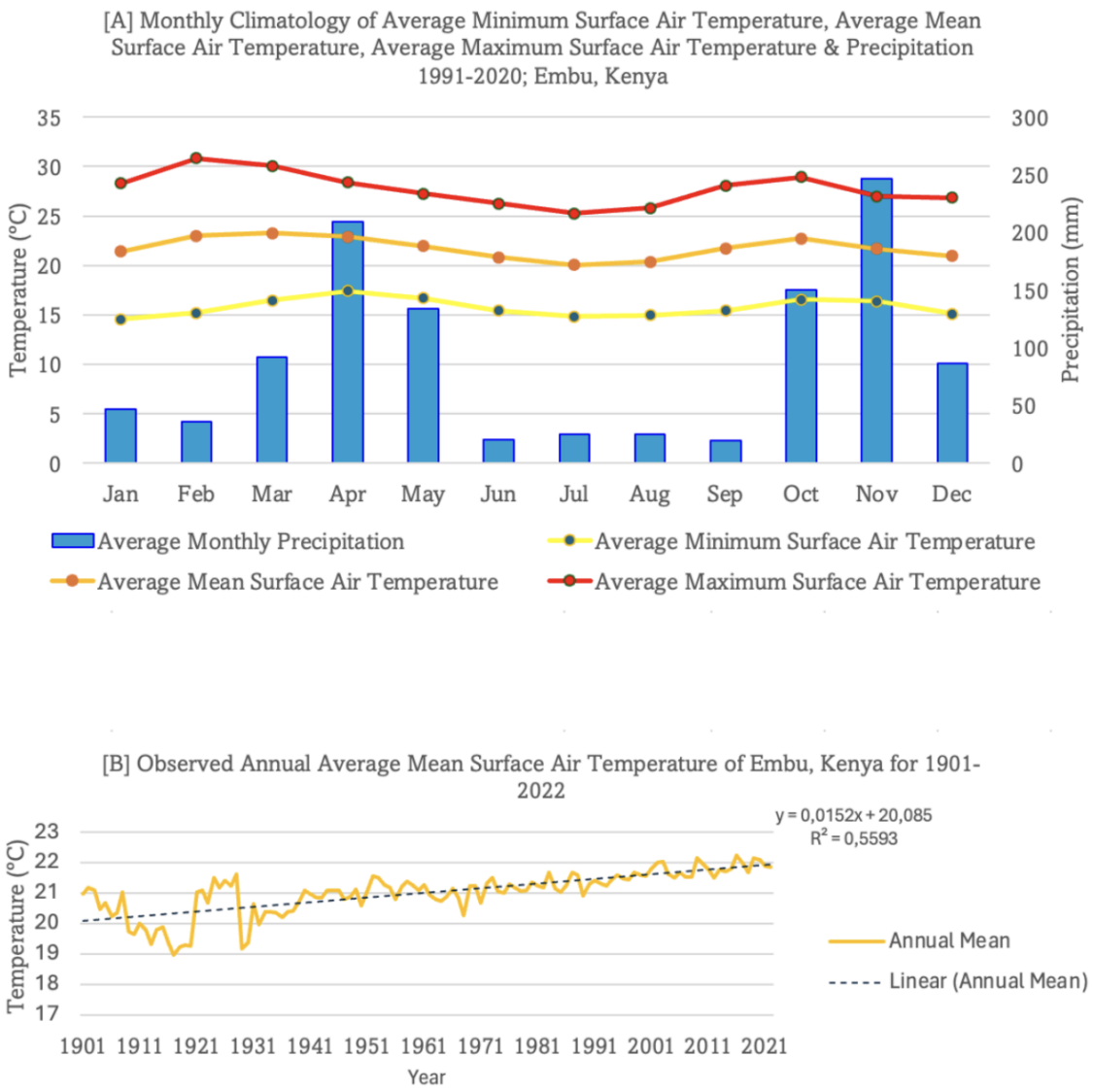

Figure 3 [A] Monthly Climatology of Average Minimum Surface Air Temperature, Average Mean Surface Air Temperature, Average Maximum Surface Air Temperature & Precipitation 1991-2020; Embu, Kenya and [B] Observed Annual Average Mean Surface Air Temperature of Embu, Kenya for 1901-202. Data taken from the World Bank Group Climate Change Knowledge Portal, for Kenya (The World Bank Group, 2022).

Under SSP situations[4], the average mean surface air temperature in Embu is projected to increase (***Figure 4, A)***. Under an SSP3-7.0 situation, the median temperature will increase from 21.84ºC (2019) to 24.81ºC (2100). Moreover, precipitations are predicted to become more abnormal, especially during the rainy seasons (Figure 4, B). As the climate changes and also becomes increasingly unpredictable, agriculture, which 87.9% of the County's population is engaged in, will be affected (Embu County Government, 2024). This fits with the government narrative of willing fish farming as a climate adaptation strategy, as crop production becomes more uncertain and reliable.

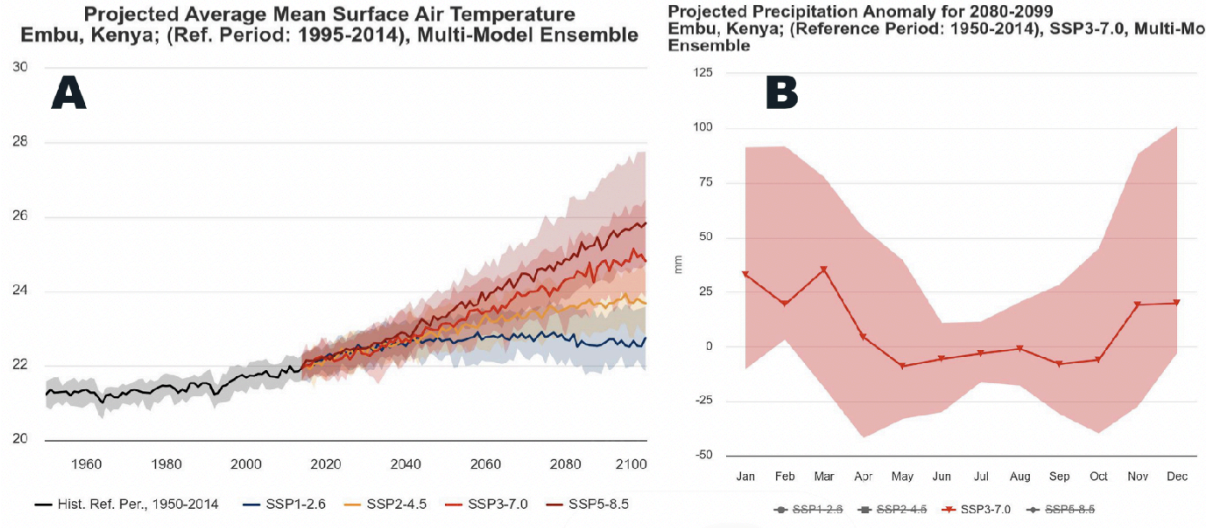

Figure 4 [A] Projected Average Mean Surface Air Temperature Embu, Kenya; (Ref. Period: 1995-2014), Multi-Model Ensemble; [B] Projected Precipitation anomaly for 2080-2099 Embu, Kenya; (Reference Period: 1950-2014), SSP3-7.0, Multi-Modale Ensemble. Data taken from the World Bank Group Climate Change Knowledge Portal, for Kenya. (The World Bank Group, 2022)

[4] The Intergovernmental Panel on Climate Change (IPCC) defines various emissions scenarios or Shared Socioeconomic Pathways (SSPs). 1 SSP-based scenarios are referred to as SSPx-Y. 'SSPx' refers to the Shared Socioeconomic Pathway describing the socioeconomic trends underlying the scenarios, and 'y' refers to the level of radiative forcing (in watts per square metre, or W m-2) resulting from the scenario in the year 2100. SPS3-7.0 is considered a *high* emissions scenario, where warming is limited to 4°C (>50%) and CO2 emissions that roughly double from current levels by 2100 (Calvin et al., 2023)

3. Methods

3.1 Presentation of methods

In this study, 17 interviews with farmers in Greater Kibugu were conducted ***(Figure 5***). 18 different pond water assessments distributed on 12 different households were also conducted. Furthermore, an interview with the local fisheries extension officer and a focus group discussion with the Samaki Tamu fisheries cooperative was conducted. Additionally, a consumer survey about fish was conducted with 33 respondents, and a market analysis where the fish accessibility was investigated, which included eight different Agrovets, three hotels and the three fish sellers in the local market.

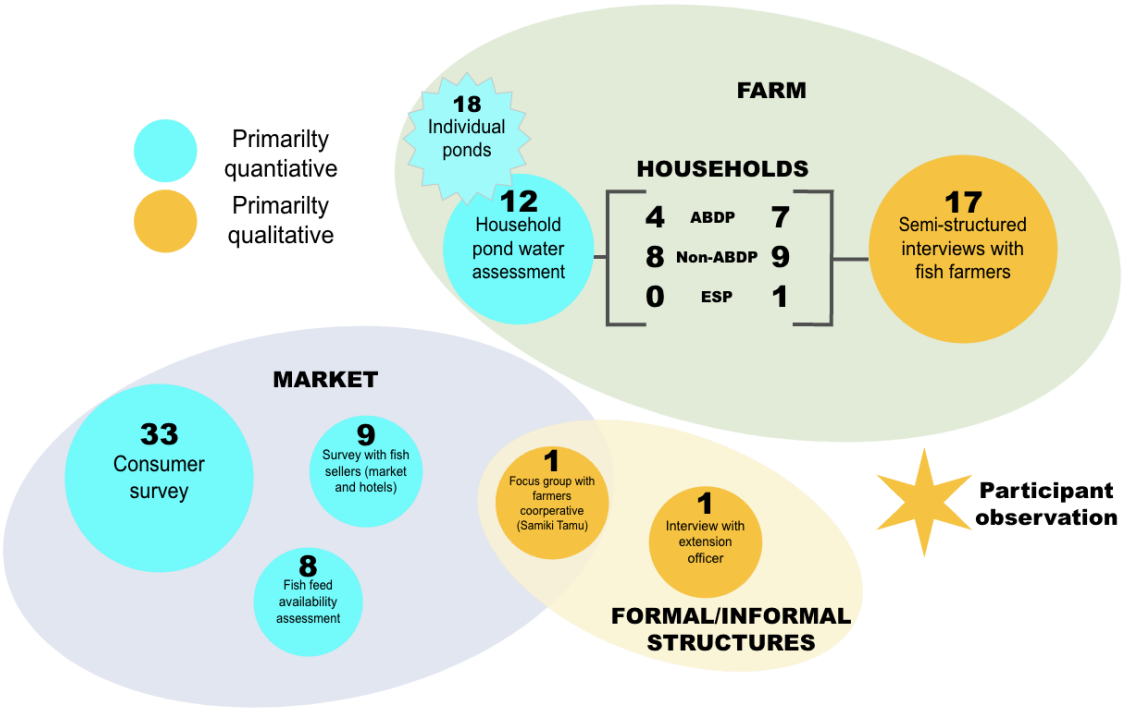

Figure 5 Overview of all methods. Methods in orange are primarily qualitative. Methods in blue are primarily quantitative. The different ellipses represent the different spaces where these methods were used. Figure is the author's own, made using Visio.

3.2 Outline of each method

In this report, a mixed methods approach has been used, incorporating both qualitative (semi-structured interviews) and quantitative methods (survey and water assessment), to triangulate and enhance the validity of the collected data (Hurst, 2023). The mixed methods approach was used to get a more in-depth perspective of the fish value chain, a more holistic view on the consumers and the process of fish farming. Certain statements such as "nobody likes fish" need corroboration so the approach is meaningful.

3.2.1 Pond water assessment

The pond water assessment was conducted for the ponds of participating fish farmers households, when they had a pond still in use. In the pond water assessment, Nitrate and Nitrite were measured using Nitrate strips, the pH-value was measured with a pH-metre, temperature with a thermometer and the turbidity was measured with the help of the visibility of the water compared to an arm (Nwangi, 2011). The pond water assessment was conducted because fish live, breed and grow in the water, making them wholly dependent on the water quality. (See **Appendix 8.2**)

3.2.2 Semi-structured interviews

The semi-structured interviews with the extension officer (EO) and the 17 fish farmers were conducted to gather general information about fish farming from two perspectives of fish farming: the government's and the fish farmers'. Furthermore, the interview with the EO also had the goal of gathering more information on the ABDP project and where we could find more fish farmers. Additionally, both parts could give more information on the fish value chain as well as basic information about fish farming.

The semi-structured interviews were conducted using a mix of open-ended questions and closed-ended questions, so the interviewer can guide the direction of the interview, but not command it. The closed-ended question also makes it possible to draw quantitative data (Hurst, 2023). The questions got more open as the interview progressed. The interview followed an interview guide to more or less standardise questions and responses (see **Appendix 8.3** and **8.4**).

While conducting interviews and water assessments, the research group also observed the doing of the respondents and their livelihoods. This was done to get a better understanding of the practical process of fish farming and the sale of fish (i.e. the kind of fish sold at the market).

3.2.3 Focus group discussion with Samaki Tamu Fisheries cooperative

The focus group discussion was conducted to gain insight into how a formal fish farming association group works and to understand the dynamics between the fish farmers but also between the fish farmers and the government. It was conducted with a specific focus and as a supplement to the semi-structured interviews (ibid.) (See **Appendix 8.3** and **8.6**).

3.2.4 Consumer survey

The consumer survey was conducted to also get quantitative insight into the fish value chain and understand the demand for and the availability of fish. The survey gave a new insight into where fish ends up and is bought from a consumer perspective, that the semi-structured interview couldn't give to the same extent, as well as what the consumers think about fish (ibid.) (See **Appendix 8.5**).

3.2.5 Fish seller and hotel survey

The survey of the fish sellers and hotels was conducted to better understand the value chain, especially the availability and sale of fish in Kibugu. The surveys were conducted by walking around Kibugu and asking fish sellers in the Sunday market questions about their fish sale.

3.2.6 Fish feed availability assessment

This was conducted to investigate if it was possible to buy fish feed in Kibugu or if people have to buy it somewhere else. The research group visited all the known agrovets in Kibugu and asked if they currently or previously sold fish feed.

4. Results

4.1 Fish farmer selection process

4.1.1 Description of farmers

In total, 17 farmers were interviewed. Nine do not receive governmental support, whilst seven receive support from the ABDP program and one received support from the ESP program.

The ESP farmer will not be of central focus, notably due to the small sample size of farmers in this program. Pond 6 is also an outlier in the data. This farmer was doing large-scale fish farming, as opposed to the other farmers who were doing small-scale fish farming (***Box 1***).

Box 1 Pond 6 – The trout farmer as an outlier doing large-scale fish farming

Pond 6 – The trout farmer: an outlier doing large-scale fish farming
The fish farmer of pond 6 is a 64-year-old male from Kibugu. A retired army colonel, he started fish farming as a hobby once in retirement, in 2018. He is a farmer and a businessman, owning multiple other businesses in the greater Kibugu area. His production consists of an old large fish farm, which he purchased after it was abandoned. It consists of 15 ponds, with a further 10 set to be constructed. He diverted the course of the river, so water passed through his farm. In that way, the ponds have running water all the time. He produces his own fingerlings and his own feed, through purchasing the raw feed products. Whilst he started fish farming as a hobby and states that fish farming is therapeutic, the economic aspect of his production cannot be ignored. Other economic activities are being created, namely a restaurant and rooms for tourists. He looks at the fish farming activity as a business which can expand on several levels.

Among the 17 interviewed fish farmers, the fish of choice is tilapia, with 16 farmers having either currently or previously farmed tilapia. The other fish present were catfish (six farmers), mudfish (three farmers), and trout (one farmer) ***(Table 1)***. The primary reasons for the popularity of tilapia farming include its widespread availability, suitability to local environmental conditions, and ease of management.

The average age of the fish farmer was 56 years, with no significant difference between the fish farmers receiving ABDP support, hereafter referred to as ABDP fish farmers, and the fish farmers not receiving ABDP support, hereafter referred to as non-ABDP fish farmers.

