IFPRI Discussion Paper 01937

June 2020

Characterization of Fish Farming Practices and Performance

Baseline Study and Implications for Accelerating Aquaculture Development in Ghana

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Abstract

Over the past decade, the aquaculture sector in Ghana has experienced tremendous growth—driven mainly by large-scale cage farms—but it has been unclear how the rural poor have shared in this growth. A research project has been initiated to help diagnose, design, and test interventions for better inclusion of the rural poor, women, and youth in the tilapia value chain. This report describes the baseline data on 603 small-scale tilapia farmers in Ghana. The data collected during two-hour face-to-face interviews during May–July 2019 are disaggregated by socioeconomic indicators, gender, and age group. Baseline data show that 9 percent of farm managers and owners were women, and an additional 9 percent of farms engaged women in some decision-making. Moreover, women contributed 16 percent of family labor and 5 percent of hired labor on farms. Youth represented 14 and 24 percent of owners and managers, respectively, but contributed 68 percent of the total family and hired labor on farms. A large majority of managers and owners had at least high school education, with a third of owners and a quarter of managers attaining at least a college degree. In Brong Ahafo and Ashanti regions especially, most farmers engaged mainly in crop farming and non-farm businesses as their main livelihood, with fish farming as a small contributor to overall household income and livelihood. Farmers in all regions had poor record-keeping and management practices and low compliance with sanitation, fish health, and food safety standards. A wide variety of input usage, management practices, and performance was observed among fish farms. As a result, the profitability of fish farms was also wide-ranging, between –12.00 and 46.00 cedi per m^2, with an average of 8.82 cedi per m^2. Despite wide variability in production and profits, the majority of farmers experienced positive profits. On average, a farmer received a profit of 2.4 cedi per kilogram of tilapia produced or a 27 percent profit margin. These encouraging figures indicate that farmers who adopt good aquaculture practices can achieve respectable profits.

Keywords: aquaculture, seed system, tilapia, rural livelihoods, inclusive value chains

Acknowledgment

The authors would like to thank the Government of the Netherlands through the Dutch Research Council under the Netherlands-CGIAR research programme on seed development systems; the CGIAR Research Programs on Policies, Institutions and Markets (PIM); and Fish Agri-food Systems (FISH) for funding this project. We are grateful to the FMMS team, especially to Stella Appiah-Kubi. We thank Matthew Oyih, Emmanuel Aryee, the Regional Directors and Zonal Officers of the Fisheries Commission (FC) for logistical support for the surveys. We are grateful to Nhuong Tran and Olivier Joffre of WorldFish and Froukje Kruijssen of KIT Royal Tropical Institute for their inputs to the survey questionnaire. We thank the staff of IFPRI and Aquaculture Research and Development Center (ARDEC) for logistical support, and Doreen Kufoalor and Mekamu Kedir Jemal for research and field assistance.

We are most grateful to the fish farmers, hatchery operators, entrepreneurs, government officials, and other value chain actors who shared their precious time to talk to us about their experiences and stories.

The opinions expressed here belong to the authors, and do not necessarily reflect those of the Government of the Netherlands, PIM, FISH, or IFPRI.

1. Introduction

Over the past decade, Ghana's tilapia farming has experienced tremendous growth in production, contributing to improved incomes for the industry and animal protein for consumers (Ragasa et al. 2018). Research found the recent growth in tilapia farming in Ghana is largely due to four factors: (i) an improved local Akosombo strain developed and released in 2005, (ii) the government's policy support initiatives, (iii) improved management practices and technologies at hatcheries and production levels, and (iv) availability of high-quality feeds locally (Ragasa et al. 2018). This growth has mainly been driven by the large-scale cage farming around Lake Volta, but it has been unclear how the rural poor, particularly women and youth, have shared in this growth (Ragasa et al. 2018). Moreover, fish diseases (e.g., *Streptococcus* bacteria and *Spleen and Kidney Necrosis Virus*)—likely triggered by poor management practices, seasonal water quality, and illegal imports of foreign tilapia strains—caused high mortality rates for tilapia in 2017 and 2019 in sections of Lake Volta (Paley et al. 2019; Verner-Jeffreys et al. 2018).

To build upon this growth, address emerging challenges, and improve inclusion and development impacts of growth, a consortium of international and local research institutes—led by the International Food Policy Research Institute (IFPRI), supported by the CSIR-Water Research Institute (CSIR-WRI), KIT Royal Tropical Institute in the Netherlands, and WorldFish, in partnership with the Fisheries Commission (FC, a government regulatory institution) and two private hatcheries (S-HOINT Ltd. and Crystal Lake Ltd.)—launched this project aimed at improving tilapia seed quality and promoting good aquaculture practices. Titled, **"Accelerating aquaculture development in Ghana through sustainable Nile Tilapia seed production and dissemination"** (TiSeed), the three-year project was launched on February 19, 2019[1] and will run from 2019 to 2022. The overall project objective is to improve productivity and profitability of tilapia cage and pond farming in Ghana. The project has multiple components including diagnostic study, capacity assessments, household surveys, characterization of fingerling and tilapia genetic make-up and productivity performance via on-farm trials, interventions design via randomized control trials, and impact evaluation.

This paper summarizes the baseline data for the TiSeed project collected from the census of active small-scale tilapia farmers in four major producing regions: Ashanti, Brong Ahafo,[2] Eastern, and Volta. The latter two regions are the major cage tilapia producers, and also where the majority of the medium- and large-scale cage farmers around Lake Volta are located. The first two regions are where most pond farmers are located. Small-scale farmers are defined as those producing less than 50 metric tonnes per year, which is consistent with Environmental Protection Agency (EPA), FC and WRI definitions (Karikari et al. 2016).[3]

The rest of the paper is structured as follows. Section 2 presents the methods and survey details. Section 3 provides a descriptive analysis of the household data, including the types of tilapia farms, characteristics of the farmers and their households, their access to credit and information, their production, costs and profits from fish farming, their practices and input use, and inclusion of women and youth in the farmed tilapia value chain. Section 4 highlights some of the major trends in the data and provides a summary of key findings from the descriptive analysis to inform this project, the Ghana Government's policy initiative on Aquaculture for Jobs and Food, and other projects about future interventions and investments to accelerate an inclusive growth in the sector.

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[1] See project website for more details https://www.ifpri.org/project/ghana-tilapia-seed-project

[2] This is the old Brong Ahafo, which is now divided into three regions. The old region was used during the proposal stage of the project, which we continued in this report.

[3] There is no updated list of active medium- and large-scale tilapia farmers. An older list from FC indicates 50 farmers with more than 20 cages, which can be considered medium- or large-scale farmers, assuming an average production of 2.5 tonnes per cage. These farmers are mainly cage farmers in the Akosombo zone and Volta region. Of the 50 farmers, about 15 are mainly hatcheries or integrated hatchery-grow-out farms.

2. Methodology

This section describes the process of data collection from the household survey that was jointly led by the International Food Policy Research Institute (IFPRI) and CSIR-Water Research Institute (WRI), implemented by FMMS survey firm from May to June 2019, and validated by a team of WRI and Fisheries Commission (FC) zonal officers in October—November 2019. The survey covered all active small-scale tilapia farmers in the four focus regions: Ashanti, Brong Ahafo, Eastern, and Volta.

The survey teams started with the list of fish farmers from FC; however, the list did not reflect currently active farmers. The survey teams adapted several ways to update the existing list from FC including working with the FC zonal officers (who are the frontline extension workers on aquaculture and fisheries), WRI researchers, community leaders, fish feed outlets, and farmer associations or groups. The updated household list and dataset are the best effort from the survey teams to update the list of all active small-scale tilapia farmers. A total of 479 active small-scale tilapia farmers (both pond and cage) were identified.

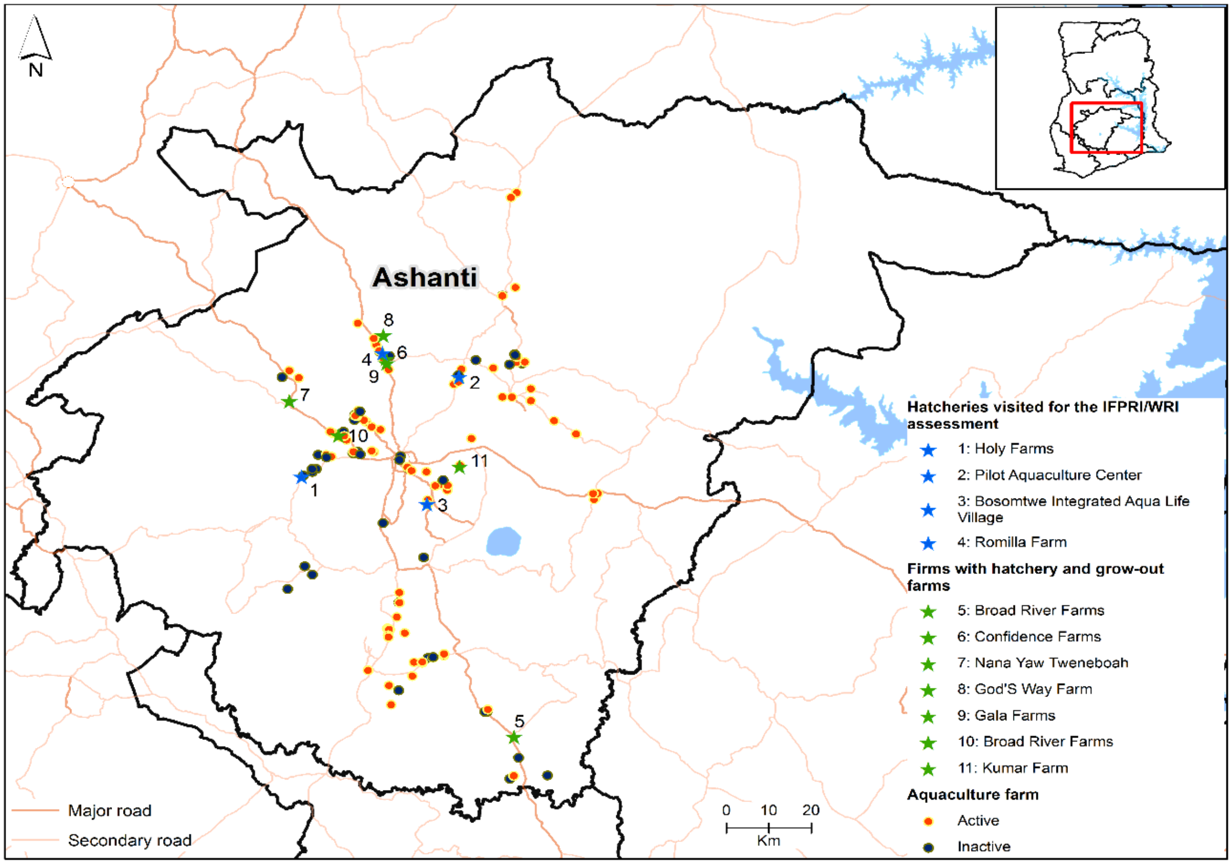
Many farmers in the original FC list are inactive (or did not farm for the last two years). We included a sample of these farmers (a total sample of 124 farmers) to get a sense of the challenges they faced. These sample inactive farmers were interested in returning to fish farming. Figure 1 shows a snapshot of the small-scale grow-out farmers surveyed in the four focus regions, as well as those with both hatcheries and grow-out farms and major hatchery operators interviewed during the IFPRI/WRI hatcheries assessment in July 2019.[4]

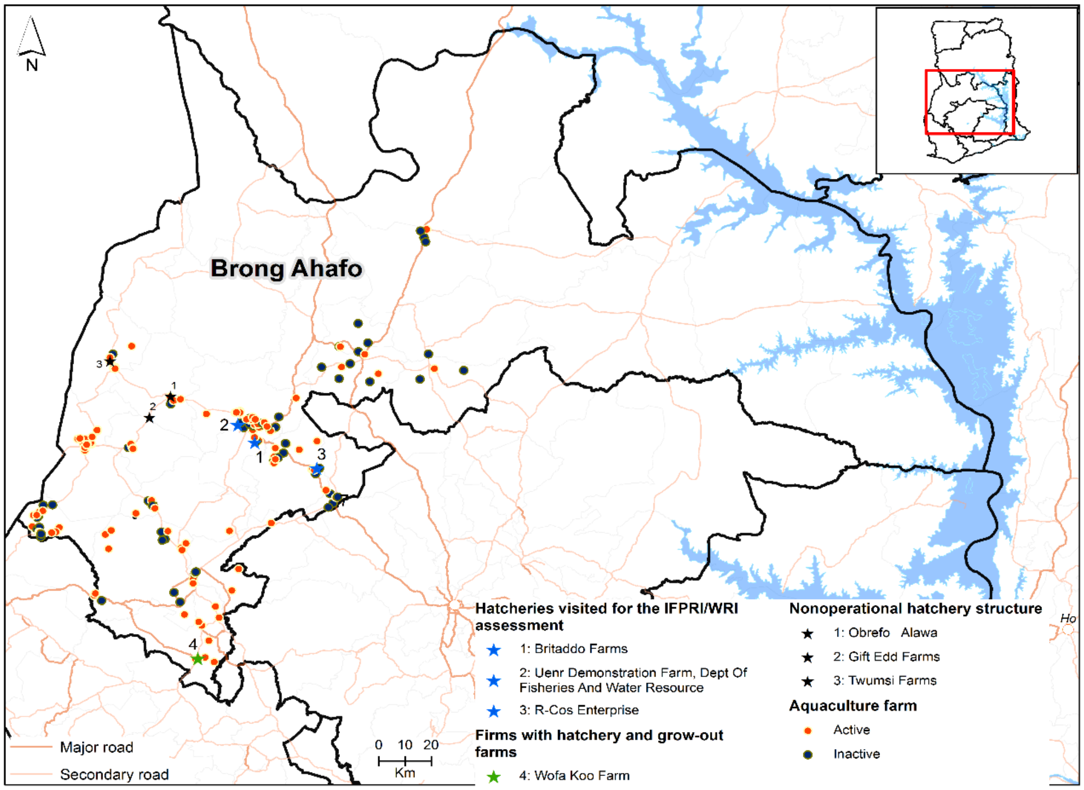
The household survey instrument covered modules on pond or cage sizes and characteristics, performance indicators, costs and constraints in production, and socioeconomic indicators. The face-to-face interviews lasted for 2–3 hours, using tablet-based and computer-assisted personal interviewing. The interviewee was either the manager or owner (if different) of the farm/firm, or the person who made most decisions on fingerlings and inputs and who would likely attend production trainings. Other staff or family members were allowed to participate in answering some of the modules and questions. Most of the interviews with the managers/owners were conducted at their fish farms (GPS coordinates were recorded).

