



Review and analysis of small-scale aquaculture production in East Africa

Summary and Recommendations

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Wageningen Centre for Development Innovation

Wageningen, October 2018

This study was conducted for Msingi East Africa.



Msingi East Africa is funded by the following organisations:



Report WCDI-18-019

Arie Pieter van Duijn, Peter G.M. van der Heijden, Bas Bolman and Eugene Rurangwa, 2018. *Review and analysis of small-scale aquaculture production in East Africa; Summary and Recommendations*. Wageningen Centre for Development Innovation, Wageningen University & Research. Report WCDI-18-019. Wageningen.

This report describes the findings of literature studies and of interviews with fish farmers and key informants in Kenya, Rwanda, Tanzania and Uganda as well as recommended actions that result from the findings. The studies were commissioned by Msingi East Africa in collaboration with Stichting BoP Innovation Centre and have been reported in four separate reports, covering each country. This final report provides a summary of all country reports.

Extensive to semi-intensive production of Tilapia and to a lesser extent, African Catfish in small ponds is the most common production system in the region. However, there is a rapidly expanding culture of tilapia production in floating cages taking place in Lake Victoria and in other lakes.

The situation of small-scale aquaculture producers as well as support services in the four countries differs but most small-scale fish farmers in the region are confronted with a shortage of essential inputs (especially fish feed, fingerlings and credit) of good quality and affordable price. The level of knowledge about better farm management practices, of related skills and application of more advanced technology (needed to increase productivity and income) is low for most farmers. For most countries the opportunities for the more advanced segment of small-scale farmers to grow are good. The study recommends a number of actions which it is believed will contribute to growth of smallholders' production and income for all the countries surveyed.

Key words: small-scale aquaculture; commercial aquaculture; small-holders; aquaculture value chain; Kenya; Rwanda; Tanzania; Uganda; East Africa

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Report WCDI-18-019

Photo cover: Ponds of Nyakoe selfhelp group, Kitutu Chache, Kisii County, Kenya. Photo: Edwin Muga

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Preamble

This report provides a summary of the findings and recommendations extracted from the following study reports that were prepared for Msingi East Africa:

1. ***Review and analysis of small-scale aquaculture production in east Africa. Part 1. Kenya*** by Joshua Meeks; Arnoud Meijberg; Maureen Nyachwaya and Tom Cadogan (Farm Africa; September 2018)
2. ***Review and analysis of small-scale aquaculture production in East Africa. Part 2. Rwanda*** by Eugene Rurangwa (Wageningen Marine Research, Wageningen University & Research) and Jean Bosco Kabagambe (AFAS Rwanda Ltd, October 2018)
3. ***Review and analysis of small-scale aquaculture production in East Africa. Part 3. Tanzania*** by Peter G.M. van der Heijden (Wageningen Centre for Development Innovation, Wageningen University & Research) and Amon P. Shoko (Tanzania Fisheries Research Institute; October 2018)
4. ***Review and analysis of small-scale aquaculture production in East Africa. Part 4. Uganda*** by Bas Bolman (Deltares), Arie Pieter van Duijn (Wageningen Economic Research, Wageningen University & Research) and Justus Rutaisire (Aquafarm Consults Ltd; October 2018)

For reference to the sources of the data and information in this report the reader is referred to the four country reports.

Acknowledgements

The study of the small-scale aquaculture producers in East Africa as described in this report would not have been possible without the many people who were interviewed during the field work in Kenya, Rwanda, Tanzania and Uganda. Their names are mentioned in the four reports that describe the small-scale aquaculture producers of Kenya, Rwanda, Tanzania and Uganda respectively. We are grateful for the time they made available and for the fact that they welcomed us on their farms or in their companies or offices. We would also like to thank the local experts that played a vital role in the field studies. Without their knowledge of the situation, network and efforts the studies of the smallholder aquaculture situation on location, we would not have achieved the same spread and depth as has been the case.

We are also grateful to the staff members of Msingi and colleagues from Wageningen Centre for Development Innovation (WCDI) who commented on drafts of this report and provided valuable suggestions for improvement.

1 Introduction

East Africa is endowed with excellent natural freshwater resources and climate. Currently freshwater aquaculture is practised by thousands of small-scale fish farmers producing Tilapia and Catfish, mainly in ponds but also in artisanal cages in lakes in the region. Smallholder fish farming has been promoted by governments and by various development partners. Nevertheless, the scale and productivity of smallholder aquaculture in East Africa remains below the level needed to support significant sector growth. International evidence suggests that small-scale aquaculture can play a significant role in parallel to the development of larger commercial production that will catalyse the sector. Development of a viable smallholder sector has the potential to greatly improve livelihoods in the industry.

Msingi (www.msingi.com), is an East African industry development organisation that aims to support the growth of competitive industries in the region. Msingi identifies strategic industries in which East Africa has a comparative advantage and supports their growth through investment and technical assistance. This is complemented by wider support to the sector on policy, technology transfer, research and development, human capacity building or support to key sector organisations. Aquaculture has been selected as the first East African industry for support under Msingi.

Currently, available data on the small-scale producer segment in East Africa is inadequate. Msingi in combination with BoP Innovation Centre contracted Fair and Sustainable Consultancy who teamed up with Wageningen University and Research and Farm Africa to carry out an independent assessment of current small-scale freshwater aquaculture production. The study is conducted in the context of the current sector with emergent commercial industry players and will also highlight opportunities to link small-scale and larger commercial producers.

2 Methods

The objective of study of the small-scale aquaculture producers in East Africa is to demystify this segment and the regional aquaculture industry and interested stakeholders with objective data on the status of small-scale aquaculture and its potential for growth. The detailed study objectives and subjects to be covered are found in Appendix 1.

2.1 Definition of small-scale commercial fish farming

This study has focussed on small-scale commercial fish farming. This sub-sector within aquaculture was defined as follows:

- A small-scale commercial fish farm is managed as a for-profit business by either an individual or a group (e.g. a cooperative).
- The individual or group invests capital in the enterprise.
- Cash returns on investment are the main criterion of success.
- Individual farmers produce less than 50MT per annum (group production can be above 50 MT per annum as long as the individual production is less than 50 MT per annum).

Production takes place in cages, ponds or tanks, open or closed systems and in stand-alone or integrated systems.

2.2 Literature and field studies

The study is comprised of desk studies and field studies. For the desk studies, literature and data available in the WUR current databases and updates from published reports, grey literature, peer-reviewed scientific articles, national statistics were analysed. These were supplemented by documentation and data not available online but accessible locally to national consultants.

Visits and interviews of fish farmers, service providers and other key informants served as additional validation method. Key informants in this study included sample groups of fish farmers, managers of fish hatcheries and fingerlings producers, fish feed producers, finance providers; national industry associations and umbrella organisations, sector associations, officials at the Ministry in charge of Aquaculture, East African Community institutions in charge of aquaculture, research and academic institutions and others.

During field visits, interviews focused on production systems and management, the fingerling and fish feed production and distribution systems, finance and market linkages available to the small-scale fish farmers. The semi-structured interview method was used to collect information from both key informants individually (in most cases during face-to-face meetings, in some cases by telephone) or in focus group discussions. From the objectives of this study and from the list of subjects to be covered, lists of questions were derived that were tailored to the various categories of key informants. These lists of mainly open-ended questions served as guidance during the semi-structured interviews.

More details about the methods, the key informants who were interviewed and the literature references that have been used can be found in the reports of the studies of the smallholder aquaculture producers that took place in Kenya, Rwanda, Tanzania and Uganda:

1. ***Review and analysis of small-scale aquaculture production in east Africa. Part 1. Kenya*** by Joshua Meeks; Arnoud Meijberg; Maureen Nyachwaya and Tom Cadogan (Farm Africa; September 2018)
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3 Main findings and recommendations

Of the four countries studied, Uganda has the highest farmed fish production. With an annual production reported to exceed 100,000 tonnes its farmed fish production is seven times the production of the first runner –up in the region, Kenya¹. Extensive to semi-intensive production of Tilapia and to a lesser extend African Catfish in small ponds is the most common production system in the region, but a growing part of total production results from the fast expanding cage culture of Tilapia taking place in Lake Victoria. Key data of the national freshwater aquaculture sector and of freshwater smallholders of Kenya, Rwanda, Tanzania and Uganda are summarised in Table 6 (page 34).

3.1 Kenya

Aquaculture production in Kenya is reported to have increased to 24,096 tonnes in 2014 as result of support through the Economic Stimulus Programme, (ESP) by the government, after which a decline has set in. Production reached an estimated 14,952 tonnes in 2016. The decline is explained by a value chain that is not well articulated, lack of good quality fish feed, lack of service providers and training facilities and inefficient market access. Major freshwater production areas are Lake Victoria and Central Kenya.

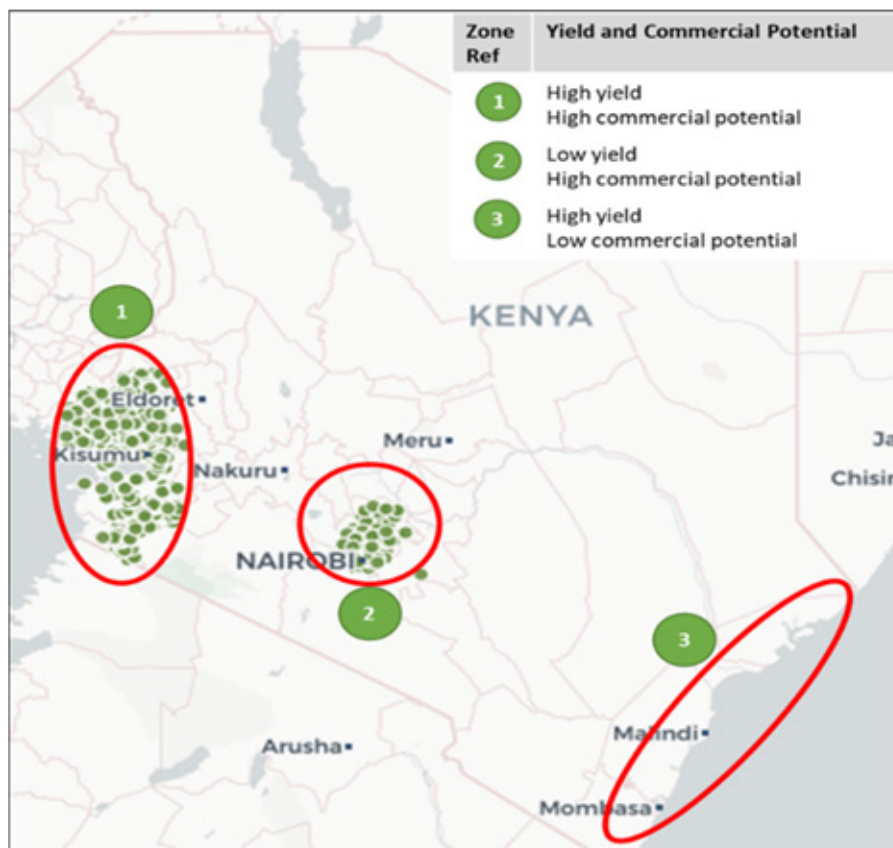


A fish farmer on his boat in Lake Victoria. Farm Africa / Gerard Brown

¹ National aquaculture production data were obtained from official government sources but there is difference of opinion as to the accuracy of these data.