Six out of the 17 farmers identify as women, whilst the other 11 identify as males. The average pond size is 95 m². The pond size is slightly larger, at 114 m² for ABDP fish farmers (SD = 105) and smaller for non-ABDP fish farmers at 92,5 m² (SD = 72) ***(Table 1)***.

The average year for starting fish farming is 2013 for both ABDP fish farmers and non-ABDP fish farmers. All fish farmers are still doing fish farming, except for four who quit due to low-quality fingerlings and one who left Kibugu.

Table 1 Demographic information about the 17 interviewed fish farmers

Pond number	Government	Fish farming status	Age	Gender	Fish Species	Number of ponds	Average Pond size of known ponds (m^2)
1	No	Stopped	23	M	Tilapia	2	20
2	No	Ongoing	56	M	Tilapia	1	100
3	No	Ongoing	49	F	Tilapia	2	17,02
4	No	Stopped	65	M	Tilapia	1	25,3
5	No	Ongoing	40	M	Tilapia; Mudfish	2	144,3
6	No	Ongoing	64	M	Trout	1	63
7	No	Ongoing	65	M	Tilapia	1	200
8	No	Ongoing	73	F	Tilapia; Mudfish	1	170
9	ABDP	Ongoing	48	M	Tilapia; Catfish	1	100
10	ABDP	Ongoing	37	M	Tilapia	1	100
11	ABDP	Ongoing	81	M	Tilapia	2	30
12	ABDP	Ongoing	29	M	Tilapia	2	147,8
13	ESP	Stopped	63	M	Tilapia; Catfish	1	16
14	ABDP	Stopped	77	F	Tilapia; Catfish	1	300
No pond visit	ABDP	Ongoing	65	F	Tilapia; Catfish	4	5
No pond visit	ABDP	Ongoing	52	F	Tilapia; Catfish	N/D	N/D
No pond visit	No	N/D	62	F	Tilapia; Catfish	N/D	N/D

4.1.2 ABDP Area Selection Process

Upon arrival in Kibugu, it was presumed that all farmers would be part of the ABDP program. However, it was found that this was not the case, firstly due to the area selection process but also due to a farmer selection process. The area selection process will be outlined in this section, followed by the farmer selection process in the next.

Upon a first glance, the ABDP program appears to cover 15 counties, presumably the whole county (IFAD, 2023). However, following the interview with the EO, it became clear that this was not the case. According to the EO, there is a selection process at the sub-county level, due to the financial inability of the ABDP to cover the whole county. This selection process is done based on a poverty index, and subsequently, the wards with higher poverty indexes are included, whilst ones with lower poverty indexes are excluded. In the Manyatta constituency, the wards of Ruguri-Ngandori and Mbeti North were included[5]. All interviewed farmers that received ABDP support were located in the Ruguri-Ngandori ward.

> *"Then they started looking at…how do you call it…not the climatic condition…poverty index [...] They just selected two. [...] The other 10 ones [wards] were left out."* **(EO)**

When triangulating this with the literature review, where six ABDP policy documents were analysed, area selection does indeed take into account poverty targeting criteria (IFAD, 2017; IFAD, 2019; IFAD, 2020; IFAD, 2021; IFAD, 2022; IFAD, 2023). According to the 2017 Project Design report:

> *"The ABDP is envisaged as National in scope but [...] area selection also takes into account poverty targeting criteria."* **(IFAD, 2023)**

However, more details on how this is measured are seemingly non-existent. Of the seven ABDP policy documents reviewed, only the one above mentions a 'poverty targeting criteria'. Moreover, there is no indication on which poverty measure is used, how and when it is calculated and how the cutoff is decided. The selection ambiguity is even outlined in the ABDP August 2020 Supervision Report.

> *"The Mission noted that the project has developed a targeting strategy, which includes tools to guide the county teams on targeting, however, it is not very clear on the methodology."* **(IFAD, 2020)**

[5] The wards of Kirimaki, Gaturi South, Kithimu and Nginda were excluded.

As such, within one county, there are differences regarding government selection.

4.1.3 ABDP Farmer Selection Process

Next, there is also a farmer selection process. However, this process is far from clear. According to the EO, the selection process for farmers is as follows. Chiefs and assistant chiefs are contacted, who mobilise farmers in a public baraza. From that, around 40 are selected who then receive training, registration and social services. They also then organise themselves into Common Interest Groups (CGI). Once set up, they receive advisory services, farm visits, fishing gear and equipment. Literature highlighted that "The Programme will work with community-based organisations and local/traditional institutions to mobilise and sensitise communities to aquaculture-related opportunities" (IFAD, 2017). This was also expressed by farmers who had participated in community gatherings.

4.2 The fish value chain

From the various methods, the fish value chain has been distilled (***Figure 1***). Three main components are:

1) Set up
2) Production
3) Sale and consumption

Two separate value chains, one for ABDP fish farmers (green) and one for non-ABDP fish farmers (red) have been identified. Different inputs are necessary. These inputs come from various sources, outlined in the legend. Key steps in the value chain, such as pond construction, stocking, harvest, and sale are identified. Knowledge is required throughout all parts of the value chain.

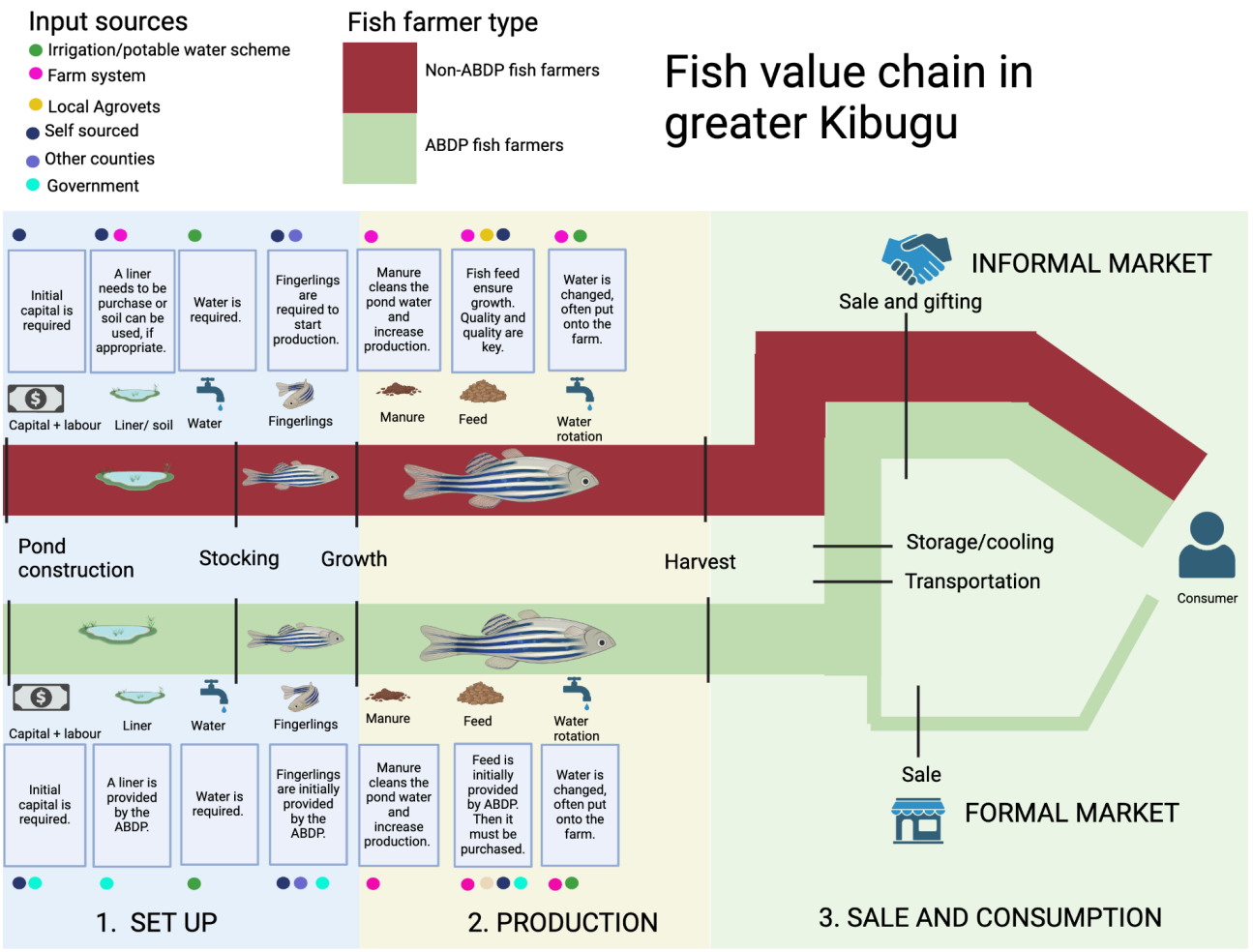

Figure 6 Fish Value Chain. Three main stages in the value chain have been identified: 1. Set up, 2. Production and 3. Sale and Consumption. The inputs are shown, accompanied by an illustrative figure. Input sources indicated where the input was sourced. Created using BioRender.

4.2.1 Set up

Capital

Capital and labour are necessary to set up the pond. Neither ABDP nor non-ADBP farmers receive capital or labour. However, all ABDP fish farmers receive some sort of support, which arguably frees up capital. Non-ABDP fish farmers had to buy all inputs from their own capital. Hired labour was often used to construct the pond. This finding challenges the narrative of small-holder farmers being perverse to risk taking; all farmers had invested some of their own personal capital into the pond setup.

Perhaps surprisingly, it is for ABDP fish farmers that capital was raised as one of the main challenges to fish farming. This could be interpreted as fish farmers who engage with the government program having a more economically inclined view in the activity.

Liner/soil

To hold water, a liner is required. Soil can be used instead of a liner if clay content is high enough. Polyethylene liners and training were provided to three of the seven ABDP fish farmers. Pond design was strikingly similar, with all ponds being approximately the same size and shape, with a mean pond size of 67.0 m^2 (SD = 42.1). The materials used were always the same: black polythene liner, that stretched over approximately 1 metre of soil around the pond (***Table 2***). Most farmers stated that the government had indeed given them training on how to build the fish pond.

Table 2 All ABDP beneficiary ponds visited. 2 ponds were not visited or geolocalized as the interview was conducted following the Focus group and therefore at Kangaru market

Pond 9

Material: Polyethylene liner

Pond 10

Material: Polyethylene liner

Pond 12

Material: Polyethylene liner

Pond 11

Material: Polyethylene liner

The ponds present in non-ABDP beneficiary households are much more diverse, notably in terms of material and dimensions (***Table 3***). Non-ABDP fish farmers did not receive liners or support for pond construction. Pond sizes range from 8.5 to 170 m^2 . The median pond size is 37 m^2 (SD = 56.4). Farmers used concrete, different types of liners or the absence of liner, and ponds were dug in various ways.

Table 3 All non-ABDP beneficiary ponds visited. Pond 1 and Pond 7 did not exist anymore as the farmers had stopped fish farming, one other pond not visited or geolocalized as the interview was conducted following the Focus group and therefore at Kangaru market. Pond 5 is missing as the photo is lost, however it was a polyethylene liner.

 **Pond 2** Material: Soil	 **Pond 3** Material: Polyethylene liner	 **Pond 4** Material: Soil
 **Pond 13** Material: Clear plastic	 **Pond 6** Material: Concrete	 **Pond 8** Material: Concrete

Water

All farmers need to acquire water in sufficient quantities. In the greater Kibugu area, it comes from various sources (***Figure 7***). Most farmers receive water from the local irrigation scheme (44%). A quarter source water from a river and a chlorinated water source, respectively. The latter can have issues, and fish farmers often state the need to remove the chlorinate from the water. Various methods are used for this, notably putting manure or charcoal in the pond.

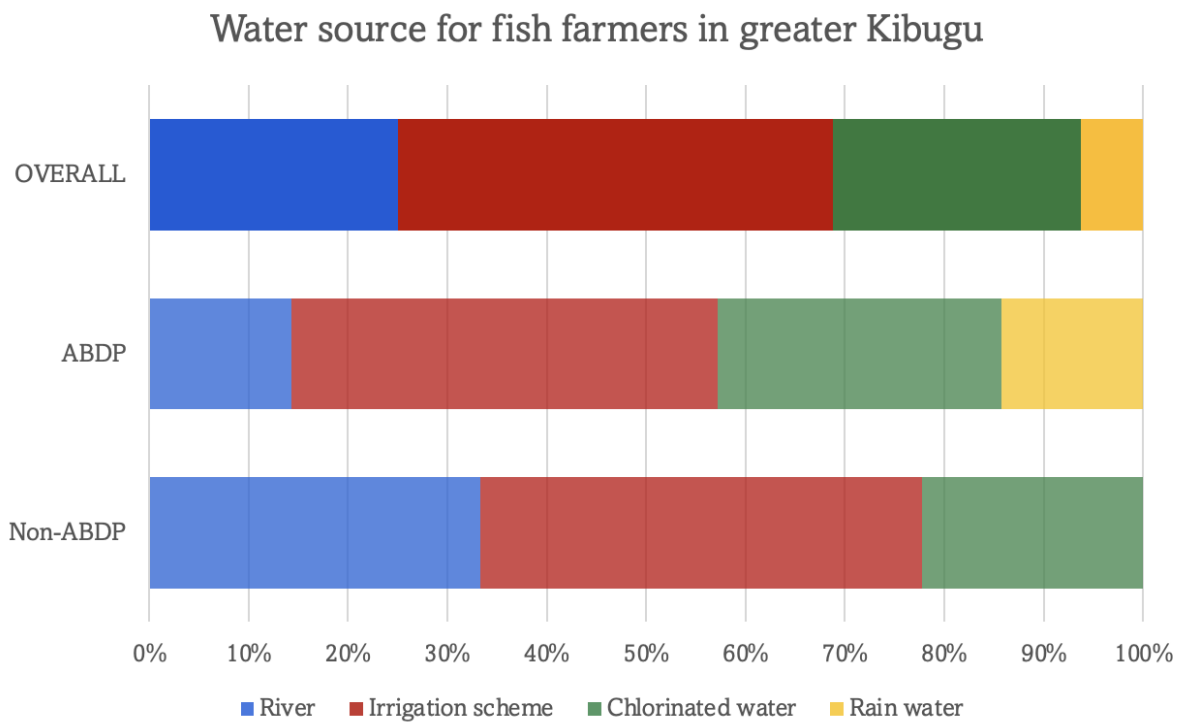

Figure 7 Water sources for fish farmers in greater Kibugu. Blue indicated water sourced from a river. Red indicates water that is sourced from the local irrigation scheme. Green indicated that water is sourced from a chlorinated water source, i.e. potable water. Yellow indicates rainwater. Total number observation is ABDP = 7, non-ABDP = 9, OVERALL = 16.

Fingerlings

For six out of seven ABDP fish farmers, fingerlings are given once by the program. After this time, ABDP fish farmers either bred fingerlings internally, or purchased fingerlings from other non-governmental sources.

Non-ABDP fish farmers purchased fingerlings from many non-specific places. Friends were often said to give fingerlings, and seven of the 10 farmers travelled, very infrequently, outside Kibugu to source their fingerlings.

The fingerlings quality and quantity are one of the most important factors influencing fish production. Issues regarding fingerling quality were frequently raised by fish farmers, both ABDP and non-ABDP. For ABDP fish farmers, who mostly receive their fingerlings from the government, four of the seven farmers were satisfied with the quality of the fingerlings.

However, all had reported having lost fish. six of the seven of farmers had, at some point, lost fish through ‘natural’ death, meaning that it was not through predators or theft, but rather that they were found floating, with a possible reason being water or fingerling quality. One ABDP fish farmer, who received 4000 government-supported fingerlings, experienced almost complete mortality due to quality, resulting in the abandonment of all five ponds.

Non-ABDP fish farmers also expressed dissatisfaction with fingerlings, but to a much lesser degree: eight out of the 10 farmers were satisfied with their fingerlings. Half of the farmers only purchased or received fingerlings at the very beginning of their fish farming activities.

Poor fingerling quality was an expected finding, as this had already been introduced in the latest ABDP report (IFAD, 2023). However, more data may be needed to draw more concrete conclusions or correlations regarding fingerling quality.