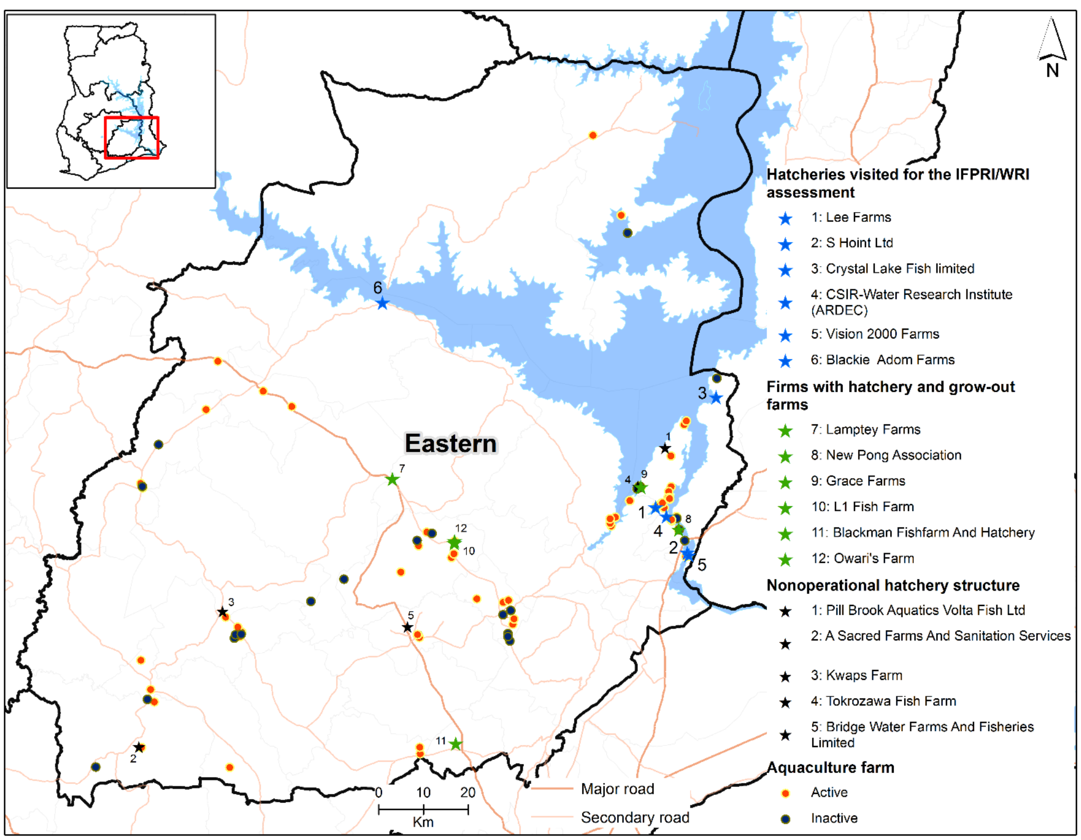
We added a module on challenges and opportunities of being women owners and managers. In the interview, it took about 5 minutes to administer this additional module for women respondents. We also interviewed the primary decision maker in the sample households of the opposite gender to get some sense of gender-based constraints or opportunities. The main respondent of the household survey (owner or manager) is usually a man; the second respondent is usually the wife. A total of 603 households were interviewed, of which 279 had second respondents (usually the wife of the owner or manager). Since most of the interviews with the managers or owners were conducted at the farm, the second respondents were not available, hence they could not be contacted or located.

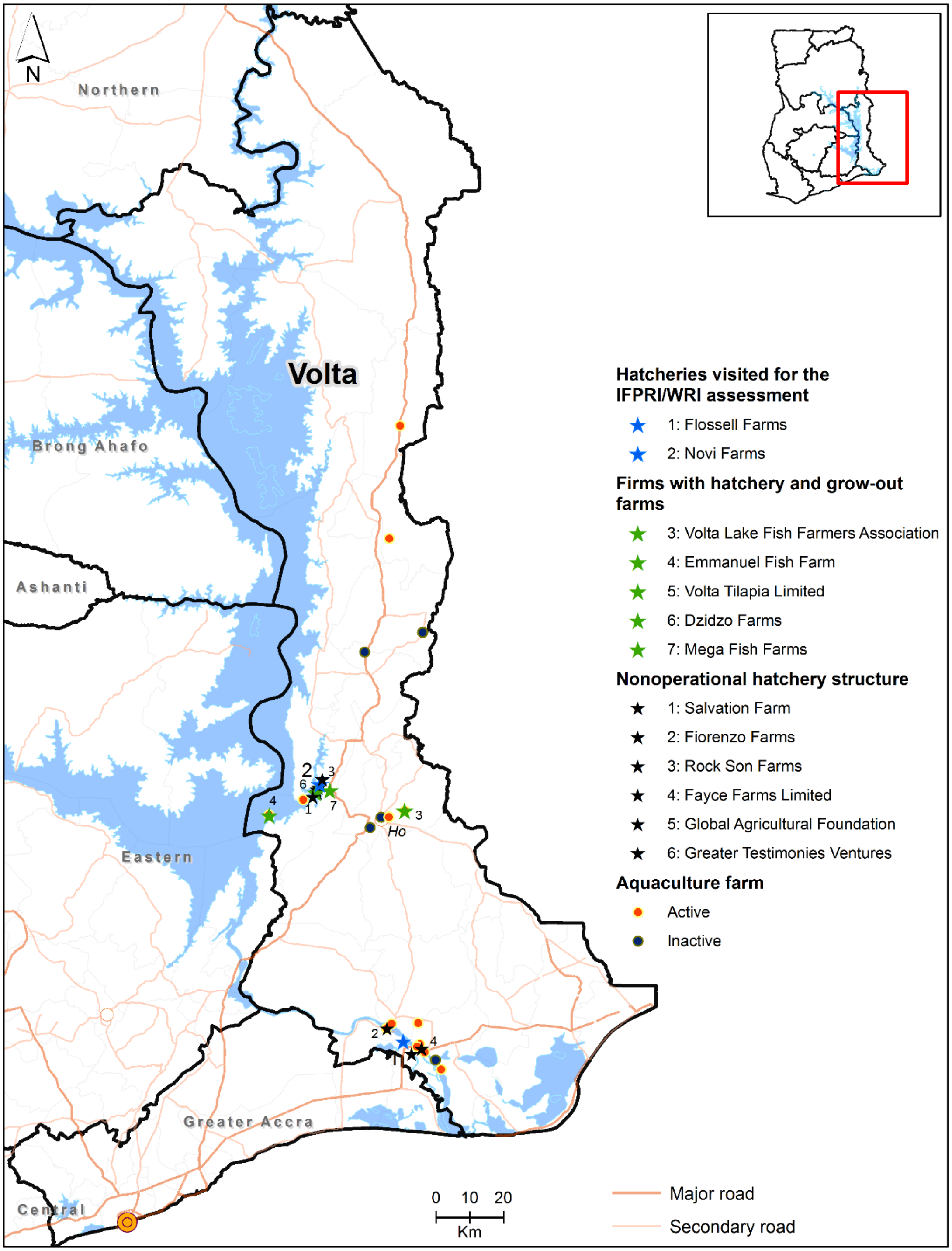
[4] For more details on the descriptive analysis of the hatchery assessment dataset (18 hatcheries), see Ragasa et al. (2020).

Figure 1. Location of tilapia farmers and hatcheries in the focus regions.




N
Brong Ahafo
Hatcheries visited for the IFPRI/WRI assessment
1: Britaddo Farms
2: Uenr Demonstration Farm, Dept Of Fisheries And Water Resource
3: R-Cos Enterprise
Firms with hatchery and grow-out farms
4: Wofa Koo Farm
Nonoperational hatchery structure
1: Obrefo Alawa
2: Gift Edd Farms
3: Twumsi Farms
Aquaculture farm
Active
Inactive
Major road
Secondary road
0 10 20
Km


N
Eastern
Hatcheries visited for the IFPRI/WRI assessment
1: Lee Farms
2: S Hoint Ltd
3: Crystal Lake Fish limited
4: CSIR-Water Research Institute (ARDEC)
5: Vision 2000 Farms
6: Blackie Adom Farms
Firms with hatchery and grow-out farms
7: Lamptey Farms
8: New Pong Association
9: Grace Farms
10: L1 Fish Farm
11: Blackman Fishfarm And Hatchery
12: Owari's Farm
Nonoperational hatchery structure
1: Pill Brook Aquatics Volta Fish Ltd
2: A Sacred Farms And Sanitation Services
3: Kwaps Farm
4: Tokrozawa Fish Farm
5: Bridge Water Farms And Fisheries Limited
Aquaculture farm
Active
Inactive
Major road
Secondary road
0 10 20
Km



Source: IFPRI/WRI household survey and hatchery assessment (2019). Note: The maps include 55 farmers without GPS coordinates of their fish farms (2 farmers in Ashanti, 10 in Brong Ahafo, 29 in Eastern, and 14 in Volta). These are situated in the middle of the district for presentation purposes. Holy Farms and Romilla Farm (in Ashanti); Britaddo Farms, UENR, and R-Cos Enterprise (in Brong Ahafo); Lee Farm and Blackie Adom Farm (in Eastern); and Flossell Farm (in Volta) had both hatchery and grow-out; and were included in the IFPRI/WRI hatchery assessments (Ragasa et al. 2020).

3. Results

3.1. Types of tilapia farms

Of the 479 small-scale active tilapia farmers active in the four focus regions, 78 percent were pond farmers and 22 percent cage farmers (Table 1). Most of them were from Brong Ahafo region (191 farmers, or 40 percent of total farmers), followed by Eastern region (140 farmers or 29 percent), Ashanti (112 farmers or 23 percent), and Volta (36 farmers or 7 percent).[5] We sampled 124 inactive farmers who were interested in returning to fish farming, of whom 96 farmers had been practicing pond farming and 27 farmers cage farming at least two years ago.

Table 1. Number of farmers surveyed, by region and culture type

Region	Active /a				Inactive /b			
	Pond	Cage	Pond& cage /c	Total	Pond	Cage	Pond& cage /c	Total
Ashanti	112	0	0	112	40	0	0	40
Brong Ahafo	191	0	0	191	45	0	0	45
Eastern	60	79	1	140	9	23	1	33
Volta	10	25	1	36	2	4	0	6
Total	**373**	**104**	**2**	**479**	**96**	**27**	**1**	**124**

Source: IFPRI/WRI survey (2019). Note: /a Includes all active small-scale tilapia farmers. /b Includes a random sample of inactive tilapia farmers (did not farm in the last two years, but indicated interest to farm tilapia again). /c Farmer had both pond and cage; farmer in Ashanti had catfish cage and tilapia ponds. There are two entries for BROAD RIVER FARMS representing a farm that is active and another farm in a different location that is now inactive.

On average, a pond farmer usually owned five ponds and used two ponds in 2018 (Table 2). Thirty-six percent of respondents used only one pond in 2018, and 64 percent used more than one pond. A few farmers used as many as 17 ponds in 2018. The most common dimensions were 10–60 meters in length and 10–60 meters in width. The most common depth was 1–2 meters. The average area across ponds was 982 square meters (m^2). Ponds in Ashanti were larger on average at 1,819 m^2. Ponds in Brong Ahafo and Eastern were the smallest with areas averaging 559–569 m^2.

A cage farmer usually owned 17 cages and used four cages in 2018 on average (Table 2). A few farmers used as many as 20 cages in 2018. The most common volumes were 125 and 216 m^3. The biggest cage was 12m x 12m x 12m (1,728 m^3 in volume), owned by two cage farmers. One cage farmer had circular cage types with a volume of 1,608 m^3.

Table 2. Number of ponds or cages owned and used

Indicator	N	Average	Median	SD	Min	Max
Number of ponds owned	375	5	3	7.8	1	120
Number of ponds used in 2018	375	2	2	2.1	0	17
Number of cages owned	107	17	8	25.2	1	148
Number of cages operational in 2018	107	4	2	3.9	0	20

Source: IFPRI/WRI household survey (2019). Note: N=number of farmers; SD=standard deviation

The large majority of the cage farmers (93 percent) practiced culture with tilapia only, and 7 percent had a mixed system with tilapia and catfish (Table 3 and Table 4). Mixed tilapia-catfish culture was more

[5] A couple of active farmers in Volta had farms in dams, which were discouraged, and those farmers were therefore not included in the survey.

common among pond farms than cage farms. A few ponds have a mix of tilapia, catfish and heterotis fish species. Thirty percent of pond farmers had mixed tilapia-catfish culture (Table 2). Most of the ponds (94 percent) were earthen ponds, 4 percent concrete, and 2 percent earthen and concrete.