3.1.1 Main small-scale commercial fish farmer segments

In addition to being a small-scale sector operating with smaller ponds, the sub-sector also includes medium and large-scale businesses using advanced technologies for fish farming in pond systems, cage growing in open water and reservoirs, and trout production on rivers.



Geographic clusters or Key Production Areas. Source: Farm Africa -KMAP Production Zone Data

The majority of fish farmers are small-scale producers with one or two ponds, each roughly 300 m² in size, who rely on other sources for the major part of their income. For them fish farming is a diversification option. This often leads to 'low-input and low-output' management strategy. 'Low output' means there is a risk of aquaculture being unprofitable, while with a different management system their pond(s) could potentially meet household dietary needs.

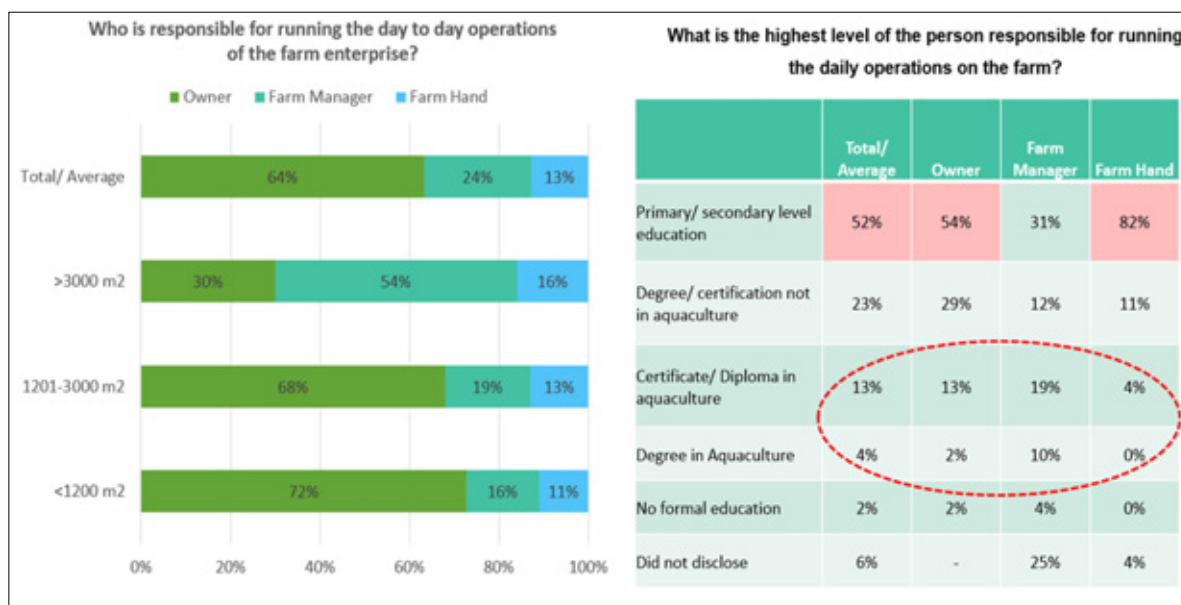
Studies by Farm Africa (FA) of fish farmers from Central and Western part of Kenya showed that the majority were tilapia farmers of which 34% practiced polyculture with catfish. Farm size ranged from 300 m² to 30,000 m². The majority (92%) of the farmers practiced semi-intensive production, meaning that they use both fertilizer and supplement it with feed. Production was also affected by extended production cycles lasting up to a year. Low productivity of about 0.31 kg/m² (3.1 tonnes/ha) was reported. In cooler areas growth and production are significantly lower and production cycles tend to be longer.

Key Production Systems of Smallholder Farmers in Kenya

Production systems	Production (Mt/farm/year)	Production intensity	Produced species	Feed used	Estimated % of producers
Earthen ponds (with or without plastic lining) of average 250 m ² , in colder areas sometimes in greenhouses. Raised ponds for catfish. Flow-through systems for trout	<2	Extensive and semi intensive	Tilapia, African catfish and Trout	Green water, home waste, Mash, pellets (local and imported)	84% ± 30 trout farmers
Earthen ponds, liner ponds of 250 m ² average and square cages 2x2x2 m and other variations (high-density low volume)	2 – 50	Semi-intensive to intensive	Tilapia and African catfish	Mash, pellets (local and imported)	15%
Larger square and circular cages (low-density high volume)	41 and up	Semi-intensive to intensive	Tilapia	Mash, pellets (local and imported)	1%
Recirculation systems designed by international experts and locally designed		Intensive	Tilapia	Pellets (local and imported)	< 10 farmers

3.1.2 Skill levels of small-scale commercial farmers

The educational background of most farm managers and workers is low. Just 10% of farm managers have degrees in aquaculture, and only 31% have completed secondary school. Only 13% of the farmers surveyed had received any training in basic business management. Different skill levels exist across the small-scale commercial farm labour force and farmers learn most often from each other (cross-farmer learning).



Education and Training Levels at Smallholder Farms. Source: Farm Africa

3.1.3 Inputs

- The majority of farmers practise semi-intensive production, supplementing fertilisers with feed. In both tilapia and catfish farming there was very low utilisation of floating feed (10% tilapia, 5% catfish respectively). Fish feed makes up an average of 64% of direct costs and therefore must be focused on to improve efficiency.

The following challenges were identified, relating to availability of cost and quality of inputs:

- Smallholder farms are characterised by limited outreach, both in terms of access to inputs, as the vast majority only seek inputs from suppliers within a range of 45 kms.
- The quality of the inputs accessed is also questionable as input suppliers mentioned by farmers were unknown or operating at a very small scale without proper infrastructure in place to produce either quality feed or fingerlings.
- The limited number of large-scale mills constrains availability of feed, potentially impacting negatively on cost and reliability of feed.
- Quality of hatchery and fry may be low due to poor brood stock used and poor management.
- There is no certification of fry in private hatcheries.
- Lack of zoning of aquaculture areas results in land sometimes not being available in the best locations for aquaculture production.
- Water quality in ponds is not well-maintained due to high pumping costs, and competitive uses of water.

3.1.4 Access to Markets

- The main reasons cited by farmers for selecting certain markets was the perception that the market had good prices or that it was easily accessible and near the farm. The farmers also valued the fact that they did not have to spend money on transport in getting their fish to the market and hence preferred to sell their produce on farm or if the buyer could cater to their own transport costs.
- Farmers may not have the appropriate information to gain full value for their produce. This will include information such as quality and size requirements, current market prices and market price cycle. For example, only 40% of farmers were able to say when the best time of year is to sell fish. Further, the availability of aquaculture markets data is scarce and inconsistent.
- With few cold storage solutions in place, over 60% of farmers in the KMAP program still sell at the farm gate to reduce costs, time and risks of looking for markets. Other reasons included: lack of trust in traders; less time consuming for sales; and reduced need of value addition.
- Cage culture is often more commercial in nature, focusing on accessing high value-markets. 75% of the small and medium-scale farmers sell their produce at farm gate. Whereas they get 6% higher value when they sell off-farm, according to Farm Africa's own surveys.
- Farmers need support to help them identify and access high-value markets through a combination of market information and effective business and production planning skills to improve cash forecasting.

3.1.5 Findings

Common conditions, habits or other factors determining success of small-scale commercial fish farming

The following factors that affect the productivity and returns of existing aquaculture farms were identified:

- Site specific water temperatures. In some areas with producers, ambient water temperatures are too low to allow optimal tilapia growth.
- Challenges with the business management systems applied and business acumen of the farmer. Many small-holder farmers have risk reduction behaviour, leading to low input – low output farm management.
- Inadequate availability of quality and affordable fish feed.
- Poor understanding by fish farmers of general pond and cage culture management for increased production.
- Lack of financial literacy, record keeping and ability to calculate costs of production and basic business plans.
- Limited understanding by farmers of market dynamics and inadequate understanding of (and attention to) the economics of fish production.

Key problems by segment and opportunities for improving productivity

KMFRI (2017) determined the following factors affecting aquaculture development as critical:

Factors external to the value chain:

- Poor infrastructure (roads, power, water);
- Lack of information for farmers and would-be investors;
- Capital inputs are expensive, have high interest rates and are not suitable for aquaculture producers;
- Inadequate investment in research, capacity building and information dissemination;
- Low levels of human capacity in county governments for extension services.

Factors related to availability and cost of quality inputs:

- Lack of quality fish feed;
- Quality of hatchery fry; no certification of fry produced in private hatcheries;
- Lack of zoning of aquaculture areas; land not being available in the best locations;
- Water quality in ponds is not well maintained; competitive uses of water.

In addition to these factors, the research done by Farm Africa identified the following additional challenges to small-scale aquafarmers:

- Farmers lack the understanding and ability to compute monthly cash flows and profits, which affects their ability to invest. Increased investment in all inputs leads to increased productivity.
- Improved FCR leads to reduced growing cycles. Fish farmers need support to help them invest in aquaculture production, they also need technical skills development to maximise FCR and reduce growing periods. This reduces the cyclical costs, the risk to stock and cash demand for fish farmers.
- Investment in fingerlings and use of the correct strain affects production. It is important to enable farmers to invest in quality fingerlings.
- Record keeping and the ability to understand the costs of production are essential for farmers to make informed investment decisions to increase their potential income.