4.2.2 Production

Feeds

Feeds affect the growth of the fingerlings. Half of the interviewed fish farmers expressed satisfaction with the quality of fish feed, and half indicated dissatisfaction. The primary reasons cited for dissatisfaction included inadequate protein content, unsuitability for the species being farmed, limited access to high-quality feed and excessively high prices. Fish pellets are the main form of feed for ABDP fish farmers, whereas non-ABDP fish farmers utilise various types of feeds. They resort to homemade or natural plant-based feeds, including a plant known as ‘McDonald's eye’, bran and cattle feed. Furthermore, only seven of respondents explicitly stated satisfaction with the quantity of feed provided.

All eight feed stores visited during the survey period reported no fish feed supply. There also appeared to be a disconnect in knowledge, as none of them knew that there were fish farmers in the area, thus choosing not to supply fish feed.

Manure

Manure was used by farmers as a way to remove chlorine from water, promote growth of worms for fish feed and increase turbidity to protect from predators.

Water

The optimal yield of fish farming is related to the characteristics of the water: turbidity, level of nitrate, pH, and temperature. Upon testing:

It was found that nine fish ponds had a high turbidity in the water, seven had low and two had a fitting turbidity ***(Table 4)***, the widespread number of ponds with high turbidity can be attributed to many ponds not having running water or infrequent water rotation, so organic material was allowed to agglomerate. While previous research suggests that high turbidity may have a detrimental effect on fish growth, this study did not directly observe this impact (Ezeanya et al., 2015).

Three ponds showed an average level of nitrate of 5 or above and no ponds contained nitrite (***Table 4)***. Given that prolonged exposure to nitrate can reduce the growth rate of tilapia fingerlings and affect their health status, the positive phenomenon we observed is noteworthy (Monsees et al., 2017).

The pH-value was in most ponds inside the desired range of a pH between 6,5 and 8,5. Only pond 2 had a lower average pH-value of 6.46 and ponds 3.1 (8.76), 12.1 (9.58), and 12.2 (9.26) had high pH-values, which can affect the production of fish.

Furthermore, the difference in average temperature in the ponds are attributed to the different fish species, for example a trout is more suitable to cold water as seen in ponds 6.1, 6.2, and 6.3. Whereof tilapia and mudfish/catfish are more suitable to warmer water, above 22 ℃. Inappropriate temperatures can result in slow growth of fish fry, reducing feeding efficiency

and increasing mortality rates (Pandit & Nakamura, 2010), but only pond 12.1 and 12.2 has average temperatures over the desired temperature range for their fish species[6].

Table 4 Results from pond water assessment

Pond number	Fish Species	Surface Area (m²)	Turbidity	Average pH-value	Average Temperature (℃)	Average Nitrate (mg/L)	Average Nitrite (mg/L)
2	Tilapia	100	Low	6,46	N/D	0	0
3.1	Tilapia	28	High	8,76	23,4	2	0
3.2	Tilapia	28	High	7,86	23,6	0	0
4	Tilapia	10	Low	7,16	21,9	7	0
5.1	Mudfish	200	High	7,4	30	1	0
5.2	Tilapia	50	Normal	7,4	26	4	0
6.1	Trout	15	Low	7,52	18	1	0
6.2	Trout	15	Low	7,6	19,8	1	0
6.3	Trout	60	Low	7,52	19,1	0	0
8	Mudfish	170	Low	8,08	25,2	4	0
9	Tilapia	105	High	7,22	23,2	0	0
10	Tilapia	97,5	High	7	22,9	5	0
11.1	Tilapia	37,35	High	7,98	23,8	5	0
11.2	Tilapia	40,2	High	8,44	25	4	0
12.1	Tilapia	175	High	9,58	31	0	0
12.2	Tilapia	108	Normal	9,26	30,8	0	0
13.1	Tilapia	13	High	7,62	24,6	3	0

[6] Desired water temperature for Tilapia is between 27-30 ℃ for adults and 22-32 ℃ for fingerlings

13.2	Tilapia	10,5	Low	6,92	23	3	0
Average:	--	70,13	--	7,77	22,85	2,2	0

Overall, the water quality did not seem to be a problem. There were no extreme values and farmers did not report experiencing major issues with their water quality. Production did not appear affected by the water quality, but there was not enough data to be certain of this.

4.2.3 Sale and consumption

Consumer survey

At the weekly Sunday market, a random sample of 32 local residents was selected for a survey on fish consumption. The results indicate that 75% of respondents expressed they enjoy consuming fish, while 66% indicated a willingness to purchase more fish if additional purchasing avenues were available. Within these 21 respondents, 50% of the respondents previously identified as not liking fish expressed a willingness to purchase fish for their families due to the high nutritional value (***Figure 8)***. 20 respondents indicated that their frequency of purchasing and consuming fish reached or exceeded twice a month (***Figure 9***). These results suggest a market demand for fish.

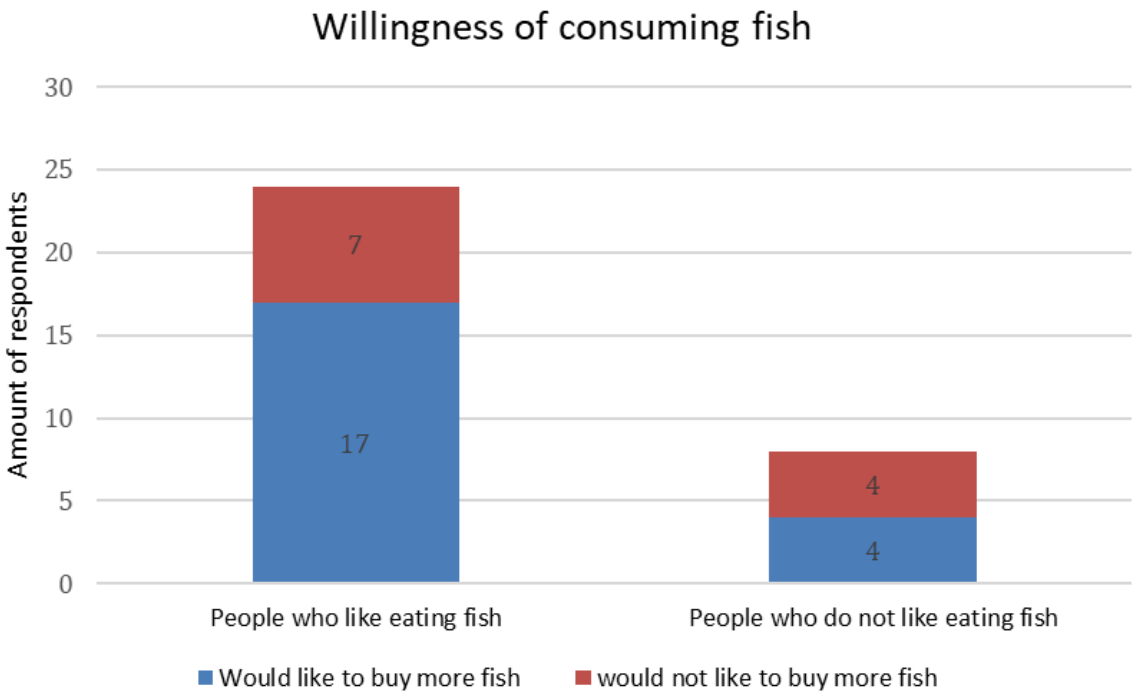

Figure 8 Consumer survey results: willingness of consuming fish. A total number of 32 were surveyed at the local Kibugu market on a Sunday.

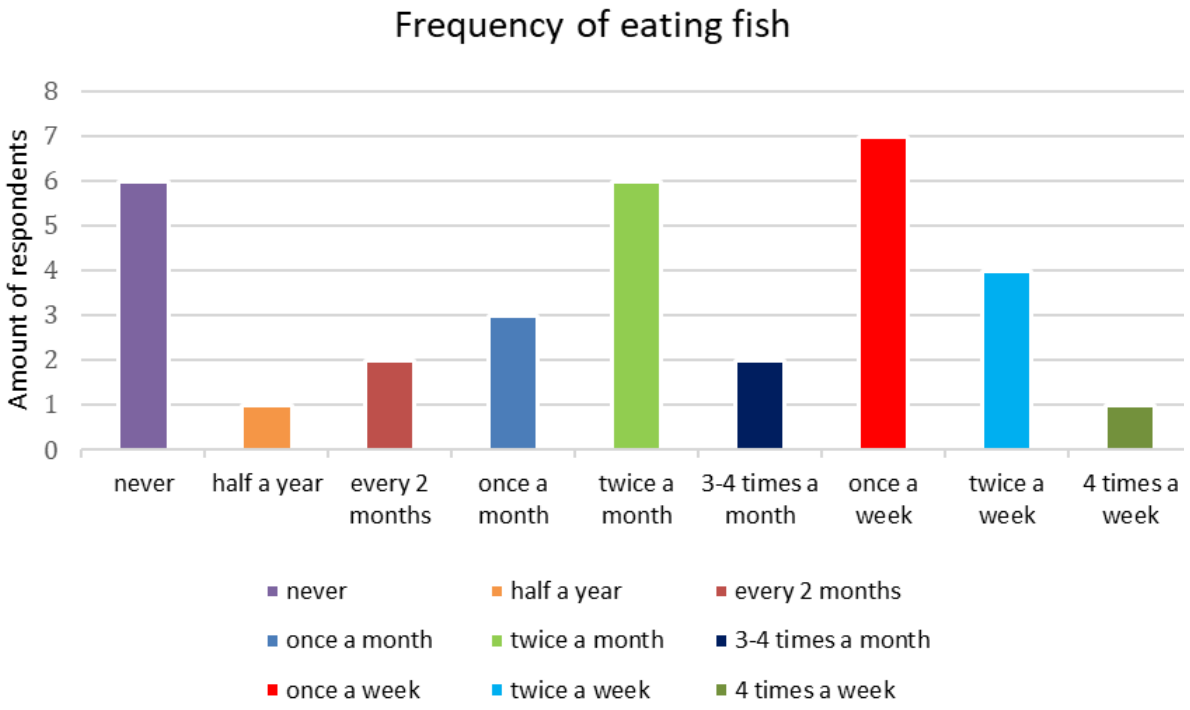

Figure 9 Consumer survey results: frequency of eating fish. A total number of 32 were surveyed at the local Kibugu market on a Sunday.

The majority of respondents who expressed a dislike for consuming fish indicated that this sentiment stemmed from fish not being a part of their regular dietary habits. They mentioned they did not consume fish during their childhood and thus did not develop a habit of purchasing fish, rather than disliking the taste of fish. However, they all acknowledged the nutritional value of fish, recognizing it as a source of high-quality protein, and expressed willingness to purchase it for their families. Nevertheless, avenues for purchasing fish were perceived as limited. Approximately half of the respondents mentioned needing to travel to Embu town to buy fish. Additionally, some respondents cited the high market prices of fish as a reason for choosing to catch fish from rivers themselves.

Sellers' perspective on demand

During the visit to the hotels in Kibugu, apart from one specialising in fish dishes, the remaining three hotels interviewed all indicated a non-provision of fish options. The owner of the fish hotel procures Nile Perch from Kisumu County.[7] She remarked that the business was challenging due to "a general lack of enthusiasm for fish consumption", stating that "fish is not a staple of the local diet here". This observation appears to conflict with the findings of the market survey, that there is a disconnect between what consumers want and what sellers are providing.

> "*...Not very (profitable). It's not our traditional food and people here don't really like eating fish*." **(Fish Hotel Keeper)**

[7] Kisumu County is located south of Lake Victoria, the world's second-largest lake that dominates Kenya's fisheries sector. Tilapia, Nile perch, catfish, lungfish, Haplochromine, and Synodontis are the principal commercially exploited fish species in the Lake Victoria basin (Akoth et al., 2021).

Picture 1 The fish hotel keeper and the Nile Perch she sells

In the Kibugu market, only two sellers selling fish were identified. However, fish sales are not their primary business focus; rather, they supplement their income by selling small dried fish locally and to nearby residents of Kibugu alongside other agricultural products. These sellers sell small quantities of fish, typically by the cup, indicating a small-scale operation. They offer silver fish, which are distinct from the fish species cultivated by fish farmers in Kibugu, and their sources are not local to Kibugu, but Kisumu. All three sellers stated that their primary reason for selling fish was profitability, although they also noted a general lack of enthusiasm for fish consumption among the local population.

Fish farmers' perspectives on demand

15 of the 17 interviewed fish farmers acknowledge the existence of a market for fish farming, and half of them choose to sell their fish. 14 of them perceive fish farming as economically viable due to the high market value of fish for sale. However, in the supplementary remarks, it is noted that such markets are primarily local and private (such as selling to neighbours), or there is limited fish supply, resulting in a lack of direct market access. Members of the Samaki Tamu Fisheries Cooperative perceive a general preference for fish consumption among the populace, indicating a promising outlook for the fish farming industry. However, they contend that the absence of a formal fish market poses a significant challenge. Both

consumers and sellers have their respective demands, but the lack of a designated marketplace hinders their ability to connect.

4.2.4 Knowledge

ABDP fish farmers received support from the government, including assistance with pond construction, fish species selection, and other essential knowledge. It is our observation that the vast majority of knowledge possessed by non-ABDP fish farmers stems from self-discovery, with a limited portion derived from exchanges among fish farmers. During interviews conducted with non-ABDP fish farmers in Kibugu, it became evident that some fish farmers were unsure about how to assess the quality of fingerlings and feeds. Furthermore, most fish farmers in Kibugu were not acquainted with other fish farmers in the area, highlighting deficiencies in knowledge among non-ABDP fish farmers and a gap in knowledge sharing.

Among all 17 fish farmers interviewed, 13 individuals expressed that they share knowledge with other fish farmers. Among these, five non-ABDP individuals engaged in informal knowledge exchange methods, such as occasional exchanging experiences with acquaintances in the community. Eight individuals reported participation in formal knowledge-sharing networks, facilitated through fisheries associations or farm visits. Notably, of these eight individuals, seven were affiliated with ABDP, while the remaining one participant also attended regularly organised fish farmer meetings.

The Fisheries Cooperative, established in 2015, aims to stimulate the growth of the fisheries sector in Embu County through farmer training and influencing policy decisions. Members of the cooperative contribute to the productional success of fellow members by sharing experiences and knowledge. In the focus group discussion, members emphasised the crucial role of government subsidies for the industry, expressing a desire for government subsidies for fish feed and other inputs. They recognised the existence of a market but noted its lack of organisation. The envisioned future entails the establishment of a formal fish market,

expansion of feed production, and increased fish farming yields to meet the growing demand effectively.

Fish farmers we interviewed after the Fisheries cooperative meeting expressed that formal knowledge-sharing groups were highly beneficial. They highlighted the significance of the group in sharing market information, which was previously inaccessible to them prior to joining the groups.

4.3 Wealth and livelihood changes among fish farmers

4.3.1 Income and food security

The findings concerning livelihood changes can be divided into economy, wellbeing and land use. However, these are closely interconnected and clear cuts can not always be made.

The interviews conducted show that 14 out of 17 participants believe fish farming makes sense at the economic level, or has the potential to.

Of the 11 participants who find economic sense, five are part of the ABDP and the remaining six are non-ABDP. This underscores how even those who are not supported by the government have managed to develop their activity in a way that makes economic sense for them. In addition, nine out of 17 participants perceived an increase in their wealth after they started with fish farming. This suggests that fish farming is indeed fulfilling a climate adaptation role, by increasing income diversification, that permits it to not be dependent on just one source. Of these nine, five are not part of the ABDP program and four are enrolled in the program. Despite this, among the participants only one mentioned an increase in his assets or material goods. With this new livelihood activity, money that was previously used to buy food can now be invested in other needs, such as school feeds.

"Before I was not able to pay my children's school fees, and now a man can pay for three children. Before I was not able to bring something on the table, but now through these fish I'm able to bring everything on the table" **(Fish Farmer Pond 14)**

Fish farming is not only income-generating. It also makes it possible to keep food on hand, thus increasing food security. By increasing incomes, it is also possible to buy more food, thus creating a cycle that powers an increase in food security and wealth. Nine participants perceive that due to fish farming their food security has increased. Of these, four are ABDP fish farmers and five are non-ABDP fish farmers. This shows that in relation to achieving food security there is no real difference between ABDP and non-ABDP. In addition, three participants were able to start eating fish thanks to fish farming, whereof it was not possible for them before, due to accessibility and high prices.