Five percent of the farmers had hatchery operations (fingerling production) in addition to their grow-out farms (Table 5). Most of them had both catfish and tilapia fingerling production. Of the 27 grow-out farmers with hatchery operation, eight farmers were identified by CSIR-WRI and FC as hatcheries and were included in the IFPRI/WRI hatchery assessment in July 2019 (Figure 1 above). These were Holy Farms and Romilla Farm (in Ashanti); Britaddo Farms, UENR, and R-Cos Enterprise (in Brong Ahafo); Lee Farm and Blackie Adom Farm (in Eastern); and Flossell Farm (in Volta). Nineteen of these farmers with hatchery operations were not well-known or had no records of buying official broodstock from Aquaculture Research and Development Center (ARDEC). Most of them were in Ashanti, Eastern and Volta. Their main activity was grow-out farming while hatchery operation was a minor activity. In addition, 19 farmers (3 percent) had a hatchery structure, but were not yet operational. Most of them were in Volta and Eastern (Figure 1 above).

Table 3. Number of active farmers, by region, specie, and culture, with detailed production data

Region	Active					
	Pond /a				Cage /a	
	Tilapia only	Tilapia-catfish mixed system	Tilapia-catfish-heterotis mixed system	Tilapia-heterotis mixed system	Tilapia only	Tilapia and catfish mixed system
Ashanti	69	39	1	3	0	1
Brong Ahafo	133	57	1	0	0	0
Eastern	45	16	0	0	75	5
Volta	7	2	1	1	23	3
All	**254**	**114**	**3**	**4**	**98**	**8**

Source: IFPRI/WRI household survey (2019). Note: /a Two farmers had both pond and cage and were counted twice.

Table 4. Proportion of active farmers, by region, specie, and culture (%)

Region	Active					
	Pond /a				Cage /a	
	Tilapia only	Tilapia-catfish mixed system	Tilapia-catfish-heterotis mixed system	Tilapia-heterotis mixed system	Tilapia only	Tilapia and catfish mixed system
Ashanti	62	35	1	3	0	1
Brong Ahafo	70	30	1	0	0	0
Eastern	74	26	0	0	94	6
Volta	64	18	9	9	89	12
All	**68**	**30**	**1**	**1**	**93**	**7**

Source: IFPRI/WRI household survey (2019). Note: /a Two farmers had both pond and cage and were counted twice.

Table 5. Number of farmers with both hatchery and grow-out farms

	Number of farmers	Percent
Yes (operational)	27	5
No	557	92
Have the structure but not yet operational	19	3
Total	**603**	**100**

Source: IFPRI/WRI survey (2019).

3.2. Characteristics of respondents

Survey respondents were mainly the owners (79 percent) (Table 6), who also doubled as the manager in most cases. Twenty-one percent of the respondents were youth (18–35 years old) (Table 7). Among owners, 14 percent were youth and about half were older than 50 years. The average age for owners was 50 (Table 7). Among managers, 24 percent were youth (18–35) and 37 percent were older than 50. The average age for managers was 46—implying owners were generally older and managers relatively younger (Table 7). More younger owners and managers were in Brong Ahafo and Eastern than in other regions. Sixty-four percent of younger owners and 61 percent of younger managers were married.

By gender, most of the survey respondents (managers/owners) were men. Eight percent of owners and seven percent of managers were women (Table 8 and Table 9).

Table 6. Characteristics of respondents (%)

Indicator		Overall	Ashanti	Brong Ahafo	Eastern	Volta
		479	112	190	140	36
Role	Owner	78	71	91	70	67
	Manager	22	29	9	29	31
	Supervisor	0	0	0	1	3
Male		93	93	92	97	89

Source: IFPRI/WRI survey (2019).

Table 7. Proportion of respondents, owners, and managers by age group (%)

Region	Respondents			Owners			Managers		
	Youth (18–35)	Middle (36–50)	Older (>50)	Youth (18–35)	Middle (36–50)	Older (>50)	Youth (18–35)	Middle (36–50)	Older (>50)
Ashanti	19	41	39	8	36	56	23	40	37
Brong Ahafo	19	35	46	15	34	51	24	34	42
Eastern	27	43	29	19	45	36	27	43	30
Volta	19	33	48	2	40	57	19	36	45
All	**21**	**39**	**40**	**14**	**38**	**48**	**24**	**38**	**37**

Source: IFPRI/WRI survey (2019).

The majority (84 percent) of the farms were within just 2 kilometer (or 15-minute walk) of the respondent's house. Thirteen percent of the owners had either no formal schooling or only primary schooling, while 33 percent had at least a college degree (as high as 56 percent in Volta). Fifteen percent of owners in Ashanti had an MS or PhD degree. For managers, 17 percent had either no formal schooling or only primary schooling, whereas 23 percent had at least a college degree (as high as 42 percent in Volta).

3.2.1 Fish farming entry and exit

Most farmers (77 percent) started fish farming on their own or as a partnership, whereas 9 percent purchased their fish farm from other farmers and 7 percent inherited from their parents or relatives (Table 10). The most commonly cited reasons and motivations to start fish farming were receiving training and technical assistance and seeing fish farmers in their community who were successful and profitable (Figure 2). Most farmers learned about fish farming for the first time from other farmers. The other sources of fish farming information were FC extension agents, reported by 36 percent of respondents (Figure 3). Conversely, many small-scale farmers had discontinued their fish farming for the following reasons: lack of funds, expensive feeds, low demand for fish (since they produce smaller sizes of fish), natural disaster (e.g., flood or drought), and labor availability (Figure 4). The underlying issue is low profitability, which is due to low production and productivity, stemming from poor management practices. Stakeholders pointed out that greater technical assistance and training can improve adoption of good aquaculture practice, and therefore productivity and profitability of fish farming.

Table 8. Profile of farm owners, by region (%, unless otherwise stated)

		Overall	Ashanti	Brong Ahafo	Eastern	Volta
Number of respondents		479	112	191	140	36
Male		92	93	91	94	92
Age (years)	Average	50	52	50	47	52
	Median	50	51	50	46	54
	SD	13	12	14	12	12
	Min	20	29	20	26	34
	Max	99	99	85	86	76
Education	No schooling	6	9	6	5	3
	Primary school	7	6	6	10	6
	Junior secondary school	25	19	31	27	11
	Technical or vocational	5	3	8	4	6
	Senior secondary school	15	14	15	18	11
	Polytechnic/Diploma	7	12	7	4	8
	University/College degree	25	23	21	27	47
	Master's degree	7	13	5	5	6
	Doctorate degree	1	2	1	1	3
Distance from home to farm (km)	Average	6	7	2	9	7
	Median	1	1	1	1	1
	SD	16	17	5	23	18
	Min	0	0	0	0	0
	Max	120	67	54	120	67

Source: IFPRI/WRI survey (2019). SD=standard deviation

Table 9. Profile of farm managers, by region (%, unless otherwise stated)

		Overall	Ashanti	Brong Ahafo	Eastern	Volta
Number of respondents		479	112	191	140	36
Male		93	93	92	97	89
Age (years)	Average	46	46	47	45	49
	Median	45	48	46	43	48
	SD	13	13	14	12	13
	Min	19	19	20	22	27
	Max	86	76	82	86	74
Education	No schooling	7	12	6	5	6
	Primary school	10	11	7	15	6
	Junior secondary school	31	23	32	37	31
	Technical or vocational	5	4	7	5	3
	Senior secondary school	17	19	18	18	6
	Polytechnic/Diploma	6	10	6	4	8
	University/College degree	19	15	20	14	39
	Master's degree	4	6	4	2	3
	Doctorate degree	0	1	0	0	0
Distance from home to farm (km)	Average	2	3	2	3	1
	Median	1	0	1	0	0
	SD	8	7	5	11	1
	Min	0	0	0	0	0
	Max	70	57	54	70	5

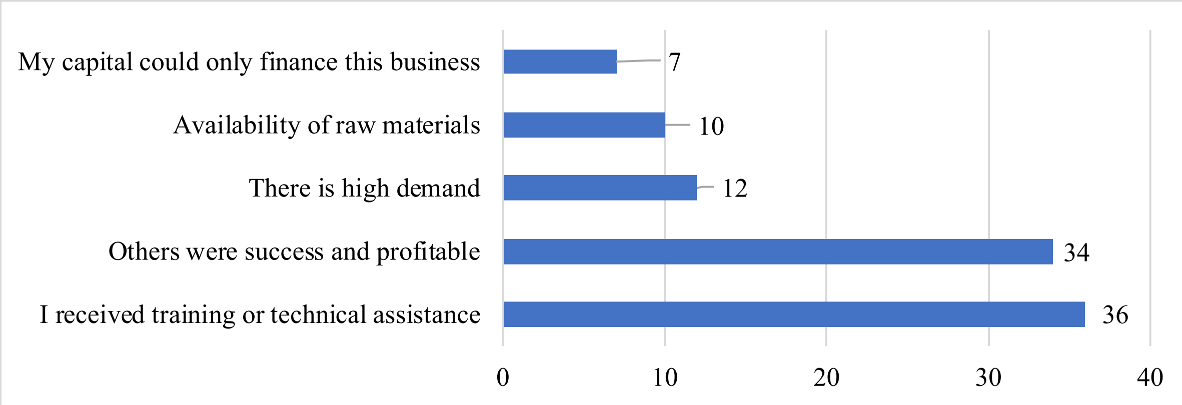
Source: IFPRI/WRI survey (2019). SD=standard deviation.

Table 10. Number of farmers by process of starting their farms

How did the farm/firm come into existence?	**Number of farmers**	**(%)**
Started by self/partnership	464	77
Purchased	55	9
Inherited	43	7
Gift	22	4
Don't know	15	2
Refuse to answer	4	1
Total	**603**	**100**

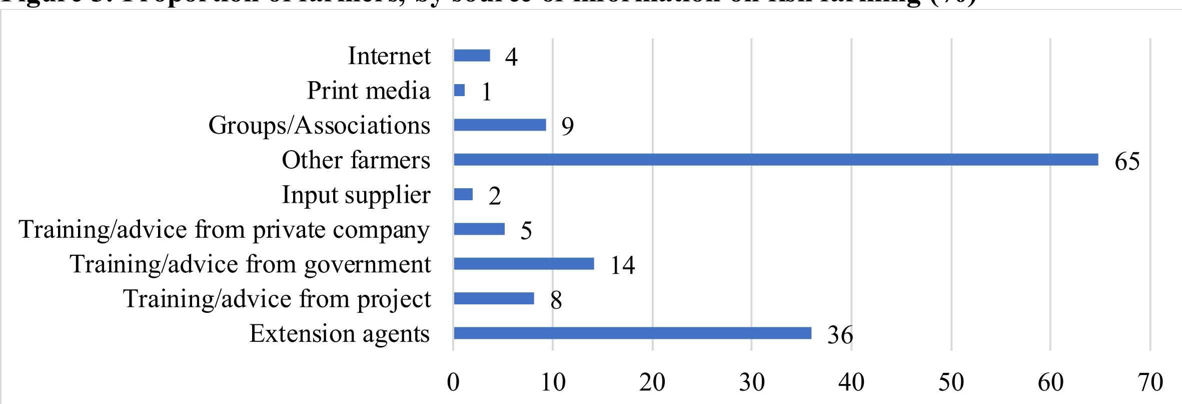
Source: IFPRI/WRI survey (2019).

Figure 2. Proportion of farmers, by motivation for starting fish farming (%)



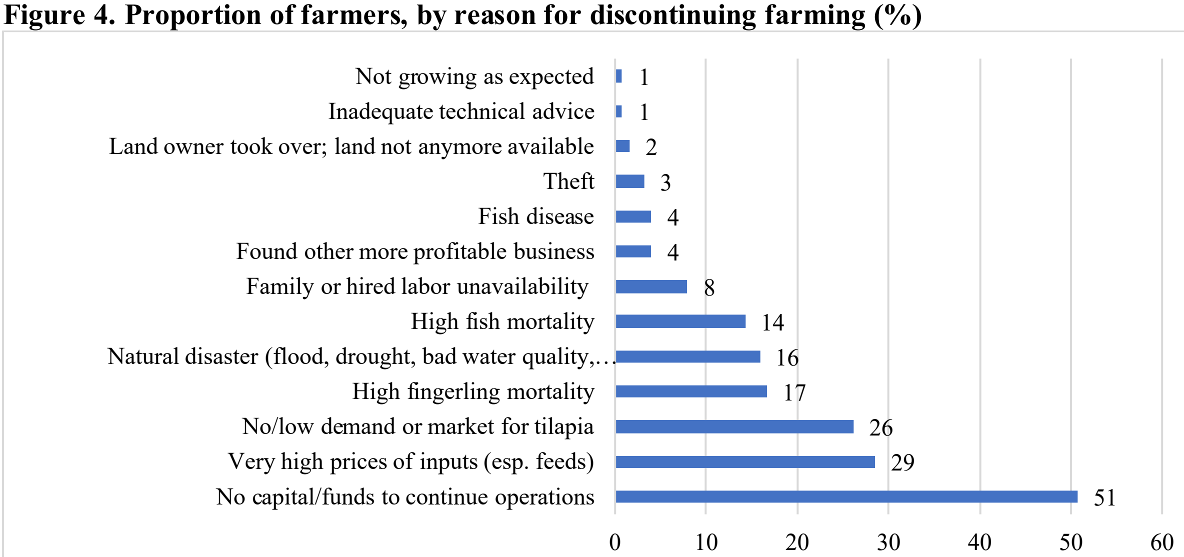
Source: IFPRI/WRI survey (2019).