In another study by Farm Africa 40% to 50% of the smallholder fish farmers surveyed identified predation (by animals and humans), the high price of feeds and the difficulty to get quality fingerlings as the most important challenges.

Despite the rapid growth of cage culture in Lake Victoria, there are currently no specific cage culture regulations in place. Addressing this issue is of an urgent nature given the fast growth of the number of cages over the past two years so as to ensure sustainability in this sub-sector. Guidelines for cage culture should, therefore, encompass at least the following:

- zoning
- use of chemicals and medical treatment
- maximum carrying capacity per production zone
- quality of feed (buoyancy and phosphor content)
- socio-economic aspects.

FA also analysed factors that affected profitability of fish farming for small-scale producers. A lack of market information resulted in many farmers selling fish not in the season with highest fish prices, selling the size of fish that was not preferred by the market or not selling their fish in the location where the best price was offered. A significant number of farmers also used the fish in the pond(s) as a savings account for emergencies: they sold off (part of) their fish when cash was needed in the household (for instance for school fees or to cover cost of medical treatment). Besides the lack of marketing information, this also explains why fish is sold when it is still too small and at a time and place where the price offered is not optimal.

Small-scale commercial fish farming trends

The following major trends were identified:

- Total fish production from pond culture is reported as having decreased after support by the Economic Stimulus Programme ESP came to an end.
- Cage culture in Lake Victoria has gained popularity in the past 4 years and is growing explosively in some locations. In early 2017 there were over 38 enterprises in Lake Victoria with 1,663 operational cages, with the Low Volume High Density (LVHD) type being the preferred methodology.

- As of now there are no specific cage culture regulations in place; this absence is a threat to the sustainability of the cage sector.

3.1.6 Recommendations

Investments in push factor and demand-led innovations should be driven by the existing private sector in Kenya, fostering local business ideas to ensure sustainable ownership of growth with potential for international investment. The following investment principles should guide the actions in support of Kenya's smallholder aquaculture producers:

1. **Market-led approaches:** Where investments in the sector do not focus on key actors, ensure that the question of consumer trends and preferences are accounted for.
2. **Acknowledge the current situation and learnings:** Ensure investment strategies account for current practices and build on learning from previous successes and failures.
3. **Sustainability and exit strategies:** All investments should build in a focus on socio-economic and environmental sustainability. This, therefore, includes a clear understanding of the socio-economic character of producers and the environmental risks of current and future production systems.
4. **Inclusive investment principles:** Balancing sector stimulation and inclusive growth must be proactively managed for both smallholder producers and household consumers with a particular focus on female participation in the sector.

Specific recommended actions according to these principles are:

1. Addressing the issue of imported fish from China either through duty or other means and reduction in duty on imported feed will increase efficiency of cost of production for Kenyan enterprises.
2. Clustering of existing farmers to access markets. Two potential solutions should be explored:
 - a. **Cage culture 'nucleus models':** Cage culture already has a diverse range of production systems with some major producers (eg African Blue, Victory Farms, Lake View Fisheries, Rio Holding, Mabro) working in proximity to smallholder producers. Major producers could replicate an out-grower model with the major producer setting sales terms and logistics. This could also be a key solution for ensuring sustainable production practices based on smallholder producers following nucleus farm requirements.
 - b. **Pond culture 'cluster model':** Farming enterprises or formalising producer groups should review clustered production strategies to improve their ability to aggregate and provide assured quantity and quality to off-takers. As certain volumes required by small-scale traders are required for fresh fish markets, it is critical for enterprises to be clustered and to practice staggered production to ensure consistent supply to different traders and processors throughout the year. Aggregated enterprises can also consider joint purchasing of inputs from suppliers to reduce unit costs.

Both models should be tested with a 'replicable' system focus to evaluate the potential for marketing solutions to scale out to other producers.

3. Streamlining/development of environmental regulations for cage culture.
4. Boosting productivity of input suppliers and fish farmers.
5. Capacity building through privatised extension model, practical training on key aquaculture techniques and business management for farmers, farm managers, extension officers and other service providers. Farmers need to be enabled to understand their present business operations (and the potential benefits of changes in the operations) better. This requires transfer of information and skills development about record keeping and cost & production data analysis (business analysis).
6. Align interventions with ABDP (IFAD) project.
7. Providing market information systems for producers to enable marketing of the most demanded product at the optimal time and in the optimal location.

3.1.7 Information gaps

- Situation regarding fish hatcheries in Kenya. The estimates of the number of hatcheries vary greatly in different reports.
- Realistic and up-dated production data on cages.
- Feed production and feed imports.

3.2 Rwanda

3.2.1 Main small-scale commercial fish farmer segments

In 2018 out of 1,413 registered ponds, 616 ponds (total pond surface area of 655,700 m²) were operated by 34 small-scale commercial fish farm cooperatives and three small-scale commercial fish farmers. In 2015 out of a total of 545 cages, 252 cages (total cage volume of 6,602 m³) were operated by 9 small-scale commercial fish farmers and one small-commercial fish farm cooperative. Finally, as only companies and cooperatives registered at the aquaculture desk office of Rwanda Agricultural Board (RAB) are known, there is also an unknown number of small-scale ponds and cages below respectively 100 ares (10,000 m²) or 100 m³ that are operated by individuals, which are scattered throughout the country and are commercially managed. Only fish farming operations that are managed for profit by either cooperatives or individuals and which each have at least 100 acres (10,000 m²) of ponds or a total cage volume of at least 100 m³ on one site are considered in this study as commercial fish farms.



Ponds integrated with animal husbandry, Huye, Southern Province

In Rwanda three segments of small-scale commercial fish farming have been identified based on production infrastructure used and volumes of production.

I. Segment I: Small-holder farmers producing tilapia in ponds mainly in cooperatives.

These farmers rely on pond fertilisation with animal manure and feeding with rice-/maize brans and vegetables. Some of them supplement with farm-made feeds and occasionally with locally manufactured feed and fish feed imported from Uganda. They lack affordable and high-quality inputs and capital. They have knowledge from different trainings from various programs such as by Paigelac, RAB, MINAGRI and FAO programs, but individual farmers tend not to keep records. Their production varies between 1.5 and 16.6 tonnes per year in 2017.

- II. **Segment II: Small-holders producing tilapia in low volume cages.** They have some degree of knowledge on farm management and entrepreneurship; and they tend to have some capital to invest. Access to affordable and high-quality inputs is still a problem for them. They feed farm-made feed and locally manufactured feed. Their production varies from 10 to 30 tonnes per year.
- III. **Segment III: Small-holders producing tilapia in high volume cages.** They are well trained and have a higher education degree. They use locally manufactured feed and imported feed from Israel and China. They have access to larger amounts of saved and family capital. Their production varies from 30 to 50 tonnes per year.

3.2.2 Geographic distribution

All pond-based small-scale commercial production systems (segment I) are implemented in all districts of the country showing a greater concentration of ponds in the Eastern Province due to the presence of irrigation dams for rice growing and Southern province.

Table 1 *Distribution of fish ponds by province*

Province	2014 # ponds	2014 Area (ha)	2018 # ponds	2018 Area (ha)	This survey # ponds	This survey Area (ha)
Eastern	-	-	385	111.69	228	23.27
Southern	389	36.60	416	34.61	142	14.34
Northern	145	18.14	210	23.23	85	12.90
Western	265	19.00	292	22.17	116	9.86
Kigali City	-	-	110	10.00	45	5.20
Rwanda			1,413	201.70	616	65.57

Small-scale commercial cage farms (segments II and III) are found in Lake Muhazi and Lake Kivu (Table 2). Lakes Burera and Ruhondo also had a few cages in the past but their number has reduced significantly during the last years because of the low water temperature (9°C). Lake Kivu, is recommended as being the most suitable for cage fish farming, being the deepest lake. Many investors also select Lake Muhazi, due to its proximity to the Kigali city market despite its shallow water. Peri-urban fish-farmers are more likely to generate higher incomes, net returns and longer-term financial viability, than similar producers in more remote rural areas due to access to both inputs and higher value markets.

Table 2 *Distribution of cages by province and lake*

Province	Lake	2014 # cages	2014 Volume (m³)	This survey # cages	This survey Volume (m³)
Eastern	Muhazi	20	240	64	4,382
Western	Kivu	150	1,200	188	2,220
Northern	Burera	195	1,660		
	Ruhondo	130	1,040		
Southern	NA	-	-		
Kigali City	NA	-	-		
Rwanda		495	4,140	252	6,602

3.2.3 Marketing and distribution of fish

Tilapia is the first choice of fish across local and regional markets and 500 to 800 grams is the preferred tilapia size for consumers in Rwanda. Currently, the market is driven by high prices which can be as high as 3,500 RWF (\$4.12) per kg of tilapia in Rwanda. Wealthy consumers in the neighbouring DRC have a high appetite for fish and a high purchasing power with transactions made in USD. Demand for fish is likely to remain high due to increasing human population, a growing middle-class population and awareness of fish-eating health benefits.

Segment I:

Pond farmed tilapia from segment I of small-scale commercial farmers is often sold at farm gate to neighbours and consumer households and part is consumed by family or cooperative members. In a few cases, middlemen buy from fish farmers to supply local and urban markets. The farm gate prices of small-scale farmers vary between 1,500 FRW (\$1.77) and 2,000 RWF (\$2.35) per kg of fish.

Segment II & III:

At least three tilapia cage farmers in segments II and III close to Kigali have outlet kiosks in the city of Kigali with fresh fish sold alive in tanks with pump-aerated water or on ice. They sell their fish for around 3,000 RWF/kg (\$3.53/kg).

Imported fish

Rwanda imports around 15,000 tonnes of fish per year. Imported frozen tilapia are not regarded as a significant threat at this moment due to the gap between fish supply and demand which is still high. Furthermore, the market is more interested in fresh, even live fish. While wealthy consumers prefer fresh to frozen fish and can afford it, frozen fish is bought by those who do not have access to fresh fish because of the high price. Small-scale fish farmers in segments I and II could be in the future the first to be affected by increasing imports of small frozen tilapia from China because of its competitive prices and similar sizes.