"You don't have to go look for fish…when kids ask for fish you go there with a net and you get it… fish is not locally available" **(Fish Farmer Pond 3)**

This means that fish farmers have the opportunity to both save economic resources that should be invested in food, achieve a wider diet diversification and easy accessibility to fish, which is an important source of protein.

4.3.2 Wellbeing

In addition to being a strategy to achieve food security, fish farming can also impact diet and nutrition. Four participants (two ABDP and two non-ABDP) perceived an increase in their health after starting fish farming, and two participants along with the economic aspect, started to increase the level of health and diet diversification (two ABDP). Fish is not only a source of protein, but also has health benefits because the fish are rich in polyunsaturated fatty acids and omega 3. Farmer of pond 6 intends to extract omega 3 from his fish, both to take advantage of it and sell it because fish oil is a product in high demand. This aspect also relates to an economic interest.

In addition to the above, fish farming can also be a passion, hobby and stress relief. To the question "why did you start fish farming?" Six participants (all non-ABDP) responded that they started because it is relaxing, aesthetic and conveys tranquillity watching fish.

> *"[fish farming] helps me relief from stress when I'm walking around the farm… for that I kept fish"* **(Fish Farmer Pond 6)**
> *"The passion make easier [to do fish farming]"* **(Fish Farmer Pond 3)**

For example, farmer pond 6 is making a restaurant and bedrooms in his trout farm that are next to the fish ponds, as the sound of the water and watching the fish takes away the stress (***Picture 2***). He plans to make his farm into a tourist attraction where people can relax and eat fish. This both works as stress relief and can generate income.

However, the wellbeing aspects are only mentioned by non-ABDP fish farmers, with the ABDP fish farmers being seemingly more driven by economic reasons.

Picture 2 Trout farm and the bedrooms for tourists

[A] [B] [C]

15 participants would recommend starting fish farming, even those who have stopped and don't have an active pond responded positively. The reasons vary, but it is interesting to note that even those who do not find economic sense for fish farming recommend starting this activity.

Overall, fish farmers are not purely economic, but have other therapeutic and personal motivations.

4.3.3 Land-use

In the Kibugu area, the main livelihood strategy is agriculture, both for personal subsistence but also as a source of profit (Embu County Government, 2024). Coffee, banana, tea, and macadamia are the crops mostly grown by the farmers who participated in the study. 13 out of 17 participants also have livestock on their farm, mainly cows, chickens and goats.

Land is a fundamental resource for livelihoods, and so the land-use has an impact on the household economy. One limitation for starting fish farming is the plot of land available. 10 participants (six non-ABDP and four ABDP) had to reduce the land for crops because of fish farming. Instead, only one participant changed the crop type when he started doing fish farming and planted mango trees around the pond in order to shade it.

The start of fish farming has also changed habits regarding crop management, particularly with regard to fertiliser use. Awareness was found regarding this aspect, and starting fish farming was often a motivation to stop using inorganic fertilisers and spraying pesticides in the surrounding fields.

> *"I changed the types of chemicals…I stop to use chemical fertilisers because it can affect my fish."* **(Fish Farmer Pond 3)**

Inorganic fertilisers could increase nitrate levels in the pond water and lead to a change in water quality. Among the participants, only three (non-ABDP) still use inorganic fertilisers in the surrounding fields despite having started fish farming.

A relationship between livestock and ponds was also found, with 10 participants emphasising this aspect (five ABDP and five non-ABDP). Manure is put in the water where fish are grown

to fertilise the water and grow algae. The manure is also put in the water to increase the fish production by balancing the ratio between carbon and other nutrients, but at the same time it can also have consequences because of the presence of pathogenic microorganisms in addition to the microflora of animal intestines (Elsaidy et al., 2015). Eight participants (three ABDP and five non-ABDP) use the pond water to irrigate their crops and the participants also perceived an improvement to the production level of their crops.

> *"Arrowroots I used to buy them, but after I started doing my fish farming, I no longer buy arrowroots, because the water that I drain is used for my arrowroots and sweet potatoes …"* **(Fish Farmer Pond 3)**

The fish farmers that found a relation between livestock and the pond also perceive that fish farming fits within sustainable farm management, creating a relationship they consider positive with livestock and crops. There are little differences between ABDP and non-ABDP fish farmers, regarding livestock and crops management strategies.

Finally, fish farming can help against some seasonal changes in water quantity, which are increasing due to climate change in Embu. The pond 2 farmer said that the fish pond helped him deal with the flooding of his crops, which were next to a river.

5. Discussion

5.1 Results in relation to theory/literature

The findings in this paper indicate that regardless of government support, fish farming serves as a supplementary activity, providing income diversification. Small-scale fish farming can easily be integrated with other agricultural activities such as crop cultivation and livestock farming, thereby increasing cash income (Mulokozi et al., 2020). Additionally, fish farming households improve food security by consuming the fish they produce. Furthermore, household fish farming can help impoverished farmers access pathways to improve dietary protein from both formal and informal markets. This trend is consistent with existing literature and aligns with theoretical expectations.

However, it was not possible to draw broader conclusions regarding livelihoods, such as how fish farming affects inequality. The literature suggests that income inequality is one of the primary drivers of poverty and food insecurity in developing countries, leading to a significant portion of the population living in poverty and experiencing long-term issues such as malnutrition (Singh & Dey, 2010). Although the number of fish farming households in the study area is limited and fish production is not high, the contribution of increasing income from fish production to directly reducing inequality is minimal.

Despite the fact that farmers are using the activity as a means of income diversification, the reasons for starting fish farming are diverse and not solely driven by profit maximisation, especially for those who did not start through a government program. Fish farmers indicate that they may start for wellbeing purposes, such as stress relief or for other health benefits related to fish.

Orthodox economic theory often portrays economic agents as profit maximisers, with producers or sellers being viewed as short-term profit maximisers, as exemplified in Marxist economics (Rudra, 1983). Economic theory makes no assumptions about the personality of economic agents, which is considered methodologically unsound. “If everything an actor

does can be explained by the principle of profit maximisation, then such analysis becomes systematic and loses much of its value as an explanation of reality" (ibid.). In reality, farmers are not entirely rational profit-maximising decision-makers; they are guided by considerations beyond short-term profit maximisation, such as social demographics, socio-economic characteristics, self-identity, attitudes, and subjective norms (Bradley et al., 2021). This corroborates with what is found. According to the theory of Silva et al. (2020), significant normative beliefs representing important others for farmers are based on opinions from "family," "neighbours," and "the government." Significant control beliefs, which are factors facilitating farmers' adoption of fish farming include "high value of fish," "easy to manage," "availability of free technical assistance," "government support," "greater knowledge about fish farming," and "availability of the flowing river." It was initially anticipated that fish farming would serve as a livelihood strategy or primary livelihood activity.

It could be mentioned that in the ABDP policy documents, climate change adaptation is a goal of the project, which also not an entirely economic goal. It was found that farmers do not specifically mention climate adaptation, apart from the farmer that created his pond in a river area that flooded his fields. As mentioned, climate change is expected to affect crop yield through reduced soil fertility, land degradation, increased temperatures and more volatile precipitations. Fish farming, being an alternative income and food source, is thus, indirectly, being used as a way to mitigate this.

Moreover, it is found that the value chain is largely informal with friction impeding the full connection between supply and demand. This is firstly due to issues around information sharing in the community, where supply and demand are not known to both parties. Consumers would like to purchase fish, but are mostly not aware of a local supply. Producers are not fully aware of this demand and are lacking market information. Moreover, logistics necessary to sell fish at a market are also limitating meeting demand. Similar findings are found in the case of the Purchase for Progress (P4P)[8] program in Kenya, where lacking

[8] The Purchase for Progress (P4P) is a World Food Program project which encourages national supplies and the private sector to buy food in a way that benefits smallholders. It notable provides training and assets to improve crop quality and facilitates access to finance and markets (World Food Program, 2024)

infrastructure and access to market information are impediments to the integration of farmers in the rural supply chain (Maja Skjöldevald, 2012). Finally, this disconnect in the market can have knock-on effects, such as suppliers not selling fish feed.

It can be argued that reducing frictions in the value chain could help both the consumer and the farmer. This is in line with ABDP policy, which wants to install cooling facilities at the Embu market. However, it could also be argued that this top-down approach may not be the best solution for this area. Even without a formal market, producers can sell their fish through informal ways. In a region where electricity shortages are common, the purchase and maintenance of a cooler could pose problems. Keeping a fish cool in a farmer pond, until the purchaser comes to pick them up, not only avoids the purchase, electricity and maintenance of the cooler, but also means the consumer gets fresh fish.

A study of small-scale inland fisheries in Timor Leste finds similar findings regarding the disconnect in the value chain. In this case, development strategies have focussed on structural improvements, such as modernising fishing gear, storage and infrastructure (Steenbergen et al., 2019). However, the authors find that these improvements are not only costly, but often fall short of their intended outcomes, whilst local informal trade persists. They argue that development support agencies need to understand the often overlooked social relations and networks that are crucial to local trade, and need to work better with local actors and existing social relations. This fits more broadly into a field of literature in rural development which recognises that interventions need to take into consideration broader local dynamics, rather than imposing a top-down view (Chambers & Conway, 1991; Harriss, 2023). Whilst the benefits of having a smoother and more formal value chain can be argued, the informal value chain has also had success in matching sellers and producers.

5.2 Recommendations and outlook

For fish farmers

For the fish farmers it could be useful to share their knowledge about their activity. Creating both formal and informal groups for sharing and collaboration, addressing the challenges of a developing sector. On the more practical side, one recommendation is to buy fingerlings from certified fish farm establishments, as this can ensure better quality fingerlings. We also recommend that fish farmers carry out the turbidity test themselves as it does not require any scientific instrument.

For the Extension officer

The EO should ensure that all farmers in the greater Kibugu are informed of the services being provided by the government. The EO could also connect sellers with buyers, for example sharing a list of fish farmers with potential buyers and fellow fish farmers.

For policy makers

Concerning policy-making, subsidising the fish feed and installing a cooler at the Kibugu market could be considered. In terms of designing future policies, the ABDP should try to better understand the area of work and local dynamics within the informal value chain, in order to design policies that are effective.

5.3 Discrepancies

In the data collection there were discrepancies between different points of view and statements from different actors. These discrepancies can, if not addressed, create problems in the value chain and make it difficult to develop fish farming in greater Kibugu.

The first discrepancy was that the EO and the fish farmers have contradictory narratives on the selection process and government services, as outlined in 4.1.2.

Furthermore, the EO said that the farmers could always contact her and ask for help, regarding training, inputs and equipment, even if they are not part of any governmental

programs they could ask for training and knowledge. However, this was not the experience of the fish farmers. Furthermore, some farmers didn't want help from the government because they didn't want them on their land. And one farmer explained that the government could improve their outreach to the fish farmers.

> *"There could be sharing of knowledge from the fisheries, the extension officers could be visiting women groups."* **(Fish farmer 9)**

There were also contradictions between the perception of fish likeability and the actual fish likeability. Whereof, sellers and hotels said "no one likes fish", this was not the picture of the consumer survey.

The discrepancy between fish seller and producer is also a drawback in the informal fish value chain and creates a gap in the supply chain leading to inefficiencies and lost opportunities for the consumers and producers.

There is also a discrepancy regarding unawareness among farmers about formal fish farming groups. According to the EO, the majority of farmers use formal groups such as Samaki Tamu and the EO advises farmers to organise themselves in groups, so they can connect better to the market and share knowledge. However, when the non-ABDP fish farmers were asked about the formal groups they weren't familiar with Samaki Tamu or any other formal group. This raises doubts in the reach of the government.

5.4 Methodology

There are limitations to this study. Firstly, the sample size was limited. Further farmers could have been investigated, should the time frame have permitted, in order to gain more credible results. Secondly, the respondents often met people the guides knew, or knew of, which created a bias. Next, investigations into livelihood activities would require deeper investigation, perhaps through using more quantitative tools, in order to distil the economic impact of fish farming on households, rather than a perceived and self-reported effect.

Pond water assessment

Regarding the methods used for pond water assessment, there were issues due to the available time. The measurements were at different times and days, so the air temperature was different, which could influence pond temperature results. Temperature and pH were measured at the surface water and not at different depths. Other issues were due to the absence of instruments, such as measuring dissolved oxygen. The water turbidity was measured with the arm test, as a more scientific tool was not available. Another issue was the diversity of site locations, some locations were exposed to sunlight and others to shade, which could influence results. Furthermore, it was decided to not include a soil sampling test, because it seemed like all the ponds had pond liners. However, this was not always the case and the soil type could be tested in a future study.

Semi-structured interviews

Regarding the conduct of the interviews, the respondents sometimes answered in Swahili or Kiembu, which meant that information was lost in the translation. Furthermore, at some interviews, the whole group of students was present and this may have influenced the participants' answers.

Semi-structured interview with extension officer

Some challenges were met during the interview with the EO. Firstly, the EO couldn’t tell us a lot about where the fish farmers were located. She also switched into Swahili, which was not immediately translated, meaning information was lost. Parts that were later translated may have lost some of their meaning in the translation process.

Focus group discussion with Samaki Tamu Fisheries cooperative

The focus group was not organised as a separate activity and was part of the cooperative meeting. This meant that the fisheries cooperative didn’t dedicate a lot of time to the discussion, as it was last minute. The attending fish farmers were often shy to speak and there were a few main respondents. This could have been improved by having a more circular seating formation.

Consumer survey

Similarly to the farmer interviews, it was challenging to get a representative sample group as the guides directed us and often asked people that they already knew. Moreover, not everyone wanted to be surveyed. It was therefore hard to get a representative sample group with a systematic selection.

Fish sellers and hotel survey

Only three selected hotels were surveyed, the search could have been more extensive but time didn't allow it. The survey of fish farmers in the market was on the first working day after the arrival in Kibugu, so the research group was not yet very experienced.

Fish feed availability assessment

This was only conducted on one day, and some agrovets were closed. The research group could have gone back on another day, but time didn't allow it.

5.5 Reflection on work

Before leaving for Kenya, the research group had an expectation to find that all farmers were part of the ABDP. However this was not the reality. Due to the informal value chain and limited knowledge from the community, locating farmers was challenging.

The meeting with the Kenyan students demanded that the research group rethought some ideas and methods, with the input from the Kenyan counterparts. However, despite these differences, the group work went well.

However, the Copenhagen part of the research group met challenges, firstly when the participants spoke Swahili and the fact that time has another meaning in Kenya than in Denmark. Other than that, the collaboration with the Kenyan students went well, all data was shared and processed during field work.

6. Conclusion

The overall goal of the research was to investigate how, in a region with little history of aquaculture, fish farming is becoming a livelihood activity, for both farmers that are supported by government initiatives and those that are not.

Firstly, even though fish farming is a non-traditional practice in the county, it is being actively practised as a livelihood activity. Moreover, this activity is not dependent on government support and initiatives, but has been born and is developing, both with and without government support.

Secondly, whilst fish farming exists without government support, there are differences between fish farmers that do and do not receive support. We find that fish farming is more uniform for those receiving government support, and that these fish farmers are more economically driven. On the other hand, farmers that are not government supported have less uniform fish farms, and have more varied reasons for starting fish farming. Fish farmers do not appear to be acting as pure rational profit maximising individuals and are also open to taking risks.

Moreover, despite the governmental presence, the fish value chain is largely informal. Farmers are dependent on contacts within the community to buy inputs and sell their produce. However, the informal value chain works for farmers - they are able to sell and give to informal connections. However, selling to a formal market is also desired. The consumer, on the other hand, suffers, in the sense that the local demand in Kibugu appears higher than the availability, especially at the market. This is accentuated by logistical impediments to meeting demand, such as cooling fish, and lacking inputs, notably fingerlings and feed.

We also find that knowledge is disjointed between the different actors in the supply chain. There is a lack of information sharing, entailing that supply and demand are not always well known and communicated.

Our findings are relevant for policy makers and can help inform the Kenyan Government as it plans future aquaculture projects, or other relevant agencies engaging with fish farming in similar contexts. The implications of this paper's results can be of use to the fish farmers in greater Kibugu. The recommendations, if taken by the extension officer, can be used to create a network, connect fish farmers, and improve knowledge sharing.