Figure 3. Proportion of farmers, by source of information on fish farming (%)



Source: IFPRI/WRI survey (2019).

Figure 4. Proportion of farmers, by reason for discontinuing farming (%)

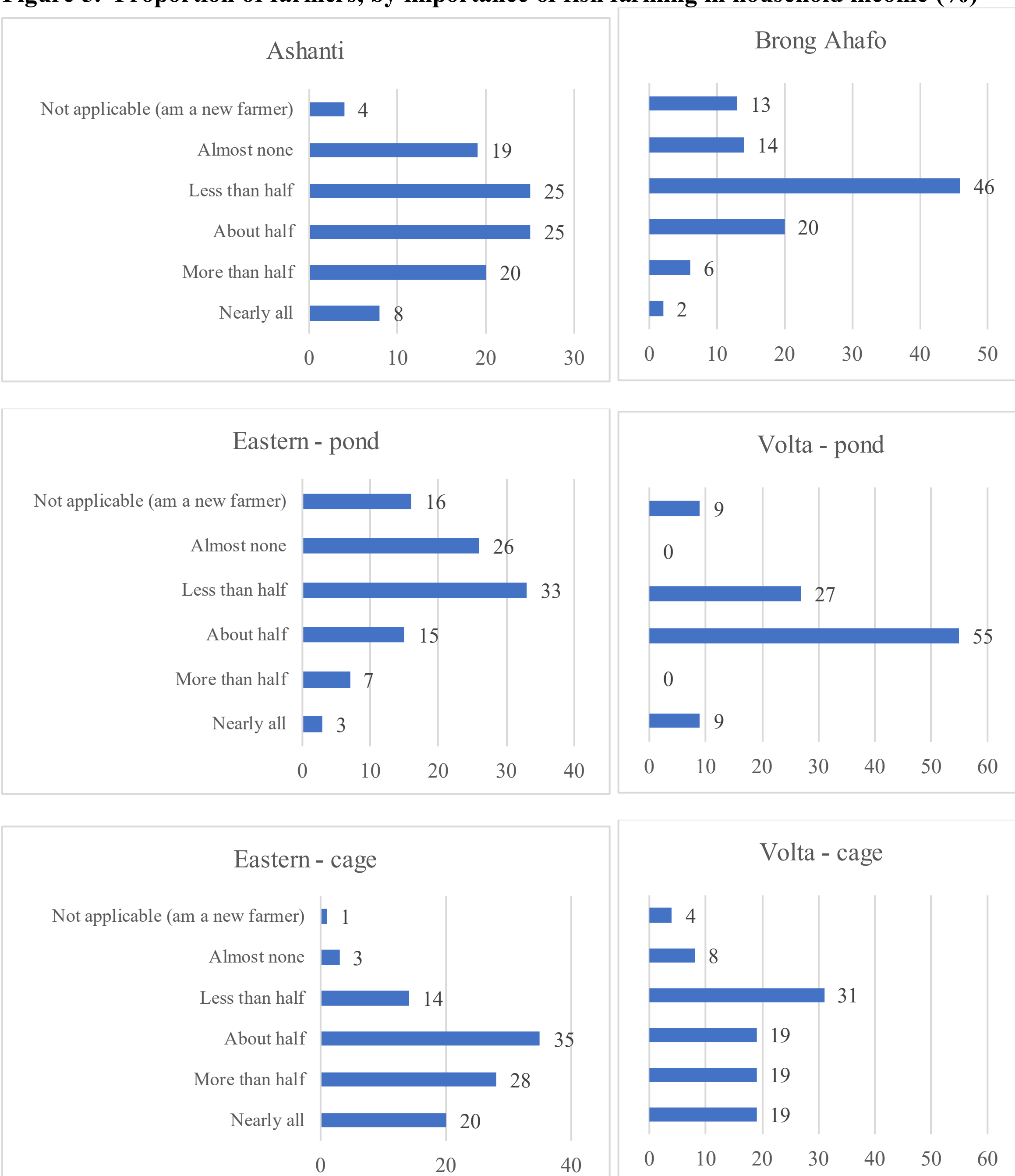


Source: IFPRI/WRI survey (2019). Some respondents had multiple responses.

3.2.2 Contribution of fish farming to household income

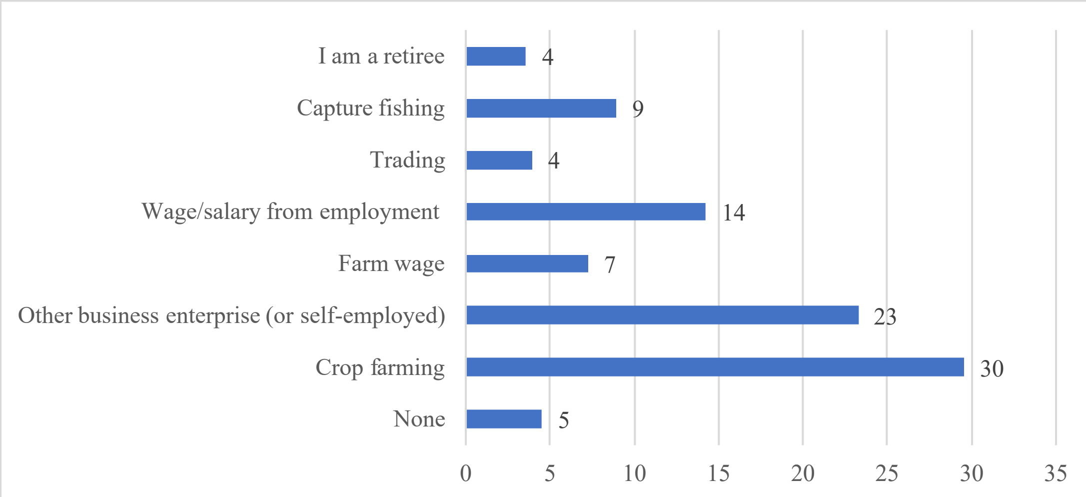
For most pond farmers, fish farming contributed less than half of their household income. Conversely, more cage farmers reported a greater contribution, with fish farming contributing at least half of household income for a majority of cage farmers (Figure 5). Most farmers, especially in Brong Ahafo and Ashanti, were also engaged in crop farming (particularly maize) or other non-farm businesses (mainly trading) as their main livelihood (Figure 6).

Figure 5. Proportion of farmers, by importance of fish farming in household income (%)



Source: IFPRI/WRI survey (2019).

Figure 6. Proportion of farmers, by main livelihood (%)

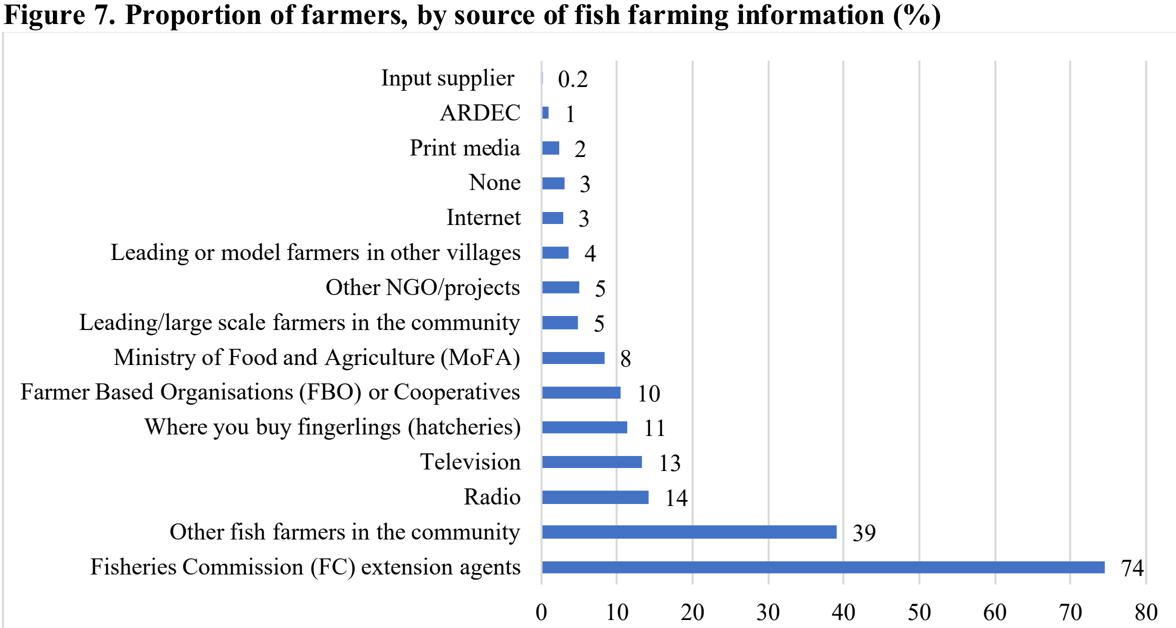


Source: IFPRI/WRI survey (2019). Four percent did not respond.

3.3. Access to information and capital

Seventy-four percent of fish farmers got information on fish farming from FC extension agents (Figure 7). The second source of information on fish farming was other fish farmers in the community, reported by 39 percent of farmers.

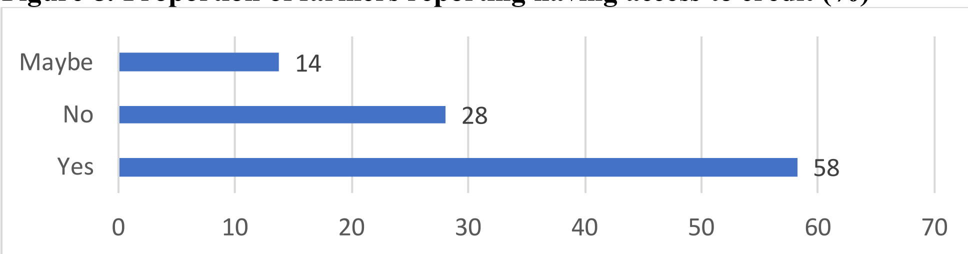
Figure 7. Proportion of farmers, by source of fish farming information (%)



Source: IFPRI/WRI survey (2019). NGO=nongovernmental organization.

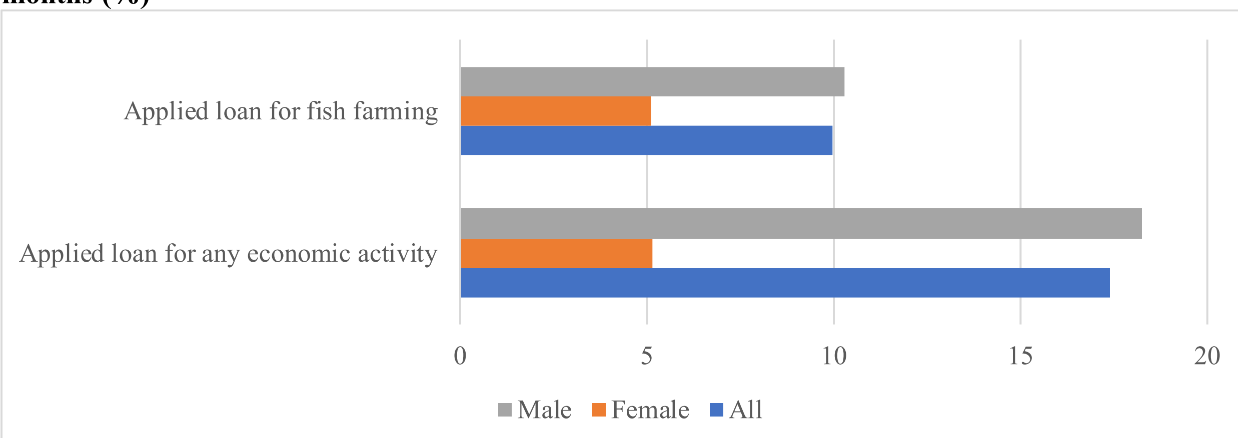
More than half of farmers reported that they could access credit or a loan if needed (Figure 8). However, only a few applied for a loan: 10 percent of men fish farmers and 5 percent of women fish farmers applied for a loan for their fish farming (Figure 9). More than half of those who did not apply for a loan said they did not need credit (Figure 10). Twenty-eight percent said they did not have access to credit (Figure 8). Sixteen percent said the interest rate was too high, 10 percent said they did not have adequate collateral, 9 percent said the loan application processes were cumbersome, and 2 percent said there were no lenders available (Figure 10). These figures indicate that about 28–37 percent of farmers seemingly had the demand for credit but were discouraged from applying because of these reasons. It seems that the lack of access to credit and capital is an issue to some farmers, but not to a majority of farmers. It seems that the profitability of fish farming is the major and more urgent issue that needs to be addressed to promote real demand for credit and enable repayments.