Until recently tilapia was imported from Uganda, but informant traders said that these numbers have greatly reduced. The same was said of tilapia from Tanzania. Imported fish were mainly frozen fillet of Nile perch and dried sardines from Uganda and Tanzania. Frozen tilapia on the market were imported from China and India. Fish is transported in refrigerated trucks or simply in trucks with boxes filled with ice, as well as by motorcycles, or cars. Fish is brought through the borders to Kigali city and then redistributed in secondary cities. There are several small cold storage facilities in Kigali and Gisenyi (on the lake shores). These cold storage facilities help traders distribute fish to urban areas. Part of frozen fish is re-exported to DRC and cross the borders to Goma and Bukavu in baskets and continued to distant cities inside DRC. Nile perch fillets were transported from Rwanda by air to Kinshasa.

Table 3 *Buying Price for Tilapia in Kigali City*

Tilapia product	Size range	Buying price (RWF/USD) per kg
Fresh Tilapia (locally produced)	800gr +	2500-2800 -> 3000 (\$2.94-\$3.30 -> \$3.53)
Frozen Tilapia (imported)	800gr +	2400 (\$2.83)
Frozen Tilapia (imported)	500-800 gr	1700 (\$2.00)
Frozen Tilapia (imported)	300-500 gr	1600 (\$1.88)

Common conditions, habits or other factors determining success of small-scale commercial fish farming

In Rwanda the following factors determine the success of small-scale commercial fish farming:

- Primary factors:
 - Access to production factors (production systems and culture water environment, inputs and markets).
- Secondary factors:
 - Education level; and
 - Experience in business.
- Management skills, personal commitment and determination and intelligent investments to reduce production costs are drivers to success.

Key problems faced by smallholder farmers

Key problems with small-scale commercial fish farming are the following:

- Lack of fingerlings (quantity and quality);
- High cost of feed;
- Low quality of locally manufactured feed;
- Lack of skills for day-to-day farming activities; and
- Lack of access to finance.

Key barriers to entry in the small-scale commercial fish farming sub-sector

Of the many constraints, two constitute key barriers for entry were identified:

- Low level of skills.
- Access to finance.

Small-scale commercial fish farming trends

Key trends for fish farming development in Rwanda can be grouped into 4 categories:

- **Increasing investment in small-scale commercial fish value chain.** As highlighted above, there are investors coming into the fish value chain either into fish farming or production and supply of inputs to small-holder commercial fish farmers.
- **Increasing capacity for fish feed production.** Three established feed manufactures in the country have added recently a fish feed production line and sell fish feeds to farmers, mainly in segment I and II: PIFA in Rwamagana, Aquahort Export located in Gasabo and Huye animal feeds in Huye. Gorilla animal feeds located in Kicukiro District imports and distributes fish feed.
- **Increasing productivity and production from small-scale commercial fish farming.** Fish production is increasing due to the increase in production units, (the number of cages/ponds), or the size of production units (size of cages/ponds). The production increases are also due to increase in unit productivity. In segment I of small-scale commercial fish farmers, pond productivity has increased on average 3-fold between 2014 and 2017. The productivity of ponds was 3.26 tonnes per ha per year on average in 2017. The average productivity of small-scale commercial cage farms increased from 26 kg/m³/year in 2015 to 30 kg/m³/year in segment II and 27 kg/m³/year in segment III in 2017, respectively.
- **Increasing capacity for fish seed production.** Because the government hatchery in Kigembe failed to produce sufficient quantities of fingerlings of good quality, private hatcheries have engaged in production of fingerlings and diversification of Tilapia strains for their own use and for selling to other fish farmers. Over 1.4 Million fingerlings were produced in private hatcheries in 2017.

3.2.5 Recommendations

Opportunities to expand small-scale commercial fish farming

- **Mass on-growing of tilapia fry in hapas in ponds.** Small fry supports better transport than old fingerlings. Partnerships between small-scale commercial fish farmers with hatcheries will encourage the mass on-growing of the fry to the stocking size.
- **Semi-intensification of pond production.** Pond aquaculture is more cost effective in case of production of smaller tilapia (up to around 200-300 g - Spliethoff and Murasira, 2013). In order to reduce feed costs (about 60-70% of the production costs), agricultural by-products and animal waste can contribute to the fertility of the ponds and increase yields from natural production reducing the feed budget by replacing some of the formulated feeds needed.
- **Small cage clusters.** Smaller cages may be relatively more cost effective for small-scale commercial cage farmers than big cages. Investment requirements are lower; they are easily manageable; and risks are lower. By clustering, small-scale commercial cage farmers can negotiate good prices for inputs/output products and services, easily access information and training and reduce labour and management costs.

Potential commercial small holder production models

- **Aquaculture park systems.** Models such as farm estates in urban and peri-urban centres or on a given water body and **contract farming** with input suppliers and fish traders are also possible with linkages to the fish market and inputs/service suppliers. Such an aquaculture park system allows for substantial collective fish production. With experience gained in fish farming as business, these cluster fish farms can grow into small and medium-scale fish-farming enterprises (SMEs) taking over the marketing and commercialisation of inputs and products.

3.2.6 Information gaps

The following information gaps were identified in Rwanda:

- The exact number of fish farmers in different segments
- The exact number, surface and volume of production systems (ponds, cages, tanks) and their geo-localisation.
- The total number and size of individual small-scale commercial pond farmers in segment I
- The exact number of fish production systems integrating animal husbandry and crop production
- The exact number of hatcheries, species/strains being bred and their production capacity
- The size and quality of brood stock in hatcheries
- The exact number of small-scale commercial fish farmers who benefited from bank loans
- The exact production data of Tilapia and Catfish (quantity in tonnes, value in USD)
- The feed production capacity of local feed manufacturers, both industrial and on-farm
- The exact fish market size and prices in Eastern DRC for both farmed tilapia and catfish from Rwanda
- The volume and value of Tilapia imports from China and India

3.3 Tanzania

3.3.1 Main small-scale commercial fish farmer segments

Fish farming in Tanzania is primarily a small-scale activity, with the majority of owners operating one or a few small ponds, little formal management and low productivity, reflecting its largely subsistence nature. Until 2015 approximately 14000 freshwater fish farmers together produced roughly 3000 tons of fish (mainly Nile tilapia but also African catfish) in approximately 20,000 ponds. However, better data collection and a marked production increase led to an estimate of 10,000 tonnes for 2017.

In addition, cage farming in Lake Victoria has taken off at modest levels compared to the neighbouring countries. At present there are approximately 60 cages reported to be in the lake, and several dozen in Kumba Lake.



Cage culture in Lake Victoria Tanzania (Photo: Charles Mashafi, TAFIRI, Mwanza)

Farming in ponds of 150-450 m² is the dominant freshwater fish farming system. Most farmers only have 1-3 ponds and are farming in an extensive way (3 fish/m² or less, feeding with on-farm available ingredients). Integration with other agriculture sectors is recommended and as result integrated fish farming practices are common, especially in the eastern region, and polyculture of fish and duck is popular.

Near Dar es Salam and the Coastal regions about 1/3 of the farmers surveyed reported the use commercial feed, mostly locally-made. The use of commercial feed is a financial investment and seen as an indicator of the owner having a commercial approach to aquaculture. Most farmers are aware of the often-superior quality of commercial feed when compared with relying on only on-farm ingredients of varying quality and availability but more common use of commercial feeds is limited by price and availability. The segment of farmers using commercial feeds is smaller in more remote areas than in Dar es Salam and Coastal regions.

Nile tilapia is by far the main freshwater species farmed. In addition, and when available African sharptooth catfish (*Clarias gariepinus*) is stocked together with tilapia to control the excessive

reproduction of tilapia. The main areas where the fresh water tilapia is farmed are in the South, especially the Ruvuma (more than 43%), Njombe (almost 14%) and the Iringa (more than 11%) region.

There are a small number of larger farms that produce table-size fish and fingerlings on a larger scale, operating 5 or more ponds, and producing several million fingerlings per year (mainly tilapia, but also catfish) for own use and for sale.

The number & size of ponds per farm and the type of fish feed used were used to distinguish various segments of smallholders.

- 45% of the farmers visited harvested over two tonnes per farm during the last year;
- 13% of visited farmers harvested between one to two tonnes per farm and;
- 24% harvested less than one tonne per farm.

66% of the farmers used only on-farm sources (maize and rice bran, food leftovers, vegetable remains, cocoyam leaves) as fish feed. These farmers admitted that they prefer commercial industrial feeds to the feeds that are available on-farm, but the high price asked by feed suppliers restrains these farmers from using commercial fish feeds. The remaining farmers (32.8%) applied locally produced commercial fish feed or imported commercial fish feed (1.5%).

Table 4 Characteristics of fish farmers in Morogoro, Dar es Salaam, Coast and Lindi regions

	Variables	Percentage
Sex	Male	87
	Female	13
Age	15-35	25
	36-55	75
	56-65	14.1
	>65	10.9
Education	Primary education	52.2
	Secondary education	14.9
	Diploma	11.9
	Degree	16.4
	MSc	4.5

3.3.2 Marketing and distribution of fish

Majority of fish producers sell fish themselves directly to the consumers in their neighbourhood or at nearby local markets, or they sell to traders who sell directly to consumers. 91% of the farmers surveyed sell their harvested fish within their own locality and the remainder of farmers sell to nearby villages, aiming to get a relatively better price.

The results of the field survey that was undertaken as part of this study in Dar es Salaam and Coastal regions show that 60% of aqua-farmers sell their fish in nearby towns while the rest (40%) sell their fish on farm. Fish are sold fresh by weight (kg) to traders (31% of respondents), to both individual customers and fish traders (59%) and to individual customer only (10%).

Recent price data showed that fish prices in Morogoro and Lindi regions ranging from USD 1.34 (farm gate) to USD 2.23 per kg (retail market). The price in Dar es Salaam and Coast regions ranged from USD 3.13 (farm gate) to USD 4.47 (retail market) per kg. The highest price was observed in Dar es Salaam and Coast urban areas. However, it was observed that the fish prices in Mkuranga district of Coast region are lower compared to other urban areas surveyed in this study. It is interesting to note that most farmers (85.5%) in the surveyed areas indicated that they had not attained their planned fish farming targets which shows that they perceive space for aquaculture expansion.