7. Reference list

AKOTH, A.J., I.O. MAHIRI & K. OBIERO (2021): Effect of climatic and non-climatic factors on fishing activities in Lake Victoria, Kisumu County, Kenya. *International Journal of Bonorowo Wetlands*, Vol. 11:1, available at:http://doi.org/10.13057/bonorowo/w110102.

Aqueon (2021): Freshwater Aquarium Water Quality: The Nitrogen Cycle & Optimal Water Chemistry.

Banerjea, S (1967): WATER QUALITY AND SOIL CONDITION OF FISH PONDS IN SOME STATES OF INDIA IN RELATION TO FISH PRODUCTION. *Indian Journal of Fisheries*, Vol. 14:, pp. 115–144.

B. Obwanga, K. Soma, O. Ingasia Ayuya, E. Rurangwa, D. van Wonderen et al. (2020): Exploring enabling factors for commercializing the aquaculture sector in Kenya. *WASS Blue and Green Economy Onderz. Form. B.*

Calvin, K., D. Dasgupta, G. Krinner, A. Mukherji, P.W. Thorne et al. (2023): *IPCC, 2023: Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, H. Lee and J. Romero (Eds.)]. IPCC, Geneva, Switzerland.*, available at:http://doi.org/10.59327/IPCC/AR6-9789291691647.

Chambers, R. & G. Conway (1991): Sustainable rural livelihoods: practical concepts for the 21st centruy. *IDS Discussion Paper 296*.

Bradley, D., Hill., B, O'Prey, L., Griffiths E. & Williams E. (2021): Understanding farmer motivations: Very Small and Small farms.

Ellingsen, C. & P. Knorringa (2022): *Unpacking the Feasibility of Upgrading Strategies in Kenya's Emerging Aquaculture Sector Claims vs. Realities*.

Ellis, F. (1998): Household strategies and rural livelihood diversification. *Journal of Development Studies*, Vol. 35:1, pp. 1–38.

Elsaidy, N., F. Abouelenien & G.A.K. Kirrella (2015): Impact of using raw or fermented manure as fish feed on microbial quality of water and fish. *Egyptian Journal of Aquatic Research*, Elsevier, Vol. 41:1, pp. 93–100.

Embu County Government (2019): *Embu County Government Integrated Development Plan 2018-2022 A Vibrant and Prosperous County*.

Embu County Government (2024): County Government of Kenya Location.

Ezeanya, N.C., G.O. Chukwuma, K.N. Nwaigwe & C.C. Egwuonwu (2015): *Standard Water Quality Requirements and Management Strategies for Fish Farming (A Case Study of Otamiri River)*. *IJRET: International Journal of Research in Engineering and Technology*, available at: http://www.ijret.org.

FAO (2021): *AQUACULTURE BUSINESS DEVELOPMENT PROJECT FOR KENYA*.

Government of Kenya (1982): Fisheries Department Statistical Bulletin: 1982. Nairobi: Ministry of Tourism and Wildlife.

Government of Kenya (2024): Kenya Vision 2030 Fisheries Development and Management.

Harriss, J. (2023): *Rural Development*, Routledge, London, available at:http://doi.org/10.4324/9781003431763.

Hishamunda, N. & N.B. Ridler (2006): Farming fish for profits: A small step towards food security in sub-Saharan Africa. *Food Policy*, Vol. 31:5, pp. 401–414.

Hurst, A. (2023): *Introduction to Qualitative Research Methods Subtitle:A Helpful Guide for Undergraduates and Graduate Students in the Social Sciences*, Oregon State University.

IFAD (2017): Aquaculture Business Development Programme - Final Design Report.

IFAD (2019): Kenya 2000001132: ABDP Supervision mission, November 2019.

IFAD (2020): Kenya 2000001132: ABDP Supervision Report August 2020.

IFAD (2021): Kenya 2000001132: ABDP Supervision Report August 2021.

IFAD (2022a): *Kenya 2000001132: ABDP Supervision Report August 2022 - Project: Fisheries: Aquaculture Business Development Programme*.

IFAD (2022b): Kenya 2000001132: ABDP Supervision Report August 2022.

IFAD (2023a): Kenya 2000001132: ABDP Interim (Mid-term) Review Report November 2023.

IFAD (2023b): Five decades of rural transformation: IFAD's greatest successes, 4 July.

Jacobi, A. (2013): Examining the Potential of Fish Farming to Improve the Livelihoods of Farmers in the Lake Victoria Region, Kenya: assessing Impacts of Governmental Support., University of Akureyri, available at: https://aquadocs.org/handle/1834/6854 (accessed 4 April 2024).

Maja Skjöldevald (2012): Small scale farmers' access to and participation in markets - The case of the P4P program in western Kenya. *Department of Human Geography, Stockholm University*.

Mbugua H. Nwangi (2011): *A Companion For Fish Farmers in Kenya*.

Monsees, H., L. Klatt, W. Kloas & S. Wuertz (2017): Chronic exposure to nitrate significantly reduces growth and affects the health status of juvenile Nile tilapia (Oreochromis niloticus L.) in recirculating aquaculture systems. *Aquaculture Research*, John Wiley & Sons, Ltd, Vol. 48:7, pp. 3482–3492.

Mulokozi, D.P., F.P. Mmanda, P. Onyango, T. Lundh, R. Tamatamah et al. (2020): Rural aquaculture: Assessment of its contribution to household income and farmers' perception in selected districts, Tanzania. *Aquaculture Economics & Management*, Vol. 24:4, pp. 387–405.

Munguti, J.M., K.O. Obiero, J.O. Iteba, J.G. Kirimi, D.N. Kyule et al. (2023): Role of multilateral development organizations, public and private investments in aquaculture subsector in Kenya. *Frontiers in Sustainable Food Systems*, Vol. 7:, available at:http://doi.org/10.3389/fsufs.2023.1208918.

Nduku, T. (2015): *Efficiency of Fish Farming under Economic Stimulus Programme in Kenya*.

Ngugi, C.C., J.R. Bowman & B. Omolo (2007): *A New Guide to Fish Farming in Kenya*.

Ngugi, C.C. & J.O. Manyala (2009): Assessment of National Aquaculture Policies and Programmes in KENYA. *Eldoret: SARNISSA*.

Pandit, N. & M. Nakamura (2010): Effect of High Temperature on Survival, Growth and Feed Conversion Ratio of Nile Tilapia, Oreochromis niloticus. *Nature*, Vol. 8:, pp. 219–224.

Rudra, A. (1983): Non-Maximising Behaviour of Farmers: Crop Selection, Vol. 18:40, pp. 1717–1722.

Scoones, I. (1998): Sustainable Rural Livelihoods: A Framework for Analysis, available at: (accessed 4 April 2024).

Singh, K. & M.M. Dey (2010): Sources of family income and their effects on family income inequality: a study of fish farmers in Tripura, India. *Food Security*, Vol. 2:4, pp. 359–365.

Steenbergen, D.J., H. Eriksson, K. Hunnam, D.J. Mills & N. Stacey (2019): Following the fish inland: understanding fish distribution networks for rural development and nutrition security. *Food Security*, Vol. 11:6, pp. 1417–1432.

The World Bank Group (2022): Climate Change Knowledge Portal Kenya .

Tran, N., L. Chu, C.Y. Chan, S. Genschick, M.J. Phillips et al. (2019): Fish supply and demand for food security in Sub-Saharan Africa: An analysis of the Zambian fish sector. *Marine Policy*, Vol. 99:, pp. 343–350.

Volpe, J.P. (2007): *"Salmon Sovereignty" and the Dilemma of Intensive Atlantic Salmon Aquaculture Development in British Columbia*, available at: https://www.researchgate.net/publication/296527937.

World Bank (2021): World Bank Data Aquaculture Production Kenya.

World Food Program (2024): Purchase for Progress.

8. Appendix

8.1 Final synopsis - mandatory

Socio-economic impacts of the ABDP project in farmers households in Kibugu, Embu County

February 2024

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List of Acronyms

ABDP	Aquaculture Business Development Programme
ABDPAH	ABDP Aquacultural household
AWP/B	Annual Work Plan and Budget
ESP	Economic Stimulus Program
IFAD	International Fund for Agricultural Development
IFI	International Financial Institution
FAO	Food and Agriculture Organization of the United Nations
FFEPP	Fish Farming Enterprise Productivity Program
GoK	Government of Kenya
Ksh	Kenyan shillings
MT	Metric tons
NABDPAH	Non-ABDP aquacultural households
PRA	Participatory Rural Appraisals
SDFA&BE	State Department of Fisheries, Aquaculture and the Blue Economy
TCP	Technical Cooperation Programme
UN	United Nations
USD	USA dollar

1. Introduction

1.1 Description of aquaculture in Embu County and Kenya

1.1.1 Aquaculture, a Government support initiative

In addressing the adverse impacts of soil degradation on agricultural production and the challenges posed by the continually growing demand for fish, the Kenyan government actively promotes inland aquaculture or fish farming. Over the past few years, the GoK has garnered support from the United Nations (UN), seeking financial and technical assistance to expedite the implementation of this sustainable development initiative.

Before 2008, the Kenyan aquaculture sector amounted to 4,452 MT. From 2009-2012, the Kenyan government launched an Economic Stimulus Program (ESP). This program promoted smallholder aquaculture and partially subsidised aquaculture, including supporting pond construction, providing fish feed, providing fingerlings and supporting post-harvest management and capacity building. The ESP was able to introduce and promote aquaculture in counties with little history of fish production. The ESP included the establishment of the Fish Farming Enterprise Productivity Program (FFEPP). FFEPP was designed to increase production and commercialization of fish farming, this was done through financial subsidies, financed by the GoK. ESP and FFEPP was together important in increase the amount of fishing ponds in Kenya and in 2015 there was 60.277 ponds (Obwanga et al. 2020). FFEPP focused on developing fish farming in the areas of Kenya with high unemployment rates and areas that were more suitable for aquaculture (Nduku, 2015). FFEPP was split into two phases, which together attributed 12 million Ksh to each of 140 different constituencies and overall constructed 48.000 fishing ponds (ibid.).

More recently IFAD came into the picture. IFAD is a response to the food insecurity and famine in the 1970s and the fund's primary task is to finance agricultural projects, whose purpose is to improve food production in a country. In 2019 IFAD launched the Aquaculture Business Development Programme (ABDP). This program is effective in 15 Kenyan counties, including Embu. The ABDP is being executed by the State Department of Fisheries, Aquaculture and the Blue Economy (SDFA&BE), within the State Department of the Ministry of Agriculture, Livestock and Fisheries (ibid.). In terms of financing, the project is said to blend both public and private funding. The total project cost is 144,5 million USD[9], of which IFAD is financing 67,9 million USD. The other domestic (Kenyan) co-financiers are the Ministry of Finance (31,4 million USD) and Beneficiaries (43,6 million USD). FAO is contributing 400,000 USD to the project. The GoK also requested FAO technical assistance to train extension officers with a Farmer Field Schools (FFS) approach. FAO

[9] Note that this number was said to be 144,3 million USD, as of the most recent 2022 audit report.

launched a USD 250,000 Technical Cooperation Programme (TCP) entitled “Aquaculture Business Development Project (TCP/KEN/3703)” developing Aquaculture Field Schools (AFS).

According to IFAD, the ABDP will “enable existing and potential aquaculture producers to benefit from fish production in an economically and environmentally sustainable manner” (IFAD, 2017). There are three main components to this project:

- Component 1: Smallholder aquaculture development (39% of the budget)
- Component 2: Aquaculture value chain development (9% of the budget)
- Component 3: Programme Management and Coordination (47% of the budget)

1.1.2 Timeline of Kenyan aquaculture

The timeline below outlines national initiatives in Kenya's aquaculture, and an estimate of the national aquaculture production, in metric tons (MT). From 2006 to 2014 the aquaculture production in Kenya increased from 1.012 MT to 24.498 MT (figure 1). Thereafter the production decreased to 12.910 MT in 2017 and increased again the year after to 15.870 MT, in 2021 the aquaculture production reached 21.825 MT. The reason for the increase of the aquaculture production is the ESP FFEPP, even though the increase in production kept going after the programs ended, the ESP can be attributed to the continued increase. At the same time the ending of ESP is the reason for the decrease of aquaculture production (Awuor et al. 2023; Obwanga et al. 2020). According to Obwanga et al. 2020 the reason for the decline in aquaculture production from ponds can be attributed to the end of the ESP, which stopped giving subsidies to the farmers. The increase of the aquaculture production from ponds can be attributed to the implementation of the IFAD´s ABDP project but according to Obwanga et al. 2020 also the recent adoption of new production systems (cage farming and land-based units/Recirculation Aquaculture Systems) because these two methods have the potential to produce more fish per area compared to ponds.

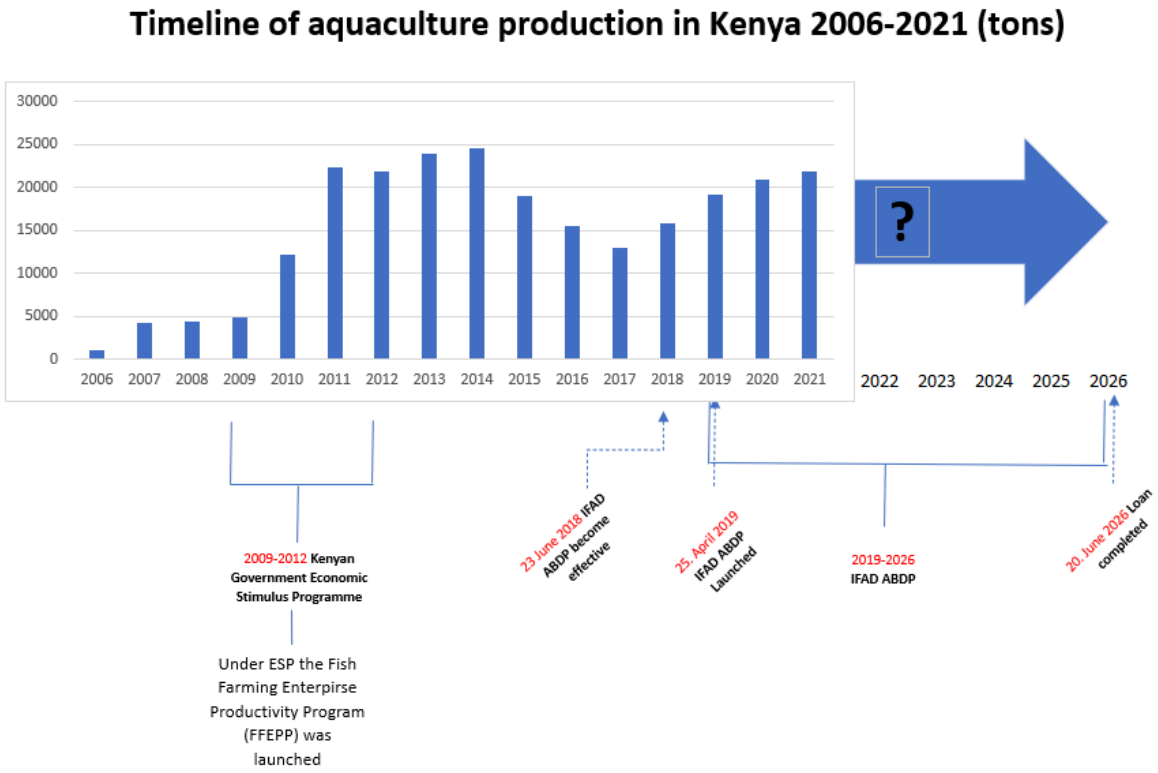

Figure 1 *Timeline of aquaculture in Kenya. Total aquaculture production taken from The World Bank u.d. - Numbers are calculated in (MT)*

1.1.3 Current state of aquaculture in Embu County, Kenya

The most recent Embu County aquaculture data seems to be that which features in the *Embu County Integrated Development Plan 2018-2022*. This plan outlines the effects of the Kenyan Government ESP program, stating that it constructed 200 fish ponds, in each of the four constituencies. Moreover, 200 kg of fish feed and 1000 fish fingerlings per pond[10] were supplied and fish from local aquaculture are generally sold locally (Embu County Government, 2019). This appears to be executed by the Agriculture Department, presumably the Embu County Agriculture Department.