Figure 8. Proportion of farmers reporting having access to credit (%)



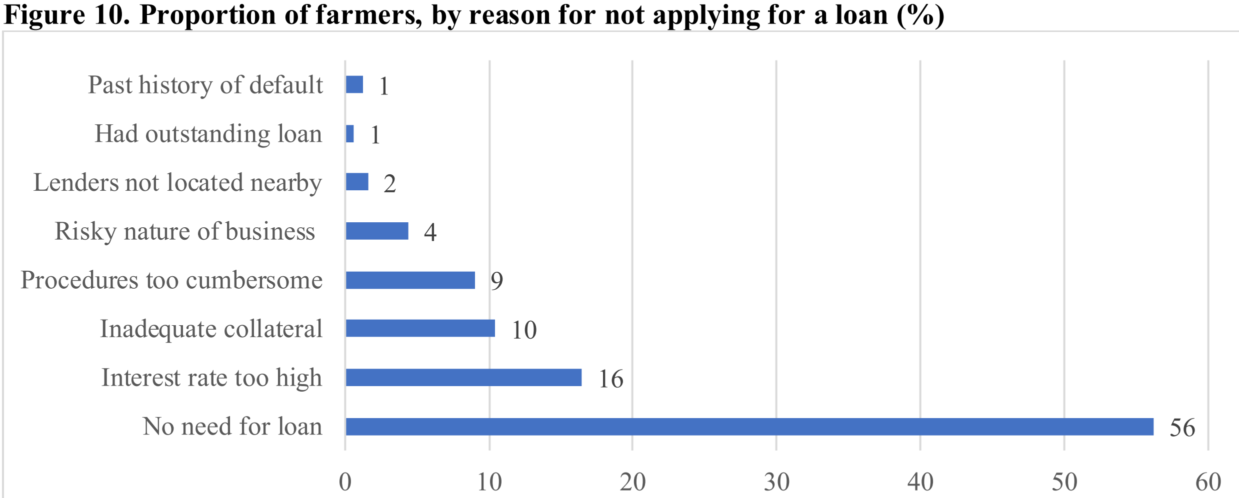
Source: IFPRI/WRI survey (2019).

Figure 9. Proportion of respondents who applied for a loan for economic activity in the last 12 months (%)



Source: IFPRI/WRI (2019). Percentage of respondents answering YES to the following question: "Did anyone apply credit for any economic activity or fish farming in the last 12 months?"

Figure 10. Proportion of farmers, by reason for not applying for a loan (%)



Source: IFPRI/WRI (2019).

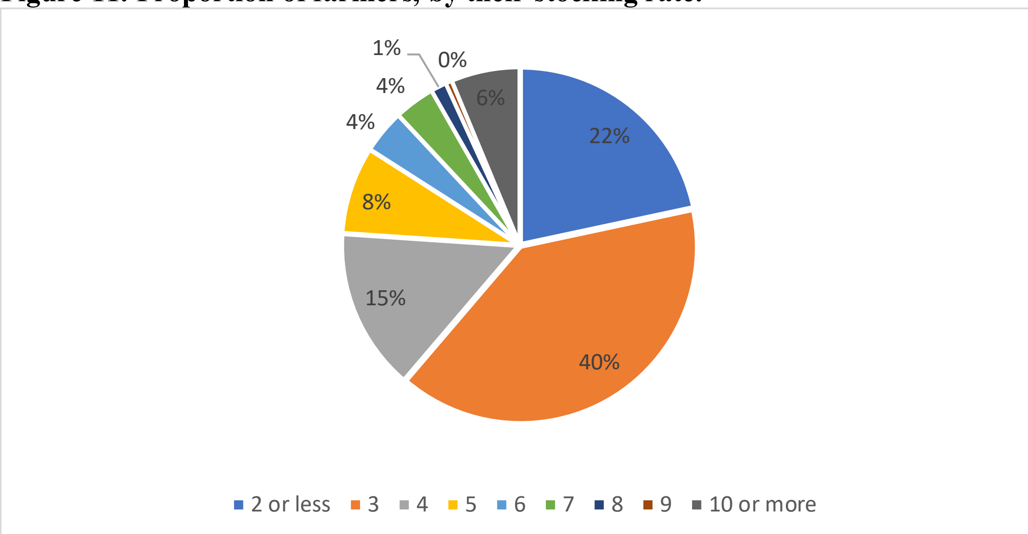
3.4. Production

This section summarizes the baseline data on production, inputs, practices, costs, sales, and profits of the biggest tilapia pond[6] of the farmers surveyed.

3.4.1 Ponds

The recommended stocking rate in tilapia ponds is 3-8 fingerlings per m^2 (FAO 2010; Pant et al. 2019). Data show that 71 percent of the farmers followed this recommendation, but 22 percent understocked and 7 percent overstocked (Figure 11). Stocking rates were lowest in Brong Ahafo (Table 11) with an average stocking rate of 4 fingerlings per m^2 (Table 12). Productivity and production can be further improved by increasing the stocking rate closer to 5–8 fingerlings per m^2, which only 17 percent of farmers were doing.

Figure 11. Proportion of farmers, by their stocking rate.



Source: IFPRI/WRI survey (2019).

Table 11. Proportion of farmers, by stocking rate (fingerling per m^2) and region (%)

Stocking rate (fingerling per m^2)	All	Ashanti	Brong Ahafo	Eastern	Volta
2 or less	22	13	29	14	17
3	40	32	52	5	17
4	15	32	8	2	0
5	8	14	4	12	0
6	4	7	3	2	0
7	4	2	3	12	17
8	1	0	1	10	0
9	1	0	1	2	0
10 or more	6	0	1	40	50

Source: IFPRI/WRI survey (2019).

[6] Thirty-six percent of farmers had one tilapia pond; this is the farm analyzed and described in this section. The rest of the farmers had more than one tilapia pond; their biggest tilapia pond was selected and described in this section. Note that these figures are indicative. Despite validation of study results in September 2019 and best efforts of CSIR-WRI technical officers and FC zonal officers to verify data collected, it was challenging to ascertain these figures because many farmers did not keep records.

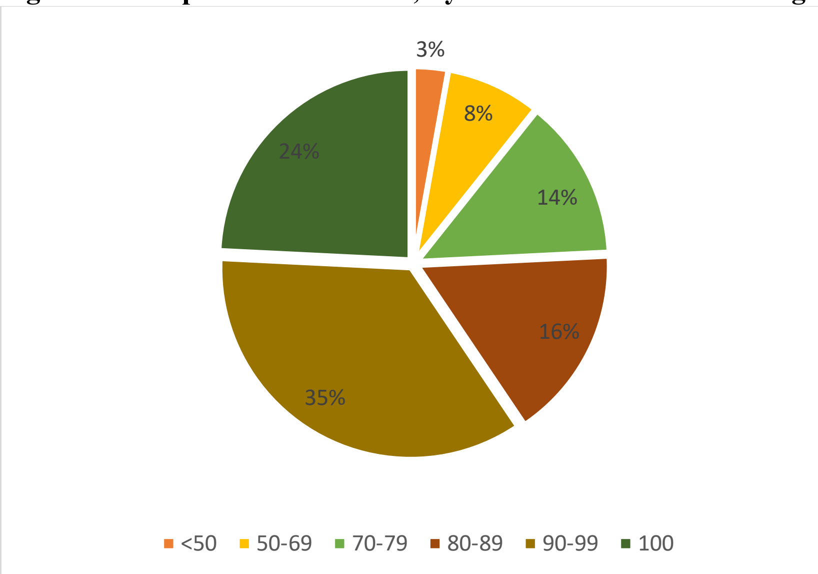
Table 12. Descriptive statistics of stocking rate, survival rate, and productivity of tilapia ponds

	N	Mean	Median	SD	Min	Max
Pond area (^{m2}) (biggest pond)						
All	354	855	377	1188	15	8000
Stocking (fingerling per m^2)						
Tilapia-only ponds	197	4.06	3.14	3.24	0.83	26.91
Mixed tilapia-catfish ponds						
Tilapia	145	4.31	3.17	3.76	0.69	22.42
Catfish	134	2.55	1.20	3.89	0.04	26.91
Mixed tilapia-catfish-heterotis ponds						
Tilapia	6	7.10	3.38	8.19	1.11	22.42
Catfish	6	1.23	1.14	0.93	0.04	2.84
Heterotis	5	0.25	0.07	0.35	0.01	0.83
Mixed tilapia-catfish-heterotis ponds						
Tilapia	5	7.17	5.53	5.94	2.59	17.50
Heterotis	4	0.14	0.09	0.17	0.00	0.38
Survival rate (%)						
Tilapia-only ponds	202	89.91	95.00	12.25	45.00	100.00
Mixed tilapia-catfish ponds						
Tilapia	144	88.81	95.00	13.24	40.00	100.00
Catfish	100	91.88	95.00	10.73	50.00	100.00
Mixed tilapia-catfish-heterotis ponds						
Tilapia	7	85.00	90.00	14.43	70.00	100.00
Catfish	2	95.00	95.00	0.00	95.00	95.00
Heterotis	1	100.00	100.00	na	100.00	100.00
Mixed tilapia-catfish-heterotis ponds						
Tilapia	5	90.20	90.00	9.42	75.00	99.00
Heterotis	2	79.50	79.50	27.58	60.00	99.00
Harvest in kg per m^2						
Tilapia-only ponds	194	1.27	0.95	0.89	0.14	5.00
Mixed tilapia-catfish ponds						
Tilapia	141	1.28	0.95	1.05	0.17	6.73
Catfish	97	1.24	0.73	1.38	0.02	6.49
Mixed tilapia-catfish-heterotis ponds						
Tilapia	7	1.49	0.54	2.34	0.26	6.73
Catfish	3	0.40	0.09	0.56	0.06	1.05
Heterotis	2	0.17	0.17	0.15	0.07	0.28
Mixed tilapia-catfish-heterotis ponds						
Tilapia	5	1.81	1.43	1.89	0.04	5.00
Heterotis	1	0.05	0.05	na	0.05	0.05

Source: IFPRI/WRI survey (2019). N=number of farmers; SD=standard deviation; na=not applicable

Surprisingly, reported survival rate from stocking to harvest was 90 percent on average. Data show that three percent of farms had lower than a 50 percent survival rate and 25 percent of farms had a survival rate of less than 80 percent (Figure 12). Survival rates were higher in Brong Ahafo and Eastern than in Ashanti and Volta (Table 13). These data are indicative and should be taken with caution. It was challenging to ascertain these figures because many farmers did not keep records.

Figure 12. Proportion of farmers, by survival rate from stocking to harvest



Source: IFPRI/WRI survey (2019).

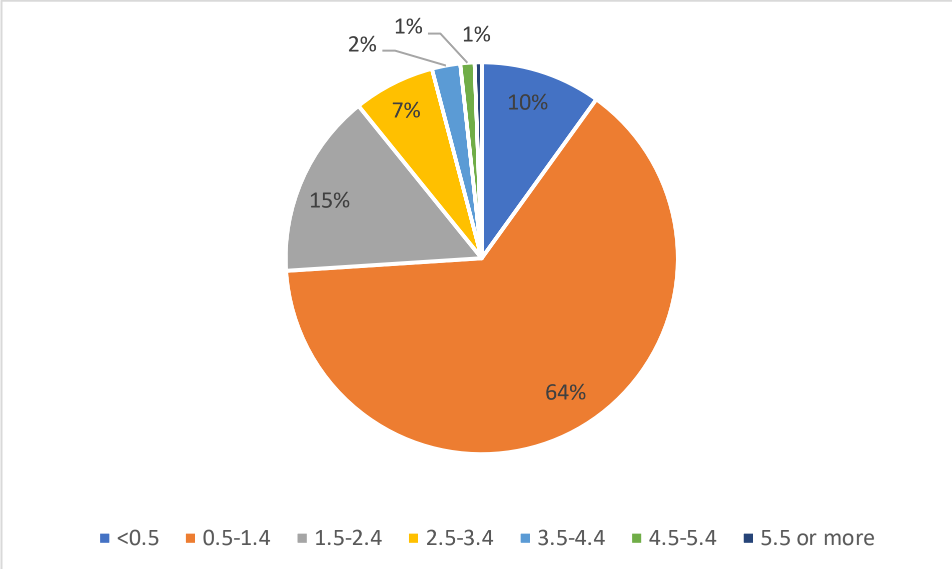
Table 13. Proportion of farmers, by survival rate from stocking to harvest

Survival rate (%)	Total	Ashanti	Brong Ahafo	Eastern	Volta
<50	3	6	0	6	0
50–69	8	19	0	8	43
70–79	14	28	3	20	14
80–89	16	29	8	16	29
90–99	35	18	48	30	14
100	24	0	41	20	0

Source: IFPRI/WRI survey (2019).

If the stocking density recommendation of 3–8 fingerlings per m^2 is followed, the survival rate is assumed to be 90 percent, and the average tilapia size at harvest is assumed to be 300 gram, then productivity is expected to be between 0.81 and 2.16 kilogram (kg) per m^2. Data show that 84 percent of farms achieved productivity close to this level (particularly 0.5–2.4 kg per m^2), whereas 15 percent of farms achieved very low yields (<0.5 kg per $m^{2)}$ (Figure 13). Productivity is lower on average in Ashanti than in other regions (Table 14). With a higher stocking rate and better management practices, farmers could improve productivity—achieving closer to 1.5–2.4 kg per m^2.

Figure 13. Proportion of farmers, by their fishpond productivity (kg/m^2)



Source: IFPRI/WRI survey (2019).

Table 14. Proportion of farmers, by productivity (tilapia harvested per m^2) (%)

Harvest (kg per m^2)	Ashanti	Brong Ahafo	Eastern	Volta	Total
<0.5	15	8	5	0	10
0.5–1.4	79	64	26	20	64
1.5–2.4	5	19	26	20	15
2.5–3.4	0	6	28	20	7
3.5–4.4	0	2	8	20	2
4.5–5.4	0	1	3	20	1
5.5 or more	0	0	5	0	1

Source: IFPRI/WRI survey (2019).

3.4.2 Cages

Stocking density in cages was generally low (40 fingerlings per m^3 average) (Table 15), compared to an expected range of 40–100 fingerlings per m^3 (Agyakwah et al. 2018). The survival rate was 73 percent during the time of the survey (June 2019). The survival rate is expected to be much lower in more recent months because of fish mortalities in Lake Volta. The harvest in cages was generally low (8 kg per m^3 average), compared to an expected range of 15–20 kg per m^3. With a higher stocking rate and better management practices, farmers could improve productivity—achieving closer to 15–20 kg per m^3 (Agyakwah et al. 2018).