Common conditions, habits or other factors determining success of small-scale commercial fish farming

The majority of fish farmers in Tanzania are small-scale and operate with limited technical knowledge and limited availability of essential inputs such as good quality seed and feed and/or the price of these inputs. Hence the majority depend on on-farm available ingredients/by-products as feed and on fingerlings of unknown quality, produced by neighbouring farms or in own ponds. Despite these limitations a small percentage (approx. 15%) manages to do better than others, achieving a productivity of 4-6 tons/ha/year. These farmers have the conditions, drive and skills to perform better.

Key problems faced by smallholder farmers

Key problems with small-scale fish farming identified in this study are the following:

- Lack of availability of good quality feed; the price of commercial feed in relation to farmer's financial capacity & willingness to invest;
- Unreliable and variable costs in seed supply; unreliable quality of the seeds;
- Inadequate credit facilities;
- Poor technical and management knowledge among farmers, partially the result of limitations of extension services (expertise and manpower available);
- Complexity of regulatory environment;

Key barriers to entry in the small-scale commercial fish farming sub-sector

Based on observations of one informant familiar with the fisheries sector in Tanzania, a potential entrant starting small-scale commercial fish farming is confronted with considerable risks. Besides from the limited availability of quality feeds and seeds, these include the following:

- It requires a considerable investment to start a fish farm and operational costs add up during the grow-out period. No credit is available, as many banks do not yet regard aquaculture as a viable commercial activity. Therefore, whether a farm can be started and on what scale depends on the availability of family or company capital/savings.
- Loan programmes are often patterned after better known agricultural cycles and practices. The conditions of such programmes may not be suitable for aquaculture and adjustment to the specific features of the aquaculture sector is required. Longer grace periods and a facility that takes care of the risks should be part of such programmes.
- The production of fish depends on the knowledge and skills of the farmer and/or his personnel. Since fish farming is a comparatively new activity for most, this means that a considerable amount of new knowledge and skills have to be learnt and mastered. The opportunities to learn such knowledge and skills for new farmers are limited.
- In areas where the supply of fish from capture fisheries is abundant, the price for the fish may be too low to recover all the costs as well as the costs related to starting a new production cycle.
- Complexity of the regulatory environment; bureaucratic procedures that may take time.

Small-scale commercial fish farming trends

From the reports, articles and field work undertaken as part of this study the following key trends for small-scale commercial fish farming were distilled:

- The proportion of farmers that applied commercial fish feed is increasing, which is an indicator of willingness to invest in, and a more business-like attitude towards aquaculture.
- Increasing private investments in aquaculture by Tanzanians, resulting in an increase of the number small-scale producers (with ponds, tanks and cages) and traders selling aquaculture-related inputs in the large urban centres. Growing demand seems to be driving this growth. Investments are paid from own (family) capital.
- Accelerated growth of aquaculture production and fingerlings. This growth is also perceived to be due to improved statistics collection.
- In many locations, retail prices for farmed fish depend on the price of fish captured from lakes and rivers. In cities the competition with imported tilapia (products) may have an additional price-reducing effect.

- Producers have recently started to organize themselves (for instance through the Aquaculture Association of Tanzania) and are forming small groups that use social media to exchange information.
- The National Fisheries Policy of 2015 emphasizes professionalization of the aquaculture industry. This should result in simpler / easier procedures. Whether this also means a change from the character and volume of support so far given to the small-scale subsistence farmers needs to be ascertained.

3.3.4 Recommendations

1. The challenge impacting aquaculture production that was mentioned most often by the small-scale farmers interviewed is the lack of education about fish farming. The development of a training programme for small and medium scale fish farmers that includes responsible and better aquaculture techniques, farm and business management is recommended. Record keeping, and calculation of cost of production and profit should be included in such a training.
2. A lack of credit hampers both new entrants in the sector as well as expansion, innovation and intensification of production by existing farmers. Development of a targeted credit programme to ensure broader financing of aquaculture development is recommended. As a first stage, such a programme could target the most promising part of the small segment of existing farmers that is obtaining a higher productivity than most small-scale producers because this segment has the conditions, drive and skills to perform better than others.
3. The genetic quality of tilapia and catfish brood stock and fingerlings used is in most cases unknown and there is probably much room for genetic improvement. A programme aimed at genetic improvement and distribution of improved brood stock (including a certification scheme for good-quality brood-stock and fingerlings) is recommended.
4. Develop a formula for a fish feed that is as much as possible made from local ingredients that can be produced for an acceptable price and make this formula available to (potential) fish feed producers.
5. The information gaps mentioned in below should be addressed. The first and third gap seem most urgent to address when an investment in the small-scale aquaculture producer segment is considered. When investment targeting farmers of African catfish or fish farming in floating cages are considered, the second and fourth gap are urgent.

3.3.5 Information gaps

During the study of the smallholder aquaculture landscape in Tanzania the following information gaps were identified:

1. Cost of investments in aquaculture farms; cost of pond or cage construction, equipment, etc.
2. Marketing situation of African catfish in Tanzania;
3. Presence, volume and price of imported tilapia in Tanzania; impact on local tilapia prices;
4. Cage culture situation in Lake Victoria and Kumba Lake (numbers, volume, intensity, investment and operating costs, market, etc.);

3.4 Uganda

3.4.1 Main small-scale commercial fish farmer segments

By 2003-2005, between 20,000 and 30,000 ponds were operated in Uganda by approximately 7,000 farmers with an estimated total production of 1,500 – 5,500 tonnes. The average surface of a pond was 200 - 500 m², with 50 m² - 200 m² for subsistence farmers and up to 7,000 m² for small-scale commercial farmers. Production has been estimated at 1,800 kg/ha/year in the period 2003-2005.

By 2010, 25,000 ponds were recorded with a production of 100,000 tonnes. In 2015 it was estimated by the National Fisheries Resources Research Institute (NaFIRRI) that there were 2,135 cages in the different lakes of Uganda, with 28 farmers and a production of 1,349 tonnes per annum. Over the past years a significant growth in cage farming has occurred. No exact figures are available, but it is estimated that the number of cages and the production have doubled in the period 2015-2018. Employment in the aquaculture sector accumulated to 24,160 persons in 2015.

Despite increasing aquaculture production, the average per capita consumption is currently 8.3 kg/year, compared to 12 kg/year in 1991. This decrease has been attributed to a reduced supply from capture fisheries and a high demand as a consequence of human population growth.

As of 2018 aquaculture in Uganda consisted of subsistence farmers, small-scale farmers and a few medium-scale farmers.

Small-holders in Uganda are involved in cultivation of two main species; Nile tilapia (*O. niloticus*) and catfish (*C. gariepinus*). In Uganda the following three segments of small-scale commercial fish farming can be distinguished:

- I. **Small-holders producing tilapia (ponds and cages) and/or catfish (ponds).** Farmers in this category lack crucial aspects such as affordable and high-quality inputs, knowledge and capital. Their production varies from 1-5 tonnes/yr.
- II. **Small-holders producing tilapia (ponds and cages) and/or catfish (ponds).** Farmers in this category have some degree of knowledge on farm management; mostly they have some capital to invest. Access to affordable and high-quality inputs is still a problem for them. Their production varies from 6-40 tonnes/yr.
- III. **Small-holders producing tilapia in cages.** Farmers in this category are well trained and have received a higher education. They can afford high quality imported feed (e.g. from Brazil, Israel and Mauritius), and may even have their own hatchery to produce fingerlings of decent quality. They have access to larger amounts of family capital. Their production varies from 41-50 tonnes/yr. This group is continuously investing in growth; in the near future they will not be a small-holder anymore.



Researchers viewing the tilapia cages of Marinas Aviators Ltd. (near Entebbe). This company is owned by a group of 11 young farmers.

3.4.2 Findings

Common conditions, habits or other factors determining success of small-scale commercial fish farming

From the collected data three key factors of success have been identified for small-scale commercial fish farming in Uganda. They include:

1. Institutional support systems
2. Availability of own (or family) capital
3. Knowledge, education and attitude of farmers

In Uganda the institutional system is generally supportive. Licenses can be obtained without much difficulty. The process is relatively inexpensive and does not take a large amount of time. District Fisheries Officers support farmers in the process by helping them to arrange the paper work. The foundation of this supportive legal environment has been laid by the National Fisheries Policy (2004) that is scheduled to be updated this year. This policy contains effective rules and regulations for the development of aquaculture. The policy also focuses on measures to improve technology for production (e.g. high-quality local feed).

Access and availability of capital is a second key success factor. From the field data it appears that for a farmer to have his/her own (or family) capital is of key importance to start a successful aquaculture business. This reliance on own (or family) capital is caused by difficulties in accessing commercial bank loans. Banks are hesitant to invest in aquaculture which is regarded as a new sector with an as yet unproven track record. Moreover, current interest rates are approximately 24%, which is too high for small-holders.

Knowledge, education and the attitude of farmers is the third key factor of success. It appears that farmers with an educational background (segment III, e.g. a BSc and/or MSc in fisheries or aquaculture) are the most successful. They understand how the legal environment works; they have the right network; they know how to manage their farm; and they often have business skills. Besides,

their attitude is also important as most successful farmers have visited farm operations in other countries and are continuously working on improving their knowledge and skills.

Key problems by segment and opportunities for improving productivity

Based on the field interviews the following key problems were identified:

1. A lack of high quality and affordable feed
2. A lack of high quality and affordable seed
3. Lack of knowledge and skills
4. Poor cooperation
5. Lack of capital
6. Environmental issues
7. Under-capacity of extension services

The first problem is a lack of high quality and affordable feed. For local feed production, the fluctuating prices of raw materials are a problem; this is specifically the case for *mukene* (dried silver cyprinids). Farmers in Segment I lack the capital to buy commercial feed and therefore, they produce their own feed. They however lack proper knowledge of the right feed formulation (FCR is 2.0–2.5). It is estimated that 85–90% of all farmers make their own feed. Farmers who do have access to some capital (Segment II) often buy low quality local feed (FCR is 1.8–2.0). It is estimated that 8% of all farmers use locally produced feed. Farmers with good access to capital (Segment III) buy imported feed from Israel, Mauritius and Brazil (FCR 1.4–1.6). It is estimated that 4% of all farmers use imported feed.

The second problem is a lack of high quality and affordable seed. The challenge of cultivating all male tilapia has been tackled by the use of hormones. However, the quality of the seed is variable, and it is perceived as being too expensive. Reported causes of fingerling mortality vary: it is uncertain what the exact causes of mortalities are. However, respondents agree that there is a need for improved genetics, for example via a national breeding programme.