Several studies have attempted to understand the factors that influence the adoption by the farmers of aquaculture in agricultural systems. The reasons are diverse and include economic, demographic and institutional aspects, but what has proved to be most relevant is the risk that aquaculture will affect the agricultural processes, including fluctuations in crop yields, livestock production, and agricultural productivity. Factors that may influence agricultural productivity are for

[10] This would mean that the total amount of fingerlings would be 1000*4*200 = 800 000 fingerlings.

example weather conditions, pests, diseases, market fluctuations, and unforeseen events that contribute to production risk (Dey et al., 2010; Islam et al., 2015; Obiero et al., 2019; Shoko et al., 2019). The instability and insecurity of profit also makes farmers sceptical about adopting the ABDP project, many prefer to remain in profit-step conditions rather than invest heavily in an action that has an uncertain profit.

Furthermore, there are multiple other factors influencing fish farming on a household level. Fish farming has different challenges such as sharing of fishing nets, reuse of old pond liners (which can carry disease and contaminate the fish pond), poor disposal of fish waste, inadequate training, affordable feeds and finding certified quality fingerlings (Mulei et al. 2021). There are also multiple different kinds of fish ponds depending on which kind of pond liners are used, size, source of water (flowing or stagnant), water in/outlet, species of fish. All these factors have an impact on fish production and therefore also the production's impact on the farmer and households' livelihood.

According to Mulei et al. 2021 and Polson and Spencer, 1991, the farmers who have adopted fish farming are dominated by males and also the older generation of farmers, which often are the ones who have land ownership. Due to disparities in economic status between males and females, females tend to have limited access to land, capital, and credit for expanding pond size, improving management, and purchasing commercial fertilisers. In comparison to older farmers, younger farmers exhibit a propensity for experimenting with new technologies and achieving higher annual fish yields (Polson and Spencer, 1991). Furthermore, farmers with a higher level of formal education are more likely to engage in aquaculture than those with a lower level of formal education (Kimenye, 2001).

This report will extensively examine the factors influencing fish production and the impacts of prevailing policies and initiatives governing fish farming, such as the 2019 launched ABDP initiative by the GoK and the IFAD, on the households of farmers in Kibugu. In order to gain a comprehensive understanding of these influences, a multidimensional assessment of social changes will be undertaken, encompassing dimensions such as dietary habits, daily schedule, social conflicts, and power relations. Special attention will be devoted to the perceived changes in wealth/ living standards for ABDPAH and NABDPAH, and the actual socio-economic effects that the GoK/IFAD project has on the community. Furthermore, there will be a focus on aquaculture's ability to contribute to food security. This will be done through the research question and sub-research question shown here:

1.2 Statement of Objectives

Drawing upon this, the overarching goal of the research project is to analyse the socio-economic effects of the GoK/IFAD ABDP project on farmer households, with a specific focus on Kibugu, Embu.

1.3 Research questions

From this overarching objective, three sub-research questions have been established. They are as follows. They are fully elaborated in the research matrix, found in Appendix 1.

1) How can the ABDP project in Kibugu be characterised?
2) How can fish and food production be characterised in households participating in the ABDP project?
3) What is the relation between wealth perception, living standards and the ABDP project after the implementation?
4) How have farmer households perceived social change with aquaculture?

2. Methodology

Based on these research questions, a research matrix has been developed (See Appendix 1). The following section outlines the methods used.

Method 1: Semi-structured interviews with extension officer

Material needed	Recorder Pencil Notebook
Goal	● To get an introduction to aquaculture in relation to ABDP in Kibugu. ● To gain knowledge of who the farmers are and where they are, the timeline . ● To begin to characterise the project and know the practicalities, from the planner's point of view. ● As well as if there are any unknown parts of the Fish farming value chain. ● And new factors to take into consideration.
Supporting variable in research matrix	1
Context	There is an extension office in Kibugu that knows aquaculture and the ABDP in the area.

How	1) Get in contact with the extension office, most probably via Dorette or Francois 2) Set up a time to meet

Method 2: Semi-structured interviews with ABDP households

Material needed	Recorder Pencil Notebook
Goal	● Getting basic knowledge such as the demographics of the farmers. ● Getting information about the GoK and IFAD project from the farmers point of view. ● Defining aquaculture and the ABDP at the household level. ● Information about the practicalities of fish production. ● Information about the process and value chain ● Informations about wealth perception to be able to see a difference between farmers who are part of IFAD´s project and farmers who aren't
Supporting variable in research matrix	1,2,3,6,7,8
Context	There are farmers engaged in ABDP aquaculture in Kibugu.
How	1) After contacting the extension office, get the location of farmers and document them on a map and paper. 2) Sampling them based on how many they are 3) Organise to meet to conduct semi-structured interviews

Method 3: Semi-structured interviews with non-ABDP households

Material needed	Recorder Pencil

	Notebook
Goal	● Wealth perception to be able to see a difference between farmers who are part of IFAD´s project and households who aren't. ● To be able to compare challenges and social changes related to the project between ABDPAH and NABDPAH.
Supporting variable in research matrix	6,7,8
Context	There are presumably households that do not partake in ABDP, and probably they also have a different perspective on the project.
How	1) After contacting the extension office, get the location of non-ABDP farmers and document them on a map and paper. 2) Sampling them based on how many they are 3) Organise to meet to conduct semi-structured interviews

Method 4: Semi-structured interviews with chief and assistant chief

Material needed	Recorder Pencil Notebook
Goal	Getting information about the project from the leaders and co-coordinator's point of view as well as the value chain
Supporting variable in research matrix	1,8
Context	The chief and assistant chief are assumed to have knowledge about the practicalities and timeline of the ABDP project. The were presumably also present when the ABDP project where initiated in Kibugu.

How	4) After contacting the extension office understand who is the chief or the assistant chief 5) Organise to meet to conduct semi-structured interviews

Method 5: Market analysis

Material needed	Recorder Pencil Notebook Camera
Goal	To get an idea about if fish are being sold in the market, if so how many, which types, and the actors involved.
Supporting variable in research matrix	1,3
Context	On average, the Kenyan prices are: - 353 Ksh/kg is the average market price for tilapia - 388 Ksh/kg is the average market price for catfish
How	**How:** Informal conversation with sellers and traders and observation at the market Go to the market and check: a) Is fish being sold? (YES/NO) b) If yes, what type of time? c) How many fish? d) How did they get there? e) Who is selling them? f) Who is buying them? g) What is the market price?

Method 6: Pond analysis

Material needed	Angle measurer GPS Measuring tape Scale
Goal	The goal is to characterise aquaculture at the household level, this is necessary information to then investigate the factors that can influence fish production. This will be done by measuring the pond dimension, location and depth. See if there are pipes. See which fish are being produced and how much they weigh.
Supporting variable in research matrix	2,3
Context	Fish are in ponds, it is important to characterise what types of ponds these are as well as the fish production. Because of the effect the pond environment and type have on the fish production.
How	- Measure soil type - What type of water inlet/outlet does it have? - How is the bottom of the pond constructed? - Is there a pond liner? - Are there any forms of agriculture/livestock present?

Method 7: Pond water assessment

Material needed	Thermometer x1 pH strips x 40 Nitrate strips x 40 Oxygen strips x 40 Test tubes x 5 Filters x 40

Goal	To characterise the pond/aquaculture system that we relate with food production.
Supporting variable in research matrix	2
Context	Fish are in ponds, it is important to know what the characteristics of these are. Could also be possible to establish relationships between the water quality and fish production.

How	Measure the following things:
	- Temperature
	- pH
	- Oxygen concentration
	- Nitrate
	- Turbidity
	
	<u>How to measure pH</u>
	- Similar time of day
	
	<u>How to measure turbidity</u>
	- Measure it with our arm, submerge the arm vertically in water until the hand disappears.
	  - If water doesn't reach the elbow the turbidity is very high
	  - If it reaches the elbow turbidity is right
	  - If the water reaches above the elbow the turbidity is too low

Method 8: Focus group discussion

Material needed	Recorder Pencil Notebook Food/drinks
Goal	● Gauge community perception of the project.

	• Evoke a discussion about the IFAD project and the positives and negatives met. Possible to compare different opinions and experiences between farmers as well as evoke opinions that wouldn't be said in a casual forum. • Bring out the dynamics of interaction between the different actors
Supporting variable in research matrix	7, 8
Context	There are different actors involved who may have different perspectives on social change and the challenges that the project implies, therefore women, men, young and older will be taken into consideration from ABDP households and no ABDP households, but also sellers, traders, owners of the land.
How	1) Organise a focus group with community members a) Find a location b) Invite respondents c) Invite translator

3. References

Awuor. F. J., Macharia. I. N., and Mulwa. R. M. 2023. Adoption and intensity of integrated agriculture aquaculture among smallholder fish farmers in Kenya. Front. Sustain. Food Sst. 7:1181502. doi: 10.3389/fsufs.2023.1181502 / https://www.frontiersin.org/articles/10.3389/fsufs.2023.1181502/full

Embu County Government (2019). County integrated development plan 2018-2022 - A vibrant and prosperous county: https://maarifa.cog.go.ke/sites/default/files/2022-08/CIDP-%20Embu-%202018-2022.pdf

FarmBiz Africa (n.d.). Embu fish farmers champion earthen ponds as alternatives to expensive dam liners. News and knowhow for farmers: https://farmbizafrica.com/embu-fish-farmers-champion-earthened-ponds-as-alternative-to-expensive-dam-liners/

FAO (2021). Aquaculture Business Development Project for Kenya. Food and Agriculture Organization of the United Nations: https://www.fao.org/3/cb8465en/cb8465en.pdf

IFAD (2017). Aquaculture Business Development Programme: https://www.ifad.org/en/web/operations/-/project/2000001132

IFAD (2022). Aquaculture Business Development Programme. Supervision Report 2022: https://www.ifad.org/en/-/kenya-2000001132-abdp-supervision-report-august-2022

IFAD (u.d.). History - An international response to global food shortages: https://www.ifad.org/en/history

Kimenye, L.N. (2001). 'Understanding Low Rates of Technology Adoption by Women Farmers: A Case Study of the Determinants of Adoption of Improved Sorghum Varieties by Women Farmers in Mbeere District, Kenya', *Journal of Agriculture, Science and Technology*, 3(1), pp. 30–40.: https://doi.org/10.4314/jagst.v3i1.31687.

MAF (n.d.) Mwea Aquafish Farm: https://mweafish.com/

Ministry of Agriculture (2020). NATIONAL FISHERIES POLICY, 2020: https://repository.kippra.or.ke/handle/123456789/4115

Ministry of fisheries development (2008). NATIONAL OCEANS AND FISHERIES POLICY, 2008: https://faolex.fao.org/docs/pdf/ken147947.pd

Mulei. I. R., Mbuthia. P. G., Waruiru. R. M., Nyaga. P. N., Mutoloki. S., Evensen. Ø. (2021). Management Practices, Farmers' Knowledge of Diseased Fish, and Their Occurrence in Fish Farms in Nyeri County, Kenya.: https://nmbu.brage.unit.no/nmbu-xmlui/handle/11250/2786984

Mwangi. M. H., (2011). A Companion for Fish farmers in Kenya: https://kefs.go.ke/sites/default/files/A%20COMPANION%20FOR%20FISH%20FARMERS%20IN%20KENYA%20%281%29.pdf

Nduku. T. 2015. Efficiency of Fish Farming under Economic Stimulus Programme in Kenya. Productive Sector Division, Kenya Institute for Public Policy Research and Analysis. KIPRA Discussion paper No. 181: https://repository.kippra.or.ke/bitstream/handle/123456789/2507/DP181.pdf?sequence=1&isAllowed=y

Nkhoswe, J. *et al.* (2024). 'Sustainability of the Sub-Saharan African Capture Fisheries and Aquaculture Value Chains: A Review of the Roles and Challenges of Youths and Women in Ethiopia, Kenya, Malawi and Zambia.', *International Journal of Research and Innovation in Social Science*, VII, pp. 1643–1674.: https://doi.org/10.47772/IJRISS.2023.7012128.

Obwanga. B., Soma. K., Ayuya. O. I., Rurangwa. E., Wonderen. D., Beekman. G., and Kilelu. C. (2020). Exploring enabling factors for commercialising the aquaculture sector in Kenya. Wageningen University & research: 3R Kenya Research Report 011.: https://www.3r-kenya.org/aquaculture-publications/

Polson, R.A. and Spencer, D.S.C. (1991). 'The technology adoption process in subsistence agriculture: The case of cassava in Southwestern Nigeria', *Agricultural Systems*, 36(1), pp. 65–78. Available at: https://doi.org/10.1016/0308-521X(91)90108-M.

The World Bank u.d. Aquaculture production (metric tons) - Kenya. Food and Agriculture ORganization (FAO): https://data.worldbank.org/indicator/ER.FSH.AQUA.MT?locations=KE

Dey, M. M., Paraguas, F. J., Kambewa, P., and Pemsl, D. E. (2010). The impact of integrated aquaculture–agriculture on small-scale farms in southern Malawi. *Agric. Econ.* 41, 67–79. doi: 10.1111/j.1574-0862.2009.00426.x

Islam, A. M., Barman, B. K., and Khondker, M. E. J. (2015). Adoption and impact of integrated rice-fish farming system in Bangladesh. *Aquaculture* 447, 76–85. doi: 10.1016/j.aquaculture.2015.01.006

Obiero, K. O., Waidbacher, H., Nyawanda, B. O., Munguti, J. M., Manyala, J. O., and Kaunda-Arara, B. (2019). Predicting uptake of aquaculture technologies among smallholder fish farmers in Kenya. *Aquac. Int.* 27, 1689–1707. doi: 10.1007/ s10499-019-00423-0

Shoko, A. P., Limbu, S. M., Lamtane, H. A., and Kishe-Machumu, M. A., Sekadende, B., Ulotu, E. E., et al. (2019). The role of fish-poultry integration on fish growth performance, yields and economic benefits among smallholder farmers in sub- Saharan Africa, Tanzania. *Afr. J. Aquat. Sci.* 44, 15–24.

Van der Knaap, M. and Jesse. A. (2021). Fisheries and Aquaculture, Aquatic Sciences and Fisheries Abstracts (ASFA). FA2202012. FAO aquaculture news page 27-28: https://www.fao.org/fishery/en/openasfa/dfe6cdde-4080-4a08-81e3-d8841281d54

4. Appendices

4.1 Appendix 1: Research Matrix

Research objective	To analyse the socio-economic effects and perception of the GoK/IFAD ABDP project on farmer households, with a specific focus on Kigugu, Embu County, Kenya.			
Duration of field work: 2 weeks	**Research team size** 4 students from the University of Copenhagen; 3 students from the University of Nairobi; 1 student the Wangari Maathai Institute for Peace and Environmental Studies		**Field site:** Kithiria Kibugu, Embu county, Kenya	
Sub research question 1 How can the ABDP project in Kibugu be characterised?				
Variables/data needed	**Data collection and method**	**Sampling methods**	**Data analysis**	**Assumption and limitations**
1. Defining the project identity (timeline,	1.1.**Literature review:** Creating a base knowledge of aquaculture and the ABDP project in	All available literature from 1960 until the present.	Qualitative review	There is literature that documents and can provide relevant information on fish

actors, practicalities)	Kibugu town and Embu county			farming.
	1.2 Semi-structured **interview with GoK extension office.**	One extension officer was present.	Transcription and qualitative analysis using NVivo.	There will be an extension officer present in Kibugu, that we can contact.
	1.3. **Survey/Semi-structured interview with farmer households involved in the ABDP project.**	Whole population (if time permits, pending 1.2). If the population is too large, systematic sampling is based on a list of aquaculture households.	Quantitative analysis using descriptive statistics	That there is information on who the farmers are and where they are. That the farmers are willing to speak to us. The presence of a translator.
	1.4 **Market analysis** (to identify the consumer, sellers, and middleman) -> Informal conversation with people who buy fish and observation	Cluster sampling 10-20 respondents.	Quantitative analysis using descriptive statistics	More women than men in the market. Not overcrowded. That the consumers are willing to speak to us
	1.5 **Semi-structured interviews with the chief and assistant chief.**	Whole population (if time permits, pending 1). If the population is too large, systematic sampling is based on a list of households.	Transcription and qualitative analysis using NVivo.	That we can get in contact with the Chief and assistant chief. They want to speak with us.
Sub-research question 2 How can fish and food production be characterised in households participating in the ABDP project?				
Variables/data needed	**Data collection and method**	**Sampling methods**	**Data analysis**	**Assumption and limitations**
2. Define the ABDP aquaculture at the household level	2.1 **Pond analysis** Measuring the pond, visual observation, soil type test, liner characterisation, net characterisation, water inputs, type of pond	Whole population (if time permits, pending 1). If the population is too large, systematic sampling is based on a list of households	Quantitative analysis using descriptive statistics	We need a measuring tape and a scale.. The farmers allow us to measure the pond.