Table 15. Descriptive statistics of size, survival rate, stocking density and productivity of tilapia cages

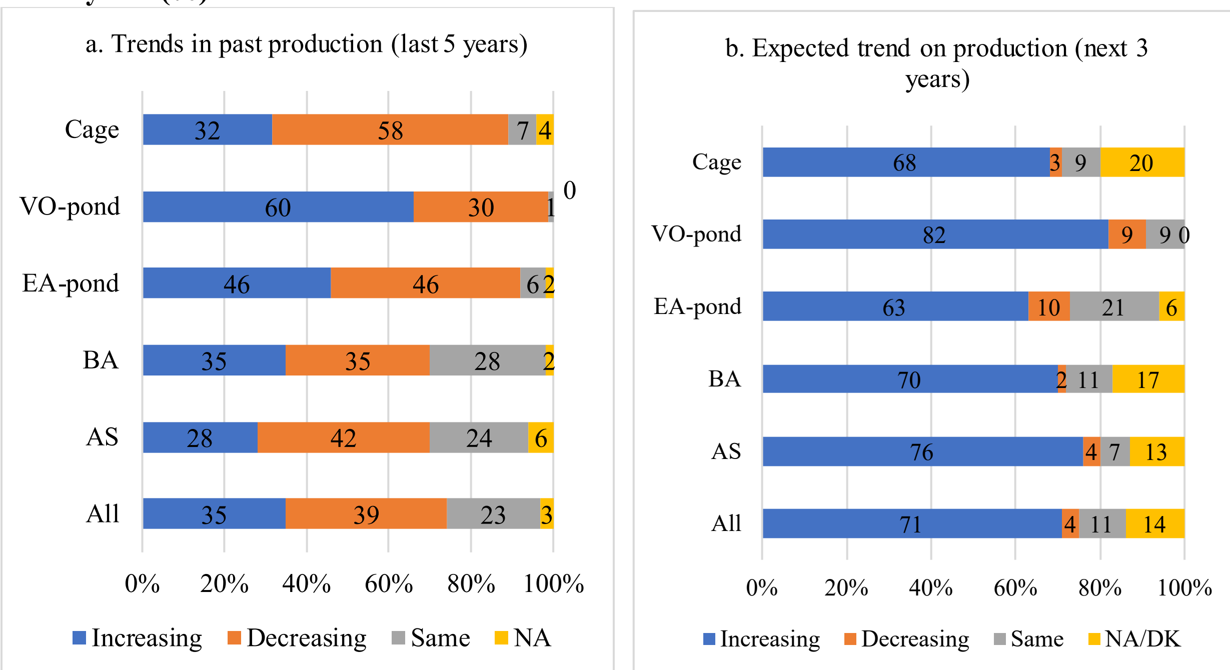
	N	Mean	Median	SD	Min	Max
Volume (m³ per cage) (most common size)						
Tilapia-only cages	101	212	125	277	14	1728
Tilapia-catfish mixed cages	8	197	216	45	125	245
Survival rate (%)						
Tilapia-only	89	73	80	22	17	98
Tilapia-catfish mixed cages						
Tilapia	8	74	76	17	50	95
Catfish	7	76	70	18	50	100
Stocking (fingerling per m³)						
Tilapia-only	92	40	32	32	2	167
Tilapia-catfish mixed cages						
Tilapia	8	37	40	14	14	56
Catfish	8	16	13	14	4	46
Harvest (kg per m³)						
Tilapia-only	86	8.0	6.9	5.8	0.7	24.0
Tilapia-catfish mixed cages						
Tilapia	8	11.2	7.5	10.0	1.9	32.7
Catfish	5	7.6	8.0	7.2	0.1	18.5

Source: IFPRI/WRI household survey (2019). N=number of farmers; SD=standard deviation

3.4.3 Trends in production

In terms of trends in pond tilapia production, the survey found mixed responses from pond farmers and some differences across regions and fish farming cultures. More farmers in Ashanti experienced decreasing trends in production, whereas more farmers in Volta reported increasing trends (Figure 14). For cage, more farmers reported decreasing trends in production in the last five years. Nonetheless, there are much more optimistic predictions in the future: most pond and cage farmers reported plans to increase their production in the next three years (Figure 14).

Figure 14. Proportion of farmers, by production trends in the last 5 years and expectations for the next 3 years (%)



Source: IFPRI/WRI survey (2019). Note: AS=Ashanti; BA=Brong Ahafo; EA=Eastern; VO=Volta; DK=do not know (inactive or new farmer); NA=not applicable. For cage, there is similar trend for Eastern and Volta, so the break down was not shown here.

3.5. Inputs, costs, and profits

The main inputs in fish farming are feeds, fingerlings, hired labor, and other materials. For tilapia ponds, the average total cost of 8.76 cedi per kg of tilapia harvested included the following breakdown of costs. The main costs were feeds amounting to 6.93 cedi per m^2 or 6.60 cedi per kg of tilapia harvested (Table 16) and accounting for 69 percent of total costs (Figure 15). Seed costs were 1.62 cedi per kg of tilapia harvested and accounted for 17 percent of total costs. Hired labor accounted for 9 percent of the costs, while lime, fertilizer, drugs, vaccines, disinfectants, fuel, electricity, and other costs accounted for 5 percent of the total costs.

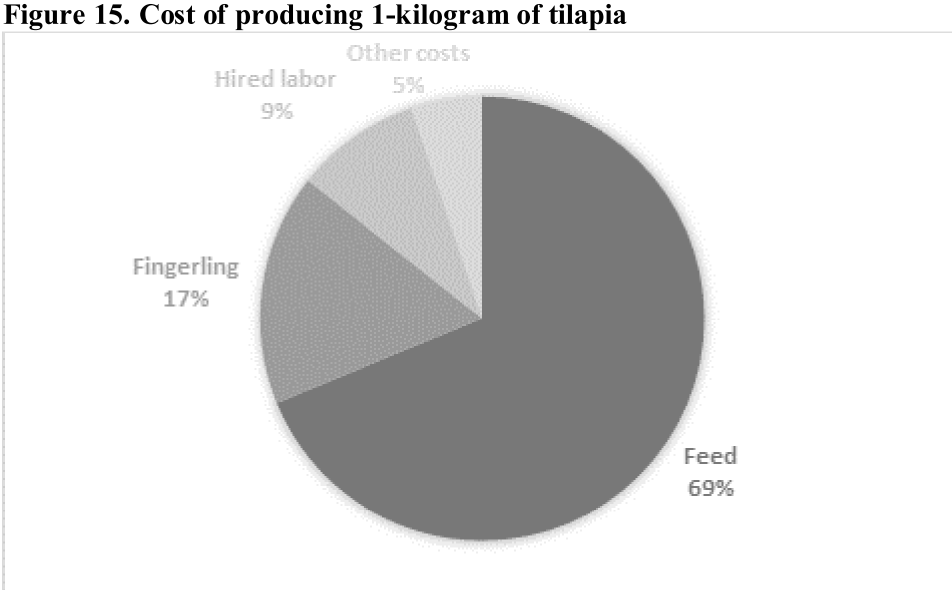
The average farm-gate price of tilapia of size 1, which is the most common, was 12 cedi per kg during the time of survey. Farmers reported selling often to aggregators who come to the farm and pick up the harvested tilapia. Others reported selling directly to sales or market outlets (Table 17). On average, a farmer made a profit of 3.24 cedi per kg of tilapia produced, or a 27 percent profit margin for every kg of tilapia produced. However, the profitability of fish farms was wide-ranging, between –12.00 and 46.00 cedi per m^2, with an average of 8.82 cedi per m^2 (Table 18). This disparity is due to the varied levels of input use, stocking, and production among farmers and the wide variety of practices and performance in the fish farms. Nonetheless, the majority of farmers experienced positive profits, which is encouraging and shows that farmers can achieve better profits with improved adoption of good aquaculture practices.

Table 16. Average costs and feed use of pond tilapia farmers

Indicators	Mean	SD	Min	Max
Costs per pond (cedi)				
Feed	6,207.77	9,246.29	85.00	42,585.00
Fingerling	1,357.52	1,881.19	0.00	12,436.15
Hired labor	636.27	3,923.11	0.00	53,760.00
Other costs	233.44	588.77	0.00	5,071.13
Total costs	8,377.75	11,384.15	247.59	57,999.46
Costs per m^2 (cedi)				
Feed	6.93	5.92	0.03	34.98
Fingerling	1.94	1.99	0.00	18.23
Hired labor	1.08	7.34	0.00	120.56
Other costs	0.81	2.32	0.00	22.74
Total costs	9.11	6.73	0.58	33.33
Costs per kg of tilapia harvested (cedi)				
Feed	6.60	5.26	0.04	19.83
Fingerling	1.62	1.02	0.00	4.88
Hired labor	0.88	3.77	0.00	41.35
Other costs	0.50	0.95	0.00	5.27
Total costs	8.76	6.38	0.56	37.91
Feed usage				
Kg of feed per pond	1,428.42	2,216.81	6.67	10,020.00
Kg of feed per m^2	1.49	1.42	0.00	8.97
Feed conversion ratio	1.32	1.10	0.00	3.93

Source: IFPRI/WRI household survey (2019). SD=standard deviation

Figure 15. Cost of producing 1-kilogram of tilapia



Source: IFPRI/WRI household survey (2019).

Table 17. Buyers of tilapia

Buyers	%
Aggregator	49.2
Sales/market outlet	41.9
Restaurant/schools/other organizations	5.2
Supermarket	1.1
Individuals	1.8
Donations	0.5
Total	100

Source: IFPRI/WRI household survey (2019).

Table 18. Average profits from tilapia farms

Indicators	Mean	SD	Min	Max
Total revenue (cedi per pond)	15439.08	21638.12	408.00	129080.00
Profit (cedi per pond)	3917.87	6198.66	-9600.44	25121.97
Profit margin per kg of tilapia produced (%)	27.22	43.33	-79.64	89.91
Profits (cedi per m^2)	8.83	12.16	-12.52	46.06

Source: IFPRI/WRI household survey (2019). SD=standard deviation

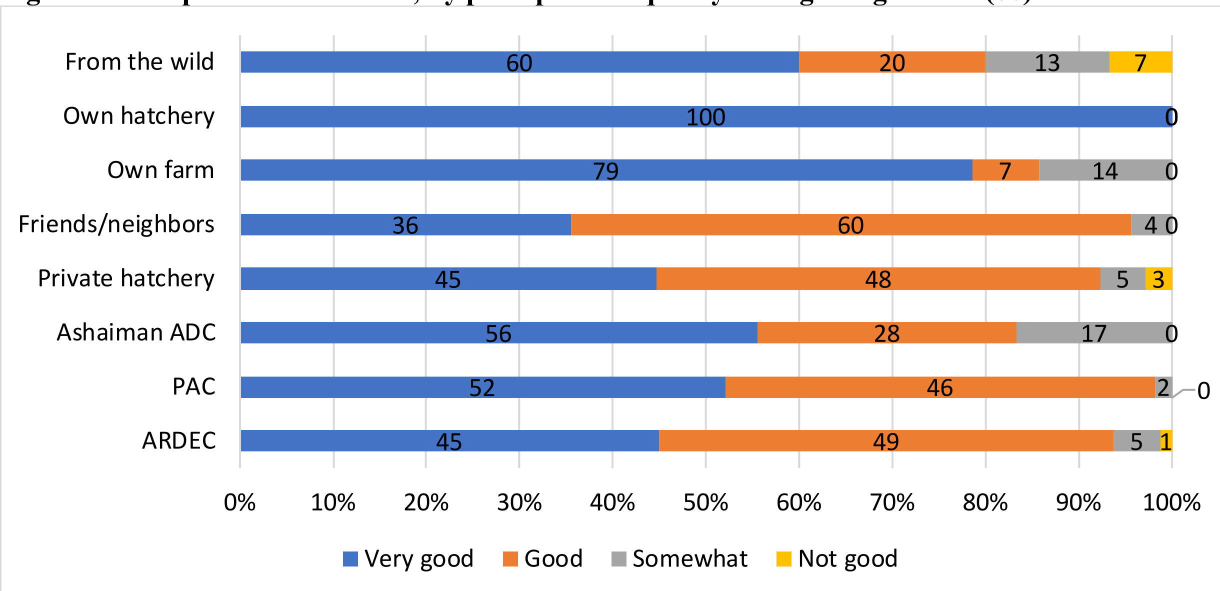
3.5.1 Feeds

Most farmers used some bags of Raanan feed, a locally produced quality feed that is about 30 percent cheaper than imported feeds (Ragasa et al. 2018). Those farmers who could not afford optimal feeding of Raanan feeds fed their tilapia with self-produced feed, mainly milled maize and other available crops. Those farmers who could afford imported feeds bought imported feeds as start-up feeds when the fingerlings were small and then used Raanan feeds when the fingerlings grew. On average, a farmer used 1,428 kg of feeds per pond or 1.49 kg of feeds per m^2. The average feed conversion ratio (FCR), defined as the ratio of quantity of feed used to the weight of harvested fish, was 1.32 (Table 16). Across the farms, the reported quantity of feeds used and therefore the FCR were wide-ranging and mainly different from the expected levels. For example, most farmers reported either lower or higher values than the expected FCR,. A majority of farmers in Brong Ahafo reported FCR less than 1.0, which means that farmers did not use enough commercial feeds and likely used mostly self-produced feeds. A majority of farmers in Ashanti reported FCR higher than 3.0, indicating that farmers used commercial feeds but were not compensated with more and larger tilapia harvested.