The third problem, lack of knowledge and skills, is one of the key issues. Respondents report that a lack of business attitude is constraining the development of most farmers (i.e. Segments I and II); most of them do not have a well thought out business plan. Records are only structurally kept by the larger small-holders (Segment III). Furthermore, knowledge and skills regarding planning of production (cycles) is often lacking. Small-holders in segment I often run out of capital, resulting in a lack of feed and starving fish. Lastly this segment of small-holders also lack technical skills, such as pond and cage construction, water quality monitoring and site selection.

The fourth problem, of poor cooperation, is visible across the entire value chain. Most farmers are not well-organised; they sell low volumes for high prices, while middlemen are searching for high volumes and low prices. This means that producers and distributors are not well connected. Farmers are not yet organised well enough to buy cheaper inputs and create higher volumes and lower prices. Some farmers also complain that middlemen have too much power and take too high a percentage of the profits. Some of the farmers in Segment III have plans to organise the distribution of fish by themselves, but no concrete examples were identified.

The fifth problem, lack of capital, is experienced especially by farmers in Segment I. These farmers do not have access to sufficient own (or family) capital while at the same time they cannot get a commercial loan. As a consequence, they run out of feed with starving fish in the ponds or cages.

The sixth problem, environmental issues, is related to reduced dissolved oxygen levels. For example, there are incidental reports of the invasion of Kariba weed (*Salvinia molesta*) in Lake Victoria and Lake Albert. This aquatic fern is an invasive species native to south-eastern Brazil. The weed causes dissolved oxygen levels to drop, which can cause suffocation of cultured tilapia. Pond farmers experience erosion problems during the rainy season. Organic matter flushes into the ponds, also causing dissolved oxygen levels to drop. During the rainy season the flushing of ponds is not possible.

The seventh problem is the under-capacity of extension services. Although all farmers should have access to at least one extension worker, this is often not the case. Currently there are 250–500

extension workers in Uganda. Due to large travel distances, extension workers cannot reach all farmers while farmers themselves do not have the means to visit extension workers.

Small-scale commercial fish farming trends

The key trends are listed below. Furthermore, the scale of the trends is indicated, i.e. national (in Uganda) or regional (in the East African Community).

- Increasing demand for fish (regional). The key trends in Uganda are a high demand for fish; this not only applies to Uganda but for the entire region of East Africa. Supply cannot meet demand, resulting in a fish deficit of 180,000 – 300,000 tonnes in Uganda and resulting in a decline in per capita fish consumption over the past decade.
- Declining fish supply (regional). The lack of supply is a result of the decline of fish production from capture fisheries while aquaculture is not yet able to fill the gap.
- Increasing production from small-scale commercial fish farming (national). Cage farming is increasing in terms of number of cages, sizes and volumes. Production volumes from cages are higher and increasing faster than the volumes from ponds. However, pond production is also on the increase by size and stocking densities.
- Increasing commercialization of small-scale commercial fish farming (national). Like cage cultivation, pond cultivation is increasingly focussing on commercial production.

Estimated current and potential production and effects on fish prices

For the analysis of the effect of production increase on prices the method of Smit (2008) is used.

Since there is a lack of quantitative data, price effects will be discussed in a qualitative manner.

According to Smit (2008) the expected price effects are mainly dependent on the size of the market in which a small-scale commercial farmer operates. In case of small-scale commercial fish farming in Uganda, different markets can be distinguished and therefore price effects differ between segments.

As illustrated in the table below price effects are expected to be more significant in segment I and to a lesser extent in segment II. Price effects are expected to be minor in segment III. The difference between segments can be explained by differences in the degree remoteness, the state of logistics and market linkages with middlemen.

Table 5 Price effect of doubling production in different segments

Segment	Markets & sales	Marketing and distribution	Price effect of doubling production
I	Farm gate to neighbours and proximal markets	Not organised; hard to sell the little amounts produced on the farms.	Price will go down as local markets are less able to absorb an increase in production. Specifically applies to small-scale commercial farmers remote areas with poor logistics.
II	Farm gate. Middlemen from Rwanda, Congo, Kenya	Fairly organised through telecommunications with each other.	Farm gate selling: price will go down as local markets are less able to absorb an increase in production. Specifically applies to small-scale commercial farmers in remote areas with poor logistics. Middlemen: Price will not be affected; regional markets are large and demand is high.
III	Middlemen from Rwanda, Congo, Kenya	Organised through the Uganda Commercial Fish Farmers' Association.	Price effects will be minor; regional markets are large and demand is high.

3.4.3 Recommendations

Opportunities to expand small-scale commercial fish farming

The opportunities to expand small-scale commercial fish farming in Uganda can be summarised in two aspects:

- A. More and better coordination of the sector through an aquaculture platform. The following actions are recommended:
 1. Create an aquaculture platform for more synergy among stakeholders.

-
2. Select lead farmers that can be a model for other fish farmers. With a Training of Trainers (ToT) approach they can be prepared to share best practices.
 3. Combine the budgets of donor projects.
 4. Use an integrated approach because issues are interconnected.
- B. Focus on improvements in segments I and II and apply a tailored approach. The following actions are recommended:
5. Improvement of the quality of the feed. Currently, homemade feeds of doubtful quality are used by a majority of farmers in this segment.
 6. Improvement of knowledge and skills, e.g. via lead farmers and a ToT approach.
 7. Improve access to capital, e.g. via microfinancing constructions.
 8. Apply an approach that is tailored to the specific needs of fish farmers in each segment.
- These two aspects are further elaborated below.

At this time the efforts of various public, private and non-governmental organisations to improve the key factors in the development of the aquaculture sector in Uganda are mostly uncoordinated. Every organisation seems to work on a particular issue; as a consequence, key issues are approached in isolation rather than in an integrated manner. This is important because, most of these 'separate' issues are in fact highly interconnected. A farmer with capital, but without knowledge will not succeed and vice versa; the same goes for a farmer with proper knowledge, but without access to high quality feed and seed. An opportunity to expand small-scale commercial fish farming is to work towards a systematic and integrated approach (both in and along the value chain), where efforts of public, private and non-governmental organisations to tackle key issues are coordinated in order to create synergy. As far as possible, this also implies the combining of budgets so that more can be done. One possible instrument to achieve this is to establish a multi-stakeholder aquaculture platform. A first element of this aquaculture platform could be the establishing of farmer groups with lead farmers. Instead of trying to reach all small-scale commercial farmers, lead farmers are educated in a Training of Trainers (ToT) approach, so that they become the ambassadors of best aquaculture practices. Each farmer could then train other small-scale commercial farmers in the field.

Looking at the three segments it becomes very clear from the analysis that small-scale commercial farmers in segment III are of the least concern. These small-scale commercial farmers are successful and continuously growing. Within a matter of a few years their production will rise above 50 tonnes and they will become a medium-scale farmer. The most concern is therefore with segment I; these small-scale commercial farmers are struggling to make a living from aquaculture. They urgently need better feed, improved knowledge and skills and access to capital. Only then the small-scale commercial farmers from segment I may be able to move towards segment II. Small-scale commercial farmers in segment II also need better local feed of affordable prices in order to grow. Although this segment does have the basis knowledge and skills for farm management, they urgently need to improve them so as to improve their business and future outlook.

Potential commercial small holder production models

Cluster farming has potential as a commercial small-holder production model. Although approximately 85% of all farmers in Uganda are already members of a cooperative, few seem to be able to professionally combine resources to actually achieve growth. An exception is Pearl Aquatics Ltd. in Lake Victoria, Entebbe. First, a separate group of investors was formed under the name of Garuga Tropical Aqua Pact. Some of these investors are active as a small-holder in cage farming, and others are not. The minimum amount of investment per investor was USD 23,000. With a total of approximately USD 400,000 a production capacity of 14 cages was installed, with the involvement of 54 small-holders. In 2017 their combined annual production amounted to about 89 tonnes, with the ambition to produce 160 tonnes in 2018. The farmers use high quality starter feed from Raanan (Israel) and grow out feed from Invovo (Brazil). Due to the high-quality feed an FCR of 1.4 is reached, with 2 annual production cycles. Due to this model, these small-holders have a serious voice in the aquaculture politics of Uganda. Furthermore, they are able to buy inputs in large volumes at a reduced price. However, the cluster farm still faces the challenge of middlemen, consuming a large part of their profit. As such the ambition of Pearl Aquatics Ltd. is to develop the local fish market by starting fish outlets in Kampala, using a cold chain.

3.4.4 Information gaps

The following information gaps were found during the smallholder aquaculture study in Uganda:

- The total quantity and value of tilapia imports from China
- The exact number of ponds
- The total surface and volume of ponds
- The exact number of cages
- The total surface and volume of cages
- The number of small-scale commercial farmers (per segment)
- The number of cooperatives

Although production data per species (quantity in tonnes, value in USD) is available from FAO databases, there is a question as to the reliability of the data. While most experts state the figures are grossly over-estimated, other experts claim figures are grossly under-estimated. The result of a lack of trustworthy data is that the exact size of the aquaculture sector is not known, as well as its exact development in terms growth over the years.