	2.2 **Pond water assessment** -Temperature -dissolved O2 content -Nitrate content -pH value -Turbidity		Quantitative analysis using descriptive statistics and T-test dependent on categories found in 2.1	We need oxygen strips, a thermometer, pH strips and Nitrate strips. The farmers allow us to take water samples.
	2.3 **Semi-structured interviews with households involved in ABDP** (inputs needed, support)		Transcription and qualitative analysis using NVivo.	That there is information on who the farmers are and where they are. That the farmers are willing to speak to us. The presence of a translator.
3. Household fish production	3.1 **Pond analysis:** Number of fish, weight of the fish, mortality rate		Quantitative analysis using descriptive statistics and T-test dependant on categories found in 2.1 or other	We need measuring tape. The farmers allow us to measure the pond. We need a scale.
	3.2 **Semi-structured interview with farmer households involved in ABDP:** Information about the practicalities of fish production. Information about the process and value chain		Transcription and qualitative analysis using NVivo.	That there is information on who the farmers are and where they are. That the farmers are willing to speak to us. The presence of a translator.

	3.3 **Market analysis:** -> Observation of fish species being sold	Whole population, while we are observing	Observation and description	We need to know which market the fish is sold at. That it's possible to observe what consumers are buying The seller is willing to let us observe
4. Household non-fish food production	4.1. **Survey with ABDPAH and survey with NABDPAH** What crops you produce +how much What livestock you have +how much Estimate of increase/decrease in food production since (DATE OF START OF PROJECT?)	Whole population (if time permits, pending 1). If the population is too large, systematic sampling based on a list of aquaculture households.	Quantitative analysis using descriptive statistics (support received dates) and transcription and qualitative analysis using NVivo.	That there is information on who the farmers are and where they are. That the farmers are willing to speak to us. The presence of a translator.
Sub-research question 3 What is the relation between wealth perception, living standards and the ABDP project after the implementation?				
Variables/data needed	**Data collection and method**	**Sampling methods**	**Data analysis**	**Assumption and limitations**
5. Households' living Standards acc. to MPI	5.1 **Survey with farmer ABDPAH and survey with NABDPAH**: MPI living standard questionnaire	Random sample of non-aquaculture and aquaculture households	T test triangulation between 5 and 6	That people want to share personal and sensitive information
6.Households' wealth perception	6.1 **Semi-structured interviews with ABDPAH and semi-structured interviews with NABDPAH** about wealth perception to be able to see a difference between farmers who are part of IFAD´s project and farmers who aren't	Random selection from surveyed samples		
Sub-research question 4 How have farmer households perceived social changes with aquaculture?				

Variables/data needed	Data collection and method	Sampling methods	Data analysis	Assumption and limitations
7.Perception of social change (schedule, dietary, conflicts, power dynamics)	7.1 **Semi-structured interviews with ABDPAH and NABDPAH.** 7.2 **Focus group discussion.**	7.1 Whole population (if time permits, pending 1). If the population is too large, systematic sampling based on a list of households 7.2 10 selected members (considering different actors (e.g. traders or farmers), gender, age, wealth, etc.)	Transcription and qualitative analysis using NVivo.	That there is information on who the farmers are and where they are. That the people are willing to speak to us. The presence of a translator. Suitable time and location for the focus group discussion. Reasonable compensation.
8. Perception and challenges of project	8.1 **Semi-structured interviews with ABDPAH and NABDPAH.** 8.2 **Semi-structured interviews with the chief and assistant chief.** 8.3 **Focus group discussion.**	8.1 Whole population (if time permits, pending 1). If the population is too large, systematic sampling based on a list of households 8.3 10-15 selected members (considering gender, age, wealth, etc.)		

4.2 Appendix 2: Semi-structured interview guide with extension officers

Overall question		
A. Base information		
What is your name? _____ How long have you been the extension officer of Kibugu? _____ years Please briefly introduce your current responsibilities and job functions.		
Overall question	**Follow up question**	**Answer**
B. Questions related to the government		

Could you please give us an introduction to the project?	Were you involved in the implementation of the project? How does the government perceive the project? Do you believe that this project has met expectations? Is the fisheries office attentive to the potential impact of the project on fisheries resources, especially in terms of long-term sustainability?	
What actors have been part of the project?Information	What do the actors get out of the project?	
C. Information related to fish farming in Kibugu		
How many ABDP households are there in Kibugu? What proportion of farmers in Kibugu are engaged in aquaculture? Could you please map the ponds and ABDP households on the map? What is the annual production of fish in Kibugu? What are the main fish species cultivated in Kibugu? What are the market prices for these fish species?		

How much economic value can be generated from fish production?		
D. Questions related to ABDP households		
How does the fisheries office engage with the local community to facilitate the smooth implementation of the project?	How does the project communicate information to the farmers and other actors involved in the project? What do farmers have to do to get support? How do you choose farmers? What happens when farmers are selected? How is the process?	
Are there any schools in the ABDP project to educate the involved actors?	If yes, what does the school teach? If not, could it be relevant to have a school?	

4.3 Appendix 3: Semi-structured interview guide with ABDP's households

Questions

A. Base information

Base information

What is your name? _____

How old are you? _____ years old

Gender? M/F/O_____

How long have you been living in Kibugu? _____ years

How many other household members are there, including yourself? _____

Do you own your land? Yes or No

Base information related to fish farming

When did you start fish farming? _____

Why did you start fish farming?

Do you sell the fish? And if yes, why did you start?

How did you obtain the knowledge about fish farming?

Are you still doing fish farming? Yes or No

If you stopped, why?

Can you describe your fish farming project?

How big is your farm? _____ Acre

How many ponds do you have? _____ (quantity)

How big are each ponds?

What activities did you do before starting fish farming? _____ _____ _____

Do you participate in any off-farm activities? Yes or No

a) Which? _____

What is your role concerning the fish pond? (fish farmer/working at fish farm/pond builder/…) _____

Fish information about species		
What fish species is produced?		

Why did you choose this type of fish? Did you consider producing other kinds of fish?		
Information about fingerlings acquisition Where do you get your fingerlings from? How often do you buy fingerlings? How many fingerlings have you had to buy per month/year? What did you pay for the fingerlings? Were you satisfied with the quality and quantity of the fingerlings? How is the mortality rate?		
What is the timeline of the water?	How often do you put water in your pond?	

How is the process of the water source, where do you get it from and where does it end?	How often do you remove water from the pond? Where do you put the water that you remove? How often do you clean the pond	
Feed Where do you get your feed from?	How often do you buy feed? How much feed do you buy? How much do you pay for the feed? What kind of feed do you use How often do you feed the fish	
Were you satisfied with the quality and quantity of the feed?	If not, what could have been better? If yes, why so?	
Pond Construction How was your pond constructed?	Why did you decide to design the pond as you did What is the pond size? Did you meet any challenges in the construction?	

	What kind of pond liner do you have? Was your soil suitable for a fishing farm? - If not, what did you do to fix the problem?	
Did you have to make any changes to the surrounding environment when you constructed the pond?	If yes, what changes? If no, then no question	
Fish production How much fish do you produce?	What is your annual fish production in Kg? Have you harvested any fish from your pond? If so, how many and when?	
Of all your fish, how many do you consume directly and how much do you sell?	If you sell fish, where? Do you ever buy fish from other farmers?	
Have you ever lost fish?	If yes, what is the reason for the fish loss? - Disease - Theft - Eaten by animals - Other?	
Integration with agriculture and livestock		

What type of agriculture is present on your farm? Did you have to reduce the land for agriculture crops? Did you change the types of crops after the start of the fish farming? Did you perceive a change in the production of any crops? If so, which ones and what was the change? What input do you put in your surrounding fields? Do you spray the surrounding fields?		
What type of livestock is present? Do you rear livestock near the pond? Is there a relationship between the pond and the livestock?		
A. Law and policies		

Do you know of any government policy that supports fish farming in Kibugu? Did you start farming for a personal reason or a government initiative? If yes, which one (ministry of agriculture, ministry of fisheries, other _____) Did you receive any support from the government? (see support tablel) Are there any local structures or frameworks that support fish farming in Kibugu? Do you share knowledge? Do you have a formal group for sharing knowledge of fish?		
C. Experience of the fish farming		
How did the transition go from non-fish farmer to fish farmer? What could have made it easier? What successes have you seen in your farm?		

What failures have you seen in your farm? Is there a market for fish farming? If it's small, why? If there isn't any, what would it take to establish one?		
C. Water quality		
Why do you change the water? What do you think about your water quality? Do you have sufficient amounts of water		
D. Wealth/livelihood change perception		
How would you say your livelihood has changed since starting fish farming?	How did the adoption of fish farming have an impact on your wealth ? Is fish farming making economic sense? Do you perceive that the material things/assets have increased in the last 6 years?	
C. Outro		

Would you recommend fish farming to others?		

4.4 Appendix 4: Semi-structured interview guide with non-ABDP's households

Questions			
A. Base information			
Base information 1) What is your name? _____ 2) How old are you? _____ years old 3) Gender? M/F/O_____ 4) How long have you been living in Kibugu? _____ years 5) How many other household members are there, including yourself? _____ 6) Do you own your land? **Yes or No**			
Base information related to livelihoods strategy 7) Do you engage in agriculture cultivation? **Yes or No** 8) Do you have any livestocks? **Yes or No** 9) Are you self–employed or employed by someone? **S/E** 10) What other activities are you participating in? _____ _____ _____ 11) What is your main income source? _____ 12) Have your economic returns met your expectations? **Yes or No**			
Overall question		**Follow up question**	**Answer**
B. Perception of the ABDP project			
Have you heard about IFAD´s ABDP project?	If Yes, how?		

	What do you think about the project? Did you have the opportunity to participate in any of the training in the project?		
Why are you not part of the ABDP project?	Did you choose not to be a part of the project or were you not chosen for the project? What were your main reasons and concerns about the project? Are you considering being a part of a similar project in the future? - If yes, why?		
C. Wealth perception			
Do you perceive your wealth level as stable?	How did the adoption of fish farming have an impact on your wealth level? Can you perceive any changes in your wealth security in the last 6 years?		
Do you think that your source of drinking water is easily accessible?	If not, how could they be better?		

Do you think your house is resistant to climatic elements?	Do you feel the need to change something in its structure? And in the materials? Do you think it is good for insulating heat?		
Do you think the electric facilities are sufficient for your needs?	If not, how could they be better? Did the ABDP project have an impact on this?		
Do you perceive that the material things/assets have increased in the last 6 years?	If yes, do you perceive that they are giving you more economic safety?		
D. Perception of social change			
Do you believe that non-fishery farming activities have altered social relationships or interactions in your community?	If yes, how so? Are there new relationships between households participating in the ABDP project and the ones who don't? If yes, in what sense? Do households engaged in the ABDP project and households that's not a part of the project share resources? - If yes, what kind of resources?		

	- If no, why not?		
Has fish farming impacted market opportunities?	If yes, how? Has the project affected your livelihood? Have the ABDP project and fish farming contributed to the development of the community (e.g. infrastructure, service, education? - If yes, how?		

4.5 Appendix 5: Semi-structured interview guide with chief and assistant chief

Given the unfamiliarity with the villages and local customs, we will collaborate with the Kenyan team to complete this section upon our arrival in Kenya.

4.6 Appendix 6: Pond analysis

Characteristics of the pond	
Soil type	- Measure soil type - Is it clayey? - What type of water inlet/outlet does it have?
Type of water in/outlet	- Open in/outlet or pipe? - How tall are the pond free board (between water surface and edge of surrounding soil)
Bottom of pond	- How is the bottom constructed? - Is there used lime or anything else used to make it

	more unimpervious?
Pond liner	- Is there a pond liner? - What kind?
Surrounding environment	- Are there any forms of agriculture/livestock present? - Anything else that could affect the pond?

4.7 Appendix 7: Pond water assessment

Temperature	<u>How to measure Temperature</u> - Measure at similar depth - Similar time of the day
Dissolved O2 Content	<u>How to measure O2 content</u> - If we can get access to a Dissolved oxygen meter in Kenya, we will use that
Nitrate Content	<u>How to measure Temperature</u> - 5 ml sample of water into test tube - Add 6 drops shaked nitrate-1 and nitrate-2
pH value	<u>How to measure pH</u> - Similar time of day

Turbidity	<u>How to measure turbidity</u>
	- Measure it with our arm, submerge the arm vertically in water until the hand disappears.
	  - If water doesn't reach the elbow the turbidity is very high
	  - If it reaches the elbow turbidity is right

	- If the water reaches above the elbow the turbidity is too low

4.8 Appendix 8: Type of governmental support received

Support received	Received (Y/N)	Who	When did you receive it?	How satisfied are you? 1:Very unsatisfied 2:Unsatisfied 3:Ambivalent 4:Satisfied 5:Very satisfied	Do you expect to receive more in the future? (Y/N)	If so, when?	How could it be better?
I.e. Pond liner	*Y*		*January 2022*	*3*	*N*	*-*	*It was too small.*
Pond liner							
Predator net							
Training							
Fingerlings							
Construction help							
Transportation							
Fish feed							

Other_____							
Other_____							

4.9 Appendix 9: Survey part for the ABDP households for food production

	Type of food produced	**Did you notice a change in the level of production from the start of the project?**
Crop	Coffee	1) No 2) Not significant 3) Significant 4) Really significant 5) Highly significant
	Tea	1) No 2) Not significant 3) Significant 4) Really significant 5) Highly significant
	Macadamia	1) No 2) Not significant 3) Significant 4) Really significant 5) Highly significant
	Miraa	1) No 2) Not significant 3) Significant 4) Really significant 5) Highly significant

	Maize	1) No 2) Not significant 3) Significant 4) Really significant 5) Highly significant
	Beans	1) No 2) Not significant 3) Significant 4) Really significant 5) Highly significant
	Cowpeas	1) No 2) Not significant 3) Significant 4) Really significant 5) Highly significant
	Green grams	1) No 2) Not significant 3) Significant 4) Really significant 5) Highly significant
	Tomato	1) No 2) Not significant 3) Significant 4) Really significant 5) Highly significant
	Others _____	1) No 2) Not significant 3) Significant 4) Really significant 5) Highly significant

Fruit trees	Bananas	1) No 2) Not significant 3) Significant 4) Really significant 5) Highly significant
	Avocado	1) No 2) Not significant 3) Significant 4) Really significant 5) Highly significant
	Citrus	1) No 2) Not significant 3) Significant 4) Really significant 5) Highly significant
	Mango	1) No 2) Not significant 3) Significant 4) Really significant 5) Highly significant
	Paw-paw	1) No 2) Not significant 3) Significant 4) Really significant 5) Highly significant
	Pineapple	1) No 2) Not significant 3) Significant 4) Really significant 5) Highly significant

	Others _____	1) No 2) Not significant 3) Significant 4) Really significant 5) Highly significant
Livestock	Milk (animal)	1) No 2) Not significant 3) Significant 4) Really significant 5) Highly significant
	Eggs (animal)	1) No 2) Not significant 3) Significant 4) Really significant 5) Highly significant
	Meat (animal)	1) No 2) Not significant 3) Significant 4) Really significant 5) Highly significant
	Cheese (animal)	1) No 2) Not significant 3) Significant 4) Really significant 5) Highly significant
	Others _____	1) No 2) Not significant 3) Significant 4) Really significant 5) Highly significant

4.10 Appendix 10: Focus group discussion guide

Questions	Answers
What excited you the most about being a part of the ABDP project?	
Which challenges were the most difficult being part of the project?	
Do you think that the ABDP project creates conflicts in the communities?	
How do you see the ABDP project contributing to the development of the community in Kibugu?	
How do you see the project going, in the future?	
Are there anything you want to add about the ABDP project that we haven't discussed?	