3.5.2 Seed

The source of fingerlings varied by farmers' location. Most fish farmers in Ashanti sourced their fingerlings from the Pilot Aquaculture Center (PAC). The other major sources were private hatcheries, directly from ARDEC in Akosombo, or from friends and neighbors. Most fish farmers in Brong Ahafo sourced their fingerlings from private hatcheries, PAC, friends, and neighbors. Most farmers in Eastern and Volta sourced their fingerlings from ARDEC or private hatcheries. A few farmers in the four regions produced their own fingerlings in their own hatchery facilities or just left the tilapia in the ponds to breed for the next season. A few other farmers in the four regions sourced fingerlings from the wild. Most farmers rated their source of fingerling as either good or very good (Figure 16). Seventeen percent of farmers who sourced their fingerlings from Ashaiman ADC rated the fingerlings as somewhat good, whereas 5 percent of farmers buying from ARDEC and another 5 percent sourcing from private hatcheries rated their fingerlings somewhat good. These ratings show a need to improve fingerling production and marketing to fish farmers.

Figure 16. Proportion of farmers, by perception of quality of fingerling source (%)



Source: IFPRI/WRI survey (2019).

The most common sizes of fingerling used were 5 and 2 grams; the average size was 5 grams for ponds and 2 grams for cages. Preferred sizes were 5 and 2 grams, and in some cases 10 grams. A total of 73 percent of farmers reported the same actual and preferred size, so they had no issue in terms of fingerling size; and 27 percent prefer bigger sizes (mainly 1–10 grams bigger than what they currently used). In the latter case, farmers cited lack of availability as the reason for not getting the preferred size. Those farmers said they prefer bigger sizes to control overpopulation; to control mortality; or for easier feeding, growing, and maintenance of the farms. The average price for fingerlings was 0.37 cedi (median is 0.30 cedi) per piece, and the average price per gram was 0.10 cedi.

Mortality rate during transport was highest and most diverse in Ashanti, averaging 27 percent mortality during transport, but with rates ranging from 0 to 99 percent (Table 19).

Table 19. Mortality rate of fingerling during transport (%)

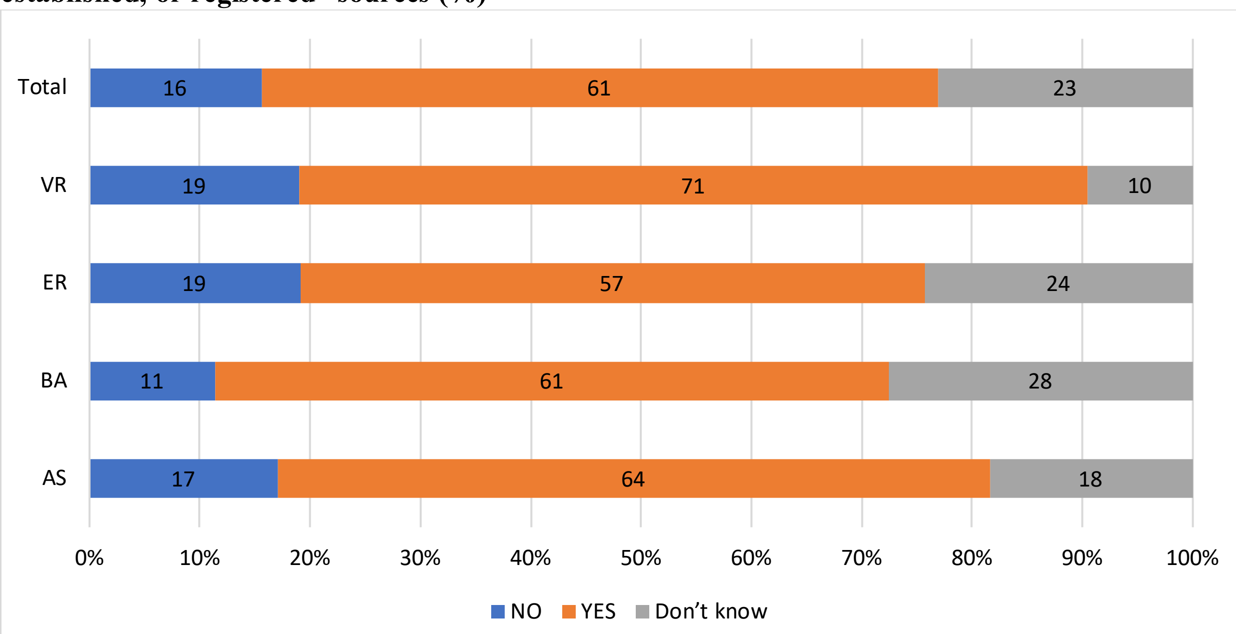
region	N	Mean	Median	SD	Min	Max
Ashanti	111	27	10	34	0	99
Brong Ahafo	181	5	1	11	0	90
Eastern	127	6	1	15	0	100
Volta	33	11	3	19	0	98
Total	452	11	2	22	0	100

Source: IFPRI/WRI household survey (2019). N=number of farmers; SD=standard deviation

We asked farmers several questions about their perception of seed quality and perspectives on certification. Only 61 percent of farmers confirmed that they bought fingerlings from a "certified, established, or registered" source (Figure 17), whereas 16 percent said they bought their fingerlings from a source that was not "certified, established or registered", and 23 percent did not know. Fifty-seven percent of farmers had complete or strong trust or confidence in the quality and performance of fingerlings from "certified, established or registered" sources (Figure 18).

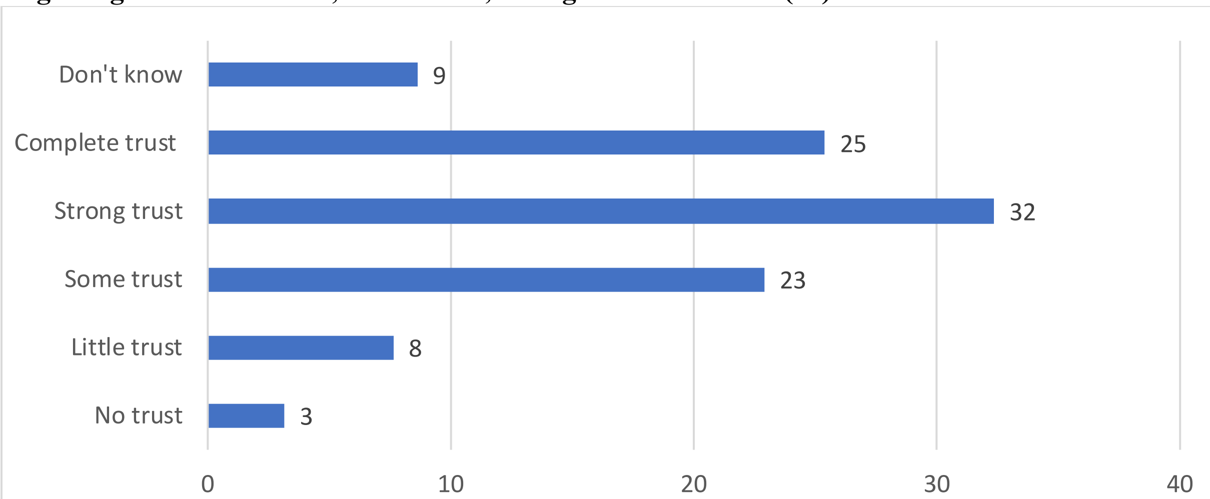
When asked if they would be willing to pay a higher price for fingerlings from "certified, established or registered" sources compared to those not "certified, established or registered," 74 percent of farmers confirmed (Figure 19). During the survey, "certification" was explained as compliance with a set of good practices in terms of sanitation, fish health management, food safety, and aquaculture verified by the government or a credible third party. Sixty-seven percent farmers said they would be willing to comply with fish farm certification (Figure 20). More farmers from Ashanti and Brong Ahafo (72 percent) reported willingness to comply. They believed that they would have more buyers, be able to expand and export, and get higher prices if they complied with certification (Figure 21). Those who reported being unwilling to comply believed that consumers would not care and would not pay higher prices, that complying with certification would be expensive, and that compliance costs and required investments would be greater than benefits. Overall, farmers generally had good perception of and confidence in the certification processes, which are generally considered a good signal for seed quality. These findings indicate plenty of avenues to improve sensitization, marketing, and demand for "certified, established or registered" sources.

Figure 17. Proportion of farmers reporting that fingerlings bought were coming from "certified, established, or registered" sources (%)



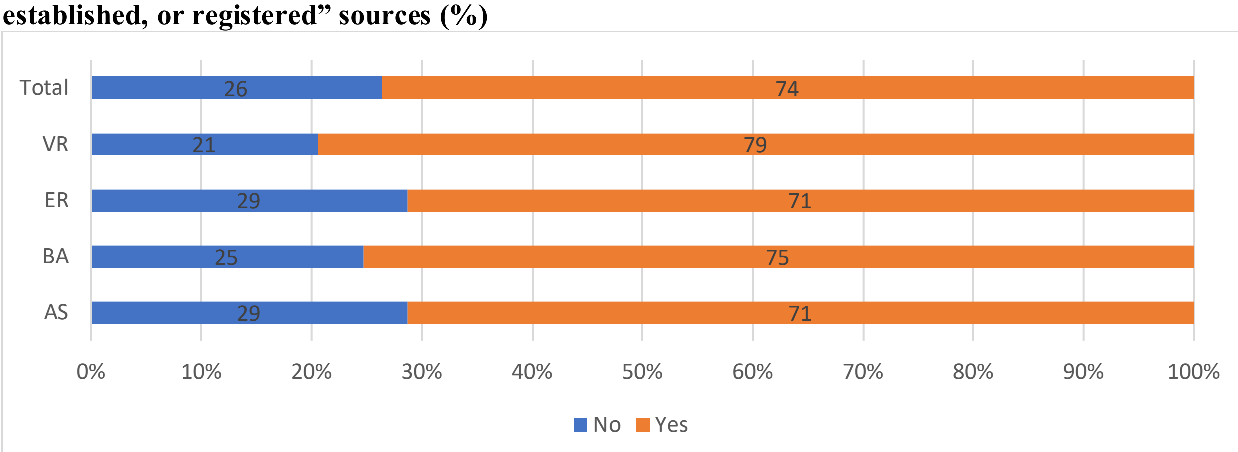
Source: IFPRI/WRI household survey (2019). AS=Ashanti; BA=Brong Ahafo; ER=Eastern region; VR=Volta region

Figure 18. Proportion of farmers, by level of trust or confidence in the quality and performance of fingerlings from "certified, established, or registered" sources (%)



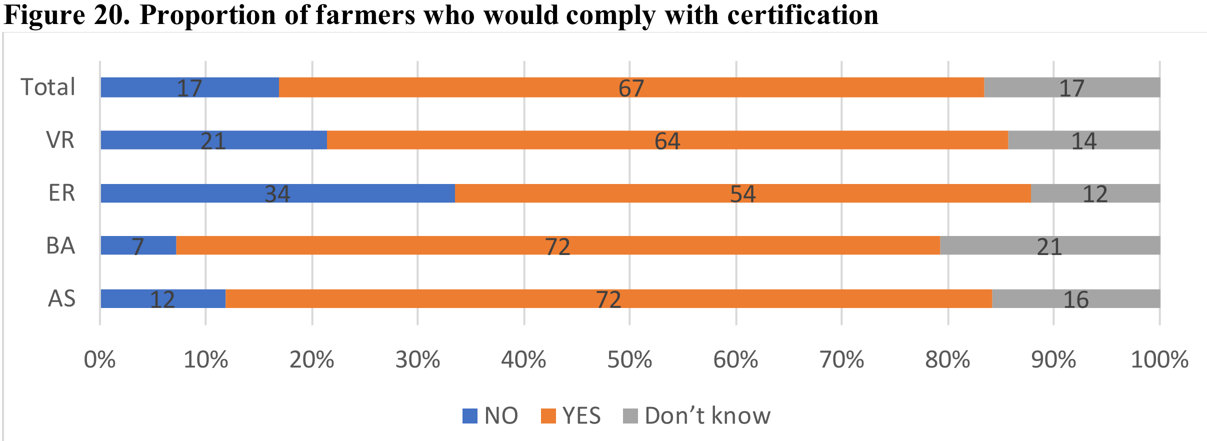
Source: IFPRI/WRI household survey (2019).

Figure 19. Proportion of farmers willing to pay higher price for fingerlings from "certified, established, or registered" sources (%)



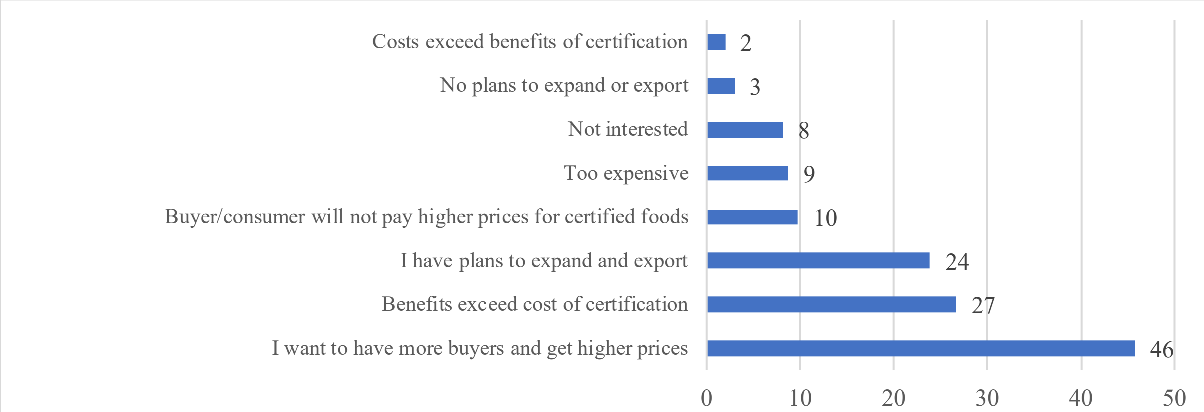
Source: IFPRI/WRI household survey (2019). AS=Ashanti; BA=Brong Ahafo; ER=Eastern region; VR=Volta region

Figure 20. Proportion of farmers who would comply with certification



Source: IFPRI/WRI household survey (2019).