Table 6 Key data of the national freshwater aquaculture sector and of freshwater smallholders of Kenya, Rwanda, Tanzania and Uganda²

	Kenya	Rwanda	Tanzania	Uganda
Most recent estimation of national freshwater production of farmed fish	14,952MT	1,580 tonnes (2016)	5,000 tonnes	117,841 tonnes
Estimated national freshwater value (USD) of farmed fish	USD 41 Million	na	USD 17 million	USD 263 million
Estimated persons involved/employed		na	19,233 (2016)	24,160 (2015)
National Aquaculture Association	CASK: Commercial Aquaculture Society of Kenya AAK: Aquaculture Association of Kenya Aquaculture Round Table	Non-existing but ongoing discussions among small-scale farmers to setup one	Aquaculture Association of Tanzania AAT	Walimi Fish Farmers' Cooperative Society (WAFICOS) Uganda Commercial Fish Farmers' Association (UCFFA)
National Aquaculture Policies and/or development plans	The Fisheries Act CAP 378, revised (2012) Fisheries (Safety of Fish, Fishery Products and Fish Feed) Regulations (2007) Specification for Compound Tilapia and Catfish Feeds (2015) Environmental Management and Coordination (Amendment) Act, No. 5 (2015) EIA Guidelines and Administrative procedures (2002)	<ul style="list-style-type: none"> • The Aquaculture and Fisheries Policy (Year) • Fisheries and Fish Farming Master Plan (2011 – 2020) • • The Organic law n° 58/2008 (2008) • The ministerial order n° 006/11.30 (2010) • The ministerial order n°010/11.30 (2010) • The ministerial order n° 011/11.30 (2010) 	Fisheries Policy (reformed in 2015); National Aquaculture Development Strategy, 2009 (NADS 2009)	<p>The National Fisheries Policy (2004) The MAAIF Development Strategy and Investment Plan (2010-2014) The Uganda National Aquaculture Development Strategy (2008) The Draft 'Aquaculture Parks Investment Policy' The Draft 'National Aquaculture Development Strategy' The Draft 'National Aquaculture Development Plan' Investment terms provided by the Uganda Investment Authority</p>
Aquaculture research organisation(s)	KMFRI; Kenya Marine Fisheries Research Institute	Rwasave Fish Culture Research Centre (SPIR)	Tanzanian Fisheries Research Institute TAFIRI	National Fisheries Resources Research Institute (NaFIRRI)
Production systems	Ponds 300m2 mainly, cages from 2x2x2m to 6x6x6m Raised ponds and to lesser extend recirculation systems	<ul style="list-style-type: none"> • Earthen Ponds of 400 m² for smaller segment • LVHD cages: square cages of 8-40 m³ for intermediate segment 	Ponds: most 100 - 450 m²; some larger Cages: from 2x2 to 6x6 m.	Ponds: 600 m² or smaller segment – 1,000 m² for larger segment Cages: square cages are 4 m² - 25 m². Circular cages have a diameter of 8m – 12m

² Sources from which data were obtained are listed in the four country reports.

Kenya		Rwanda	Tanzania	Uganda
		<ul style="list-style-type: none"> HVLD cages: rectangular and circular cages of 40-500 m³ for larger segment 		
Intensity	Extensive and semi intensive	Semi-intensive for smaller segment & intensive for larger segment	Extensive to semi-intensive (1 to 5 tonnes/ha)	Extensive for smaller segment & intensive for larger segment
Species	Nile Tilapia, African catfish, (the research did not include other species e.g. rainbow trout, marine species)	Nile tilapia (most farms), African catfish (few farms)	Nile tilapia; African catfish	Nile tilapia, African catfish
Production cycles	Tilapia in ponds 6-11 months in average (range 6-12 months)	<p><i>Smaller segment:</i></p> <p>Tilapia: 1.0-1.5 cycles per annum, 8-12 months to grow to 500 grams</p> <p><i>Intermediate segment:</i></p> <p>Tilapia: 1.5-2.0 cycles per annum, 6-8 months to grow to 500-800 grams</p> <p>Larger segment</p> <p><i>Larger segment:</i></p> <p>Tilapia: 2.0 cycles per annum, 6 months to grow to 500 grams average</p>	5-9 months/cycle to grow 250-500 gr tilapia.	<p>Tilapia: 1.3 -2.0 cycles per annum, 6-9 months to grow to 400-500 grams</p> <p>Catfish: 1.3 – 2.0 cycles per annum, 6-9 months to grow to 1 kg</p>
FCR	1.2 – 3 depending on type/quality of feed and water temperature. WFC/FA Feed-v Strain trial recently conducted.	<p>Catfish: n.a.</p> <p>Tilapia: 2.0-2.5 (smaller segment)</p> <p>Tilapia: 2.0 (intermediate segment)</p> <p>Tilapia: 1.6 (larger segment)</p>	<p>1.5 (Ruvu Fish farm)</p> <p>1.5 -3,5 (Not exactly known, due to poor record keeping)</p>	<p>Tilapia: 1.4 - 2.5</p> <p>Catfish: 1.7 – 2.2</p>
Feed	Mash, local and (high-quality) imported pellets, green water farming systems	<p>Catfish: n.a.</p> <p>Access: Limited to Fair</p> <p>Quality: Low quality of farm-made & locally manufactured feed; fair to good quality imported (few in larger segment)</p>	<p>Mostly from on-farm sources but 1/3 of farmers surveyed in Dar es Salam and Coast Regions used commercial feed.</p>	<p>Access: limited to fair</p> <p>Quality: local & imported</p>
Seed	Both local developed brood stock and imported (YY) brood stock available	<p>Access: Limited to Fair</p> <p>Quality: Bad to Fair</p>	80% of farmers buy from private hatcheries; 20% from public hatcheries	<p>Access: no access to good access</p> <p>Quality: fair</p>
Education of farmers/ farm managers	10% certificate in aquaculture, 31% have completed secondary school	Limited to Good	52% has primary education only, remaining part has secondary education or higher.	<p>Low to fair</p>

	Kenya	Rwanda	Tanzania	Uganda
Knowledge of farmers	Low to fair	Low to Good	Low - Lack of education about aquaculture techniques and farm management is perceived as problem by 67% of farmers.	Low to fair
Skills of farmers	Low to fair	Low to Good	Low to fair	Low to fair
Training possibilities for farmers	Limited	Access and availability limited	Limited access and availability	Access and availability limited
Capital	Private sources; cross financing. Formal financing limited for aquaculture	Access: No access to limited access Availability: Limited to fair savings/family capital	Available only from private sources (family capital). Banks expect good feasibility study showing viability of the investment	Access: No access to limited access Availability: family capital (poor to fair)
Technology	Limited use of technology	Access: No access to good access Availability: Materials and local technology available; no distribution of imported technology	Limited use of equipment by majority of farmers. Available only in Dar es Salam.	Access: No access to fair access Availability: Materials and local technology/equipment available. No distribution centre for imported technology
Record keeping	Poor to non-existent	Non-consistent to fair	None to poor by most farmers	Non-existent to fair
Market & sales	Farm gate and market Limited value addition	Farm gate/Middlemen/City outlets	Farm gate selling by producer to consumers & traders; sale by producer in nearby village/town/; all production for domestic market.	Farm gate selling / middlemen from Rwanda, Congo, Kenya
Marketing & distribution	Not organised	Not organised in smaller segment to organised in intermediate and larger segments	Not organised.	Not organised / Organised through the Uganda Commercial Fish Farmers' Association.
Permit requirements	Controversial for cage culture and no harmonized approach among county, national government & NEMA.	Site suitability assessment for smaller segment and EIA and business plan for intermediate and larger segment	Consent from nearby communities needed; Permit from MALF to use land; Strategic EIA from TAFIRI.	Varying from getting a permit to conducting site suitability assessment, EIA, business plan
Environment	Cage: no regulations in place, though NEMA certificate, letter from county and national government needed for commercial aquaculture	Ponds: land scarcity, inundation and flooding. Water scarcity in dry season. Water quality reasonable to good. Cages: good site availability, good water quality	Gov't is concerned with environmental impacts of especially cage farming (pollution, introduction of alien/exotic species).	Ponds: land scarcity in urban and peri-urban areas. Water scarcity in dry season. Water quality reasonable to good. Cages: good site availability
Growth potential	Huge.	Very limited for smaller segment, good for intermediate and larger segment	Suitable climate, sites and water available in many parts of the country. Credit facilities and supportive environment required.	Limited for small small-holders, good for larger small-holders

3.5 Recommended actions

The suggestions for actions at national level recommended by the study have been summarised in Table 7. While some recommendations are relevant for all four countries studied, others are specific for one or two countries only. Aquaculture smallholders in all four countries would benefit from more and/or better opportunities for capacity development that should be both technical (best aquaculture practices) as well as aimed at improvement of business management skills and record keeping. Also, the sector in all four countries will benefit from improved availability and accessibility of credit, from the availability of good quality and affordable fish feeds and fingerlings, and from actions aimed at better collaboration of producers with the aim to improve the purchase of inputs and the marketing of products. For many aquaculture producers in the region the strong demand for fish from the Democratic Republic of Congo offers an export opportunity.

Certain actions that would benefit the aquaculture sector of all four countries are probably better taken care of at a regional level. This will require collaboration and coordination among the four countries involved. Examples are research of issues and topics that are relevant to all four countries (applied research aimed at genetic improvement of Nile tilapia, culture of Nile perch and impact of fish from the Far East) and measures that are aimed at better fish disease detection and avoiding the spread of such diseases within and between the four countries. A list with recommended actions at regional level has been added to Table 7.

Table 7 Recommended actions

	Kenya	Rwanda	Tanzania	Uganda
Production systems		Organisation and empowering of small-scale LVHD cage farmers through clustering (aquaculture parks, farm estates) (4)	Improve ponds and cage farming system	Facilitate medium segment to find new locations for ponds
Intensity		Promotion and production intensification of African catfish for its market potential (in DRC)		No recommendations
Species		Valorisation of the African catfish potential through product diversification (fish fillet for hotels, smoked fish for local/regional markets)	Develop culture techniques of endemic tilapia species.	No recommendations
Production cycles / FCR / feed	Increase competitiveness of the sector to reduce taxes on imported feed and improve quality of locally available feed.	<ul style="list-style-type: none"> • Improve technological capacity of local fish feed manufacturers (3) • Put in place a quality control (QC) mechanism of fish feed available on the market (both local & imported) • Integrate fish farming and animal husbandry as a source of organic fertilisation to improve primary pond food production and to lower FCR. 	Develop affordable feed made from local ingredients (4)	Invest in building capacity for high quality and affordable feed production. Find alternatives for the use of Mukene as fish feed ingredient. (3)
Seed	Improve availability of quality seed, standards to be set for seed and enforcement of quality regulation.	<ul style="list-style-type: none"> • Professionalization and specialisation of hatcheries (1) • Mass on-growing of tilapia fry in hapas in tanks and in ponds to supply the increasing demand of fingerlings • Introduce QC in brood stock & seed quality certification • Breeding programs to develop low temperature tolerant tilapia strains (2) 	Set-up of brood stock improvement and distribution programme; (3) develop certification system for brood stock.	Further improvement of seed quality via breeding programmes (6)