4.11 Appendix 11: Summary of material needed

Material	Need from the	Who is sourcing

	university?	
Recorder	X	
Pencil		
Notebook		
Thermometer x1	X	
pH strips x 40	X	
Nitrate strips x 40	X	
Oxygen strips x 40		
Test tubes x 5	X	
Filters x 40	X	
Camera		Noa
GPS	X	
Measuring take		Francois?
Print out of surveys		
Print out of semi-structured interview (METHOD 1)		
Print out of semi-structured interview (METHOD 2)		
Print out of semi-structured interview (METHOD 3)		
Print out of survey (METHOD 5)		

8.2. Information about water quality and optimal fish conditions

Firstly, the temperature of the water has an impact on the activity, growth, reproduction and feeding of the fish when the water temperature is outside the fish species preferred temperature, the body will either be too hot or cold and fish growth will be affected, on table 5 the preferred temperature for Nile Tilapia, Catfish/mudfish and Trout is shown:

Table 5 Optimal temperature ranges for different fish species (Mbugua H. Nwangi, 2011)

Fish species	Lethal water temperature (C)		Optimum temperature (C) range for adults	Temperature range for fingerlings (C)
	Lower	Upper		
Nile Tilapia	12	38	27-30	22-32
Catfish/Mudfish	-	-	25-27	20-30
Trout	Close to 0	22	15-17 (16)	4-18

Secondly, the nitrate and nitrite contents in the pond can stress the fish, affect the fish growth, damage organs, as well as make the fish more susceptible to diseases if the fish are exposed to it over longer periods. Nitrate and nitrite can be transferred to the fish from pesticides and other inputs in the surrounding fields and are therefore relevant to measure (Aqueon, 2021).

Thirdly, the turbidity in the water is also important for the growth and feed of the fish and tells something about the amount of oxygen in the water. Turbid water has a bad visibility

and may be due to organic organisms such as plankton in the water or the amount of suspended solids (soil). The suspended solids may be due to fish species that stir up the bottom or not enough water flow. A high turbidity can also be because of the content of organic organisms. This can be caused by a lack of water flow in the pond, lack of cleaning or fertilisers. Too much organic materials in the pond means less oxygen for the fish because of not enough sunlight penetration causing the plankton to not create enough photosynthesis. On the other hand, too little organic material means that there is not enough photosynthesis in the pond and therefore not enough oxygen so that the fish can grow.

Furthermore, there are the chemical aspects of the water quality such as acidity and alkalinity, measured through the water's pH-value. The fish production can be affected by too high or too low pH, which can affect production, and with extreme values the fish can die. On figure 10 is shown the optimal pH-values for fish production, which should be as close to 7 as possible.

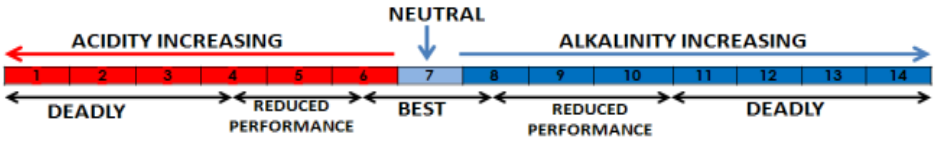

Figure 10 Optimal pH-value for fish production as well as thresholds for reduced performance and deadly content of pH (Nwangi, 2011)

8.3 Table with overview of all methods - mandatory

8.3.1: Semi-structured interviews

Extension officer	
Material needed	Recorder Pencil Notebook
Goal	• To get an introduction to aquaculture in relation to ABDP in Kibugu. • To gain knowledge of who the farmers are and where they are, the timeline . • To begin to characterise the project and know the practicalities, from the planner's point of view. • As well as if there are any unknown parts of the Fish farming value chain. • And new factors to take into consideration.
Context	There is an extension office in Kibugu that knows aquaculture and the ABDP in the area.
ABDP fish farmers	
Material needed	Recorder Pencil Notebook
Goal	• Getting basic knowledge such as the demographics of the farmers. • Getting information about the GoK and IFAD project from the farmers point of view. • Defining aquaculture and the ABDP at the household level. • Information about the practicalities of fish production. • Information about the process and value chain • Informations about wealth perception to be able to see a difference between farmers who are part of IFAD´s project and farmers who aren't

Context	There are farmers engaged in ABDP aquaculture in Kibugu.
Non-ABDP fish farmers	
Material needed	Recorder Pencil Notebook
Goal	• Wealth perception to be able to see a difference between farmers who are part of IFAD´s project and households who aren't. • To be able to compare challenges and social changes related to the project between ABDP and non-ABDP.
Context	There are presumably households that do not partake in ABDP, and probably they also have a different perspective on the project.
Conduction of interviews	The semi-structured interview was conducted by asking a mix of open-ended questions and closed-ended questions. Whereof the questions got more open as the interview progressed and the interview followed an interview guide. During the interview the members of the group got assigned roles so there was one main interviewer, one person recording, who also acted as a secondary interviewer and one person taking notes. The rest of the group listened and had the chance to ask follow up questions in the end. This interview was fully transcribed. If the respondent didn't speak English, the question would be asked in English and translated to either Swahili or Kiembu, in which the respondent would also answer in. After this one of the Kenyan students or the guides would translate the answer to the question. The respondents were found by the guides by asking for leads to other farmers from the fish farmers we interviewed and people the guides knew in Kibugu. All the farmers that were found and who were willing to be interviewed were interviewed.

Focus group discussion	
Material needed	Recorder Pencil Notebook Food/drinks
Goal	• Gauge community perception of the project. • Evoke a discussion about the IFAD project and the positives and negatives met. Possible to compare different opinions and experiences between farmers as well as evoke opinions that wouldn't be said in a casual forum. • Bring out the dynamics of interaction between the different actors
Context	There are different actors involved who may have different perspectives on social change and the challenges that the project implies, therefore women, men, young and older will be taken into consideration from ABDP households and no ABDP households, but also sellers, traders, owners of the land.
Conduction of focus group interview	The discussion was conducted with one person asking questions to the assembly, one person taking notes, and one person recording. The rest of the group was listening and could ask follow up questions if needed.

8.3.2: Pond water assessment

Water assessment	
Material needed	Thermometer x1 pH strips x 40

	Nitrate strips x 40 Oxygen strips x 40 Test tubes x 5 Filters x 40
Goal	To characterise the pond/aquaculture system that we relate with food production.
Context	Fish are in ponds, it is important to know what the characteristics of these are. Could also be possible to establish relationships between the water quality and fish production.
Selection process:	The selection of ponds to be measured was dependent on the number of ponds the farmer had. In this study all ponds were measured because the farmers had between 1 and 3 ponds, except with two farmers. With pond 13.1 and 13.2 we chose two different ponds with the same fish species but with two different states of fish. One where the fish didn't grow and one where the fish was growing to see if there was a difference in the water quality that affected the fish. And also with pond 6.1, 6.2 and 6.3 to see if there was a difference in the water quality in the ponds with fingerlings and the ponds with fully grown fish. This farmer had over 10 pond's and we therefore also assessed both the first pond the water inlet reached and also the last pond the water inlet reached, to see if there was a difference in the water.
How the assessment was conducted	<u>Nitrate and Nitrite:</u> In the pond water assessment we measured the Nitrate and Nitrite with the help of a Quantofix Nitrate 100 set. This was done by collecting five water samples from the pond and filtering the water to remove any disturbances. After the filtering process the water was tested by dipping a nitrate strip in the filtered water for 1 second, followed by shaking excess water off the strip and waiting for 60 seconds. After this the

	colours on the nitrate strip were compared to a scale on the nitrate strip container. pH-Value: The pH-value was measured with an eco Testr pH 1 apparatus. This was done by dipping the apparatus in the water for 10 seconds in five different places to ensure a representative sample and reading the pH-value from it. This was done at the surface of the water. Temperature: We also measured the temperature because it has an impact on the growth and well being of the fish. The correct temperature of the pond varies depending on the fish species. Whereof a trout lives in colder water and climate a Nile Tilapia and Catfish lives in warmer water. The temperature was also measured in five different places in the pond at the surface, around 5 cm deep in the water. Turbidity: The turbidity is the amount of organic material in the pond. If there is too much organic material in the pond there will be a decrease in the photosynthesis and therefore a decrease in the production of oxygen, leading to algae death, decomposing of plankton and therefore less food and oxygen for the fish. Whereof if the turbidity is too low there will not be enough oxygen produced for the fish and there will not be enough food (organic material) for the fish. So, the turbidity affects the growth of the fish. The turbidity was measured by dipping one's arm vertically in the water until the hand disappears. If the hand disappeared before the water reached the elbow, then the turbidity was too high, if the hand disappeared after the water reached above the elbow, the turbidity was too low. If the hand disappeared when the water reached

	the elbow the turbidity was normal or the density of organic material should be around 30 cm (source).

8.3.3: Surveys

Consumer survey	
Material needed	Recorder Pencil Notebook
Goal	Understand a part of the value chain and figure out if there was an actual demand for fish
Context	The demand for fish is one of the drivers for fish production
How the consumer survey was conducted	The survey was conducted by splitting the research group into four groups of 2-3 people and walking around the market surveying consumers. The research group tried to survey the same amount of women and men and also get an equal representation of age groups to get a more representative sample group.
Fish seller and hotel survey	
Material needed	Recorder Pencil Notebook Camera
Goal	To get an idea about if fish are being sold in the market, if so how many, which types, and the actors involved.
Context	Are fish sold at the market and hotels?

How the Fish seller and hotel survey was conducted	The survey was conducted by walking around Kibugu and asked fish sellers in the Sunday market questions about their fish sale. On a separate day, hotels were asked if they sold fish.
Fish feed availability assessment	
Material needed	Recorder Pencil Notebook
Goal	To assess the possibility of buying fish feed in Kibugu
Context	Multiple different agrovets in Kibugu, but multiple informal ways the fish farmers bought feeds
How the Fish seller and hotel survey was conducted	The research group visited all the known agrovets in Kibugu and asked if they sold fish feed or ever did sell it.

8.4 Interview guide fish farmers

Questions
A. Base information
Base information What is your name? _____ How old are you? _____ years old Gender? M/F/O_____ How long have you been living in Kibugu? _____ years How many other household members are there, including yourself? _____ Do you own your land? Yes or No

Base information related to fish farming

When did you start fish farming? _____

Why did you start fish farming?

Do you sell the fish? And if yes, why did you start?

How did you obtain the knowledge about fish farming?

Are you still doing fish farming? Yes or No

If you stopped, why?

Can you describe your fish farming project?

How big is your farm? _____ Acre

How many ponds do you have? _____ (quantity)

How big are each ponds?

What activities did you do before starting fish farming? _____ _____ _____

Do you participate in any off-farm activities? Yes or No

a) Which? _____

What is your role concerning the fish pond? (fish farmer/working at fish farm/pond builder/…) _____

Fish information about species What fish species is produced? Why did you choose this type of fish? Did you consider producing other kinds of fish?		
Information about fingerlings		

acquisition Where do you get your fingerlings from? How often do you buy fingerlings? How many fingerlings have you had to buy per month/year? What did you pay for the fingerlings? Were you satisfied with the quality and quantity of the fingerlings? How is the mortality rate?		
What is the timeline of the water? How is the process of the water source, where do you get it from and where does it end?	How often do you put water in your pond? How often do you remove water from the pond? Where do you put the water that you remove? How often do you clean the pond	
Feed Where do you get your feed from?	How often do you buy feed? How much feed do you buy? How much do you pay for	

	the feed? What kind of feed do you use How often do you feed the fish	
Were you satisfied with the quality and quantity of the feed?	If not, what could have been better? If yes, why so?	
Pond Construction How was your pond constructed?	Why did you decide to design the pond as you did What is the pond size? Did you meet any challenges in the construction? What kind of pond liner do you have? Was your soil suitable for a fishing farm? - If not, what did you do to fix the problem?	
Did you have to make any changes to the surrounding environment when you constructed the pond?	If yes, what changes? If no, then no question	
Fish production How much fish do you produce?	What is your annual fish production in Kg?	

	Have you harvested any fish from your pond? If so, how many and when?	
Of all your fish, how many do you consume directly and how much do you sell?	If you sell fish, where? Do you ever buy fish from other farmers?	
Have you ever lost fish?	If yes, what is the reason for the fish loss? - Disease - Theft - Eaten by animals - Other?	
Integration with agriculture and livestock		
What type of agriculture is present on your farm? Did you have to reduce the land for agriculture crops? Did you change the types of crops after the start of the fish farming? Did you perceive a change in the production of any crops? If so, which ones and what was the change? What input do you put in your surrounding fields?		

Do you spray the surrounding fields?		
What type of livestock is present? Do you rear livestock near the pond? Is there a relationship between the pond and the livestock?		
A. Law and policies		
Do you know of any government policy that supports fish farming in Kibugu? Did you start farming for a personal reason or a government initiative? If yes, which one (ministry of agriculture, ministry of fisheries, other _____) Did you receive any support from the government?（see support tablel) Are there any local structures or frameworks that support fish farming in Kibugu? Do you share knowledge? Do you have a formal group for sharing knowledge of fish?		
C. Experience of the fish farming		
How did the transition go from non-fish farmer to fish farmer?		

What could have made it easier? What successes have you seen in your farm? What failures have you seen in your farm? Is there a market for fish farming? If it's small, why? If there isn't any, what would it take to establish one?		
C. Water quality		
Why do you change the water? What do you think about your water quality? Do you have sufficient amounts of water		
D. Wealth/livelihood change perception		
How would you say your livelihood has changed since starting fish farming?	How did the adoption of fish farming have an impact on your wealth ? Is fish farming making economic sense?	

	Do you perceive that the material things/assets have increased in the last 6 years?	
C. Outro		
Would you recommend fish farming to others?		

8.5 Interview guide extension officer

Interview guide extension officer:

Overall question		
A. Base information		
What is your name? _____ How long have you been the extension officer of Kibugu? _____ years Please briefly introduce your current responsibilities and job functions.		
Overall question	**Follow up question**	**Answer**
B. Questions related to the government		
Could you please give us an introduction to the project?	How did the government start the project Were you involved in the implementation of the project?	

	How does the government perceive the project? What is the state of the project Do you believe that this project has met expectations? Is the fisheries office attentive to the potential impact of the project on fisheries resources, especially in terms of long-term sustainability?	
What actors have been part of the project?	What do the actors get out of the project?	
C. Information related to fish farming in Kibugu		
How many ABDP households are there? What proportion of farmers are engaged in Fish farming? Could you please map the ponds and ABDP households on the map? What is the annual production of fish? What are the main fish species cultivated? What are the market prices for these fish species? How much economic value can be generated from fish production?		

D. Questions related to ABDP households		
How does the fisheries office engage with the local community to facilitate the smooth implementation of the project?	How does the project communicate information to the farmers and other actors involved in the project? What do farmers have to do to get support? How do you choose farmers? What happens when farmers are selected? How is the process?	
Are there any fish ponds in schools in the ABDP project to educate the involved actors?	If yes, what does the school teach? If not, could it be relevant to have a pond in a school?	
D. Structure of fish farming		
Are there any local structures	What kind of support does the farmers get Are there any collaborations	

	- E.g between NGO and government	
We have visited some fish sellers in the market and fish ponds but we dont great results for the project and it seems like a lot of farmers does not know about the project, why is there a gap	What are some of the challenges impeding the success of the project in Kibugu	

8.5 Questions for consumer survey

Questions:	Answer:
Name:	
Gender:	
Age:	
Do you like fish farming?	
Do you ever buy fish?	
If yes, where?	
If no, why not?	
How often do you buy fish?	
How often do you eat fish?	
Would you like there to be more fish available?	

8.6 questions for focus group discussion

Tell us about your group and its goal
Do you share knowledge?
What do you think of the help by the governmental programs ABDP and ESP?
What do you think about fish farming in Kibugu?
What is the group's future vision of fish farming?