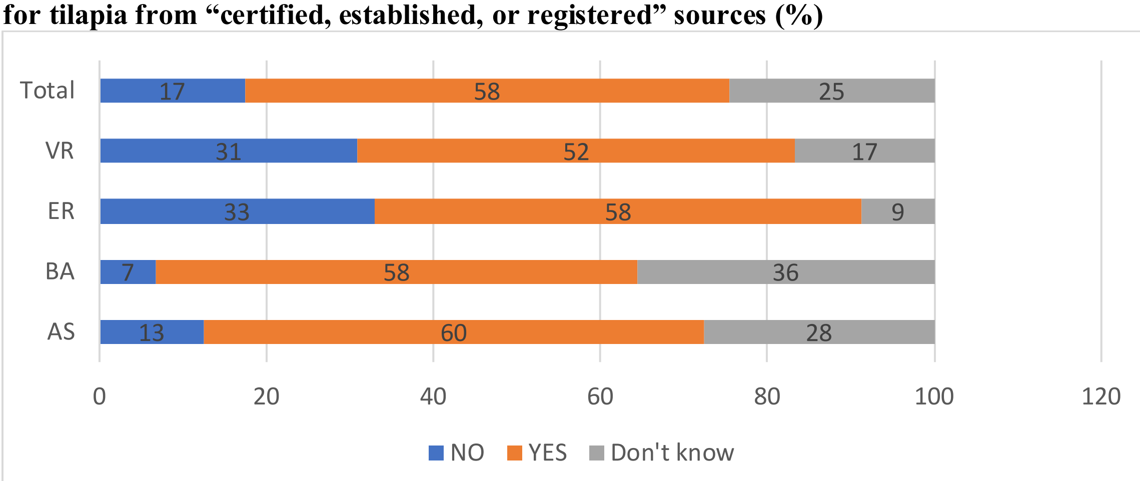
Figure 21. Proportion of farmers, by reasons for complying with certification (%)



Source: IFPRI/WRI household survey (2019).

Certification likely implies higher costs for fingerlings and production, and these higher costs would have to be absorbed by fingerling producers, tilapia producers, and consumers. More than half of farmers surveyed believed that consumers would be willing to pay higher prices for tilapia from "certified, established, or registered" sources (Figure 22).

Figure 22. Proportion of farmers believing that consumers would be willing to pay a higher price for tilapia from "certified, established, or registered" sources (%)



Source: IFPRI/WRI household survey (2019). AS=Ashanti; BA=Brong Ahafo; ER=Eastern region; VR=Volta region

3.5.3 Other inputs

Very few farmers used lime and fertilizer for their fishponds. Twenty-one percent of pond farmers used lime, and 5 percent used fertilizer in pond preparation; less than 1 percent used drugs, vaccines, and hormones. Other expenses reported were fuel, electricity, transportation costs, disinfectants, and pond maintenance. These other costs amounted to 560 cedi per pond per cycle or season (or 2.05 cedi per m^2 or 1.56 cedi per kg), accounting for 6 percent of total production costs (Table 20).

Table 20. Other production costs related to the farmer's biggest tilapia pond

Indicators	Mean	SD	Min	Max
Other costs (excluding feed, seed, labor)	560.40	3449.27	0.00	64,760.00
Other costs per m^2	2.05	9.98	0.00	165.20
Other costs per kg of tilapia	1.56	8.48	0.00	143.91

Source: IFPRI/WRI household survey (2019). SD=standard deviation

3.5.4 Labor and participation by women and youth

Fish farms are usually family farms with household members working together. If family labor is not available or not enough, farmers hire extra laborers. Sixty-three percent of tilapia farmers used family labor, and 60 percent of farmers hired laborers (Table 21). On average, a tilapia farmer used a total of 55 person-days of hired labor and 35 person-days of family labor from pond or cage preparation to harvesting and marketing for the farm's largest pond or cage.

Table 21. Person-days of family and hired labor in largest pond/cage

Variable	% of farmers with family/ hired labor	Mean	SD	Min	Max
Hired labor					
Total hired labor	60	55	174	0	1,680
Young male	50	35	139	0	1,680
Older male	20	17	90	0	1,298
Young female	7	2	22	0	278
Older female	4	0	3	0	60
Family labor					
Total family labor	63	35	94	0	1,083
Young male	43	19	58	0	580
Older male	26	10	44	0	645
Young female	11	4	49	0	903
Older female	11	2	11	0	181

Source: IFPRI/WRI household survey (2019). SD=standard deviation

The TiSeed project has a particular focus on inclusion of women and youth in the fish seed value chain, so we discuss their participation in more detail. Youth had a high level of engagement in fish farming. Among owners, 14 percent were youth; among managers, 24 percent were youth (Table 8 and Table 9). Youth also contributed 68 percent of the total person-days in family and hired labor on farms.

In terms of women's inclusion, a total of 45 owners are women (8 percent), and 39 managers are women (9 percent) (Table 8 and Table 9). In the Eastern region, mainly in cage farms, women owners had male managers or supervisors overseeing the cage operations. Most of the women respondents were married or co-habiting with a husband or male partner (62 percent); three had husbands who had been away for more than six months, so they and their children had been taking care of the fish farms (Table 22). Thirty-eight percent of women respondents were single, divorced, or widowed.

Table 22. Marital status of woman respondents

Marital status	Freq.	%
Married/consensual union	23	58.97
Single	5	12.82
Divorced	3	7.69
Co-habitation/living together	1	2.56
Widowed/widower	7	17.95
Total	**39**	**100**

Source: IFPRI/WRI household survey (2019).

The 39 women respondents were asked about the advantages and disadvantages as well as the opportunities and challenges of being a women owner or fish farmer. In terms of advantages, the common responses are that fish farming helps bring income, employment, and food for the family and that it helps create employment for other people in the community. One female respondent said, *"I processed my tilapia harvest into koobi and it provides income for my family."*

Many of the women respondents also mentioned the empowering effect of their fish farming. Below are some of their quotes:

"It brings respect and knowledge to women."

"Women become more brave, confident, and empowered."

"Women become more financially independent."

"It brings publicity, exposure and respect in the community It keeps women active and busy; fish farming is a good form of exercise."

In terms of disadvantages, it seems that there were gender bias against women's engagement in fish farming. Below are some quotes from women respondents:

"Fish farming is perceived by the public as a sector for only men."

"The public perceives that fish farming is a male job and women are not considered as fit to join associations."

"You may have issues at home if your husband is not in agreement with you in fish farming."

Gender bias against women's engagement in fish farming occurred but was not as strong or widespread as initially predicted by the research team. At most, 25 percent of the respondents—mostly men—believed that fish farming is for men (Table 23). Gender awareness campaigns in the community and among household members, including both men and women, can help to break this gender-biased attitude.

Table 23. Proportion of female and male respondents, by gender attitudes on fish farming (%)

Statement	Women (N=32 active farmers) Agree	Women (N=32 active farmers) Disagree	Men (N=447 active farmers) Agree	Men (N=447 active farmers) Disagree
Women should leave fish farming to the men especially if there is an able man in the household to do it	3	97	24	76
A man will be considered less of a man if his wife is involved in fish farming	0	100	13	87
It is dangerous/ risky for a woman to travel to suppliers, buyers or markets	6	94	22	77
Women should not own fishponds or cages, fishing nets, and other equipment and gadgets use for fish farming	6	91	16	83
Women should primarily be the ones who clean and process fish	56	44	59	39
Women should primarily be the ones who trade or market fish, not men	53	47	50	49
Men should primarily be the ones who transport fish to a market for sale	22	78	24	75
Men should primarily be the ones who control the earnings obtained from the sale of fish	13	84	45	55
Women should primarily be the ones who prepare meals (including fish) for the family or if guests come to visit	63	38	64	35
Men should mostly be the ones who belong to aquaculture or fisheries clubs, organizations, or associations, not women	0	100	20	79
It brings benefit to the family to have women participate and be engaged in training activities, such as aquaculture trainings	91	9	87	11

Source: IFPRI/WRI household survey (2019). N=number of farmers.

Moreover, women's involvement in fish farming added to their time burden, considering their time already spent on domestic chores. Below are some quotes that depict this issue:

"The public perceives fish farming to be time consuming so it is not for women who have to take care of the family."

"You will have problems at home if you don't have someone who takes care of family, children, food, and household chores."

"When one is very much occupied with domestic chores, one can forget to feed the fish."

"At times, you do not get much time for our family because much time is spent on the fish farming business."

"Fish farming is very stressful. It makes you feel tired all the time."

Most women respondents said fish farming was very stressful and required a lot of time, although one said it was "less stressful, and not much time needed, especially when you can hire labor to help out." Many women respondents thought fish farming was a good income source, although one mentioned that it was capital-intensive and "it feels you always have to spend a lot of money."

In terms of what can be done to encourage more women fish farmers, the overwhelming response was more education and training. A few women mentioned support through financial assistance, capital, or subsidized feeds or fingerlings. Other women said that men should encourage their spouses to be more involved in fish farming. Moreover, they said that men who are already doing fish farming should encourage and support women who are interested in fish farming. As a female respondent said, "*it will help when husbands do not discriminate against their wives or any female who would want to be employed or be engaged in fish farming.*"

Opportunities to involve more women will arise as the productivity and profitability of these farms improve. Greater profitability will likely provide greater incentive to shift family labor and greater capacity to hire more labor, which is especially important for women to better balance domestic and productive work.

3.6. Production practices

One of the major practices being promoted among fish farmers is keeping records. Most farms do not keep records: only 47 percent keep records on stocking, and only 39 percent keep records on harvest and sales. A few have a farm sketch or plan (16 percent of farmers), water quality record (9 percent), or pest control or sanitation plan (4 percent of farmers) (Table 24). There is generally poorest keeping of records in Ashanti, with only 19 percent of the farmers keeping records on harvest and sales. There is usually much better record keeping among cage farmers.

Table 24. Proportion of farmers, by type of records kept (%)

Region	N	Farm sketch/ plan	Harvest records	Sales record	Stocking record	Water quality record	Pest control plan for feed	Written sanitation plan
Ashanti	112	4	19	19	12	6	2	6
Brong Ahafo	191	20	33	34	48	7	2	1
Eastern-pond	80	16	68	68	71	19	3	3
Eastern-cage	61	13	36	38	56	5	14	9
Volta-pond	26	38	88	88	92	15	9	9
Volta-cage	11	45	36	55	55	0	8	4
All	**479**	**16**	**39**	**39**	**47**	**9**	**4**	**4**

Source: IFPRI/WRI household survey (2019). N=number of farmers.

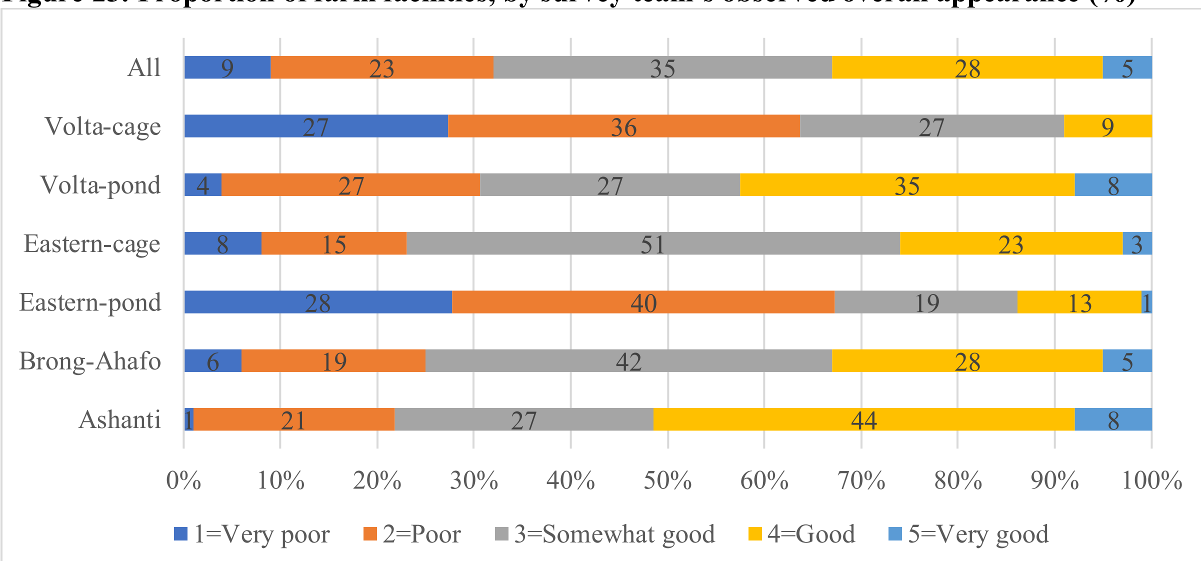
Enumerators checked each facility and its surrounding areas to rate the order and sanitation of the facility. Eight percent of farm facilities had storage cabinets (for drugs, chemicals, or feeds used for fish farms), and 36–37 percent had toilets or changing rooms (Table 25). Because most farms were next to the home, most farmers did not have separate toilets and changing rooms on the farm. A third of the farms observed had animals roaming around, which is not recommended practice. In terms of overall facility appearance (order and sanitation), 9 percent were rated by the enumerators as very poor (score of 1), 23 percent were rated poor (score of 2), 35 percent were rated somewhat good (score of 3), 28