	Kenya	Rwanda	Tanzania	Uganda
Education, knowledge, skills, training	Skills have proven by KMAP to increase productivity, increase business planning usage for clustered marketing and linkage to traders and formed a potential privatised aquaculture agent model (4)	Develop technical and business skills for farm operators and investors (5)	Develop a training programme that includes aquaculture techniques, farm and business management for small and medium segment (1)	Specifically focus on trainings to improve skills and knowledge for smaller and medium segments (4)
Capital	Based on business model capital should be made available for growth of the sector	<ul style="list-style-type: none"> • Inform financial institutions with facts to know better the aquaculture sector • Partnerships between fish farmers & input suppliers and between fish farmers and fish retailers to secure capitals and consistent supply of inputs and products 	Set up a targeted credit fund to ensure broader financing for most promising part of the small segment (2)	Set up a micro-finance fund to ensure broader financing for small segment (2)
Technology	<ul style="list-style-type: none"> • Continue to support independent testing to further refine aquaculture production variables and identify pathways for information flow to producers (eg Muranga v Kakamega). • Support private sector input suppliers (such as Sigma, Unga, Jewlet etc) of feeds to provide feeding charts based on scientific trials. 	Set up distribution centres for materials/equipment and imported technology	Provide training on aqua farm technology	Set up distribution centres for imported technology (5)
Record keeping	Invest in training and develop apps/make it fun. Purpose of this action: farmers know their cost of production	<ul style="list-style-type: none"> • Invest in training of farm operators and managers; • Make mandatory data collection and record keeping throughout the whole fish value chain (6) • Invest in a central database that supports the sector with market information (8) 	Invest in trainings to improve this essential skill (1)	Invest in trainings to improve this essential skill (4)

	Kenya	Rwanda	Tanzania	Uganda
Marketing, sales, distribution	<ul style="list-style-type: none"> Clustering for continuous supply of the market (2) Vertical integration of Fish Choma zones to increase consumer demand. Review upwards the price of Chinese fish through Common External Tariff import duty (1) Providing market information systems for producers (6) 	<ul style="list-style-type: none"> Linkage of clustered aquafarms to inputs/services/output products markets (4) Establishment of a grass-rooted commercial fish farmer association 	Stimulate organisation of trade among farmer groups to strengthen their position	Stimulate trade organisation among farmer groups to strengthen their position (1)
Permit requirements	Streamline process	<ul style="list-style-type: none"> Introduce a mandatory condition for data collection and reporting Independent evaluation commissions of EIA's dossiers Regular monitoring of cage farming activities to maintain/extend the permit (7) 	Improve speed in permit provision	No recommendations
Environment	Develop cage culture policy for Lake Victoria and streamline processes (3)	<ul style="list-style-type: none"> Monitoring of cage farming activities for escapes, eutrophication and diseases outbreak risks Regulate free movement of live fish through disease control certified laboratory(ies) and transport certificates 	The government should acquire baseline information on fish diseases and on likelihood of disease outbreaks in cage farming	Facilitate government to prepare for disease outbreaks in cage farming
Sector coordination	Create an aquaculture platform for more synergy among stakeholders	Create an aquaculture platform for more synergy among stakeholders	Create an aquaculture platform for more synergy among stakeholders	Create an aquaculture platform for more synergy among stakeholders
Growth potential	Healthy mix of big enterprises to get the volume going (tipping point) and small enterprises for inclusivity and job + wealth creation	Empower medium LVHD cage segment to grow and to reduce land pressure of on-land based aquaculture	Focus on enabling small and medium segments to grow	Focus on enabling small and medium segments to grow

Note: numbers between brackets after a recommendation indicate priority according to the authors for that particular country.

Recommended actions at regional level:

1. The Eastern DRC market is important for the region. The exact volumes, prices and margins, market channels and key players (collectors, transporters, wholesaler, retailers, consumers) of this informal market remain unknown. This market can boost small-scale aquaculture development as a pulling factor in the region. We recommend a study be carried out on distribution channels, volumes, markets and retail prices, players, import barriers and opportunities to reduce these barriers. The findings should be linked to production and distribution in the four East African countries studied.
2. Catfish when smoked is also more demanded in eastern DRC than in local markets. We recommend exploration of catfish farming and processing after a market study in eastern DRC has been done. Catfish constitutes an opportunity for product diversification for East African producers with a better organisation of production and supply. Catfish is easier to farm than tilapia because it is tolerant of lower water quality and can be kept in higher densities.
3. There is a small but growing interest among farmers and investors in Uganda in farming Nile perch for its high market potential on international markets, but knowledge of its biology is still lacking at all levels. We recommend support to research on Nile perch for farming, preferably in a Public-Private Partnership construction. Such research is relevant for aquaculture producers of all four countries that were studied.
4. Technological level and innovation are basic in all farm operations: production system construction is manual, farm operations (stocking, feeding, grading, harvesting) are manual and labour intensive in bigger segments. We recommend establishment of a regional centre for Aquaculture Equipment and Innovation, possibly with national branches in the countries.
5. Most fish farmers and companies obtain inputs and take care of the sales and marketing of their products individually. It can be economically beneficial, especially for small-scale producers, to organise such activities collectively. We recommend research into the most suitable organisation form for east African small-scale aquaculture producers and capacity development of officers of fish farmer organisations. Useful examples can be found, and valuable lessons can be drawn from successful collective action by fish farmer organisations elsewhere and from examples of collective action by producers in other agricultural sectors.
6. There is room for improvement in the collection of reliable aquaculture (production & marketing) data in all four countries studied. Improved data collection starts with farmers recording the relevant data and passing on such data to the staff of the institutes charged to collect aquaculture data on county, district or national level. This requires support to capacity development on farmer as well as on enumerator (extension agent) level. At national level, development of a system is required that includes use of modern IT programs and equipment (mobile phones, internet) to collect the data, as well as capacity development of staff charged to organise and maintain the data collection systems and to analyse and distribute the collected data. This up-ward data flow channel can be used also for downward flow of technical and market information and news to aquaculture producers. The national governments of the four countries could consider provision and extension of permits to aquaculture producers conditional on supply accurate production data.
7. To detect, prevent and stop the spreading of diseases within and between the four countries the region should be supported with development of strong regulations regarding the movement of fish from farms, trained personnel to implement the regulations, fish disease specialists and fish disease infrastructure (fish health laboratories).

Appendix 1 Study objectives and subjects covered

a. Provide an analysis of the sector that answers the following questions:

- Establish smallholder baseline. Identify main segments/groupings by scale (number of ponds, volume of output or other factor), species farmed, production system used, geographic clusters, management systems (record keeping, accounting etc.), technology used, supporting systems including extension services, funding and so on and any other relevant data.
- Map geographic distribution of small-scale producers and identify key existing or potential production areas based on temperature, water availability, logistics, market access, etc.
- Assess the motivation of small-scale producers: why are they engaged in fish farming? What are their aspirations (growth plans)? What is their level of knowledge about the opportunity?
- Describe in detail the main small-scale production models in use and their production dynamics for example setup costs, cost of production/gross margins realistically achieved, use of inputs, cost of labour (including cost of family/own labour).
- How do production dynamics/economics differ between the small-scale production models and segments? Which models are proving most successful and why?
- Define key challenges in small-scale fish farming for each segment/production model. Focus especially on access to inputs (seed, feed), financing, labour, market linkages, availability of knowledge/expertise and extension services.
- Technological assessment: what are the current technologies in use, which ones are proving successful and why? Are there any real technological barriers currently faced by small-scale producers?
- Level of entrepreneurship – movement from subsistence to small-scale commercial production?
- What it is that is limiting the development of small-scale production? Development Capital? Working Capital? Technical knowhow? Quality and availability of inputs? Access to markets? There is both an objective assessment and also an understanding of what small-scale fish farmers perceive to be their constraints.
- To what extent does current small-scale fish farming create (or is adversely affected by) environmental, social (including gender) and governance (including corruption, rent-seeking) factors? And how and to what extent will ESG issues be a limiting factor in the growth of the small-scale sector in future.
- What are the key trends within the subsector? Are these local or regional?
- To compare and contrast the “classic” issues facing smallholder agriculture and livestock in East Africa with small-scale fish farming and see whether or not aquaculture is a “special case” or just another farm livestock activity.
- What are the critical success factors?
- Skill levels – what formal aquaculture training has been received? From where? Informal training? Knowledge networks? Access to skills and knowledge by smallholder?
- Interaction with Government? What are the policy dynamics – supportive/unsupportive environment. What kind of support would be required?
- Supporting ecosystem i.e. extension services, input (fingerlings, feed, equipment etc.), financing etc.
- Disease and health management in the smallholder sector.
- Marketing and distribution of fish – pricing data and dynamics, selling points, supply chain, how is fish in the smallholder sector sold etc.
- Where do smallholders get information from?
- Production cycles – how long do the fish take to mature, harvesting cycle etc.
- Access to Inputs: e.g. feed quantities and pricing, fingerlings etc – pricing, packaging, reliability; who are the key input suppliers.
- Innovations if any?
- What is extent of sector coordination? Do smallholders recognise/participate in organised associations? How do sector organisations engage with smallholders? If at all.

-
- Regulations and standards – what are these? What compliance, licensing requirements etc. are there.

b. Make analysis and give insights

- Identify where small-scale producers are successful and growing, and any common conditions, habits or other factors which may determine this.
- Describe the key/root problems faced by small producers in each segment and show where the productivity can be addressed through better inputs, adoption of technology, improved management, access to markets (input/output), finance or other services.
- Analyse the key barriers to entry and estimate how much this contributes to the current gap in production.
- Define and prioritise opportunities to expand small-scale production by number of producers or size of farms. Which locations and production models offer the best potential for growth?
- Consider models through which smallholders could be linked to the market and support services.
- Specifically explore the potential for larger companies and investors to profitably engage with smallholders.
- Quantify the current and potential production of current fish farmers and do some kind of analysis on the elasticity if some of the factors are influenced e.g. impact of a potential drop in price of feed? Availability of higher quality fingerlings?

c. Formulate recommendations to Msingi

- In collaboration with the aquaculture industry team, determine clear focus area (s) for Msingi programme to invest in small-scale producers as part of overall sector development programme. Such investment could cover the full scope of Msingi interventions and include technical assistance, training, grants, or commercial investment.
- Define a potential implementation plan for the recommended areas of intervention and prioritize potential actions by impact, time lines, cost and any other relevant parameters.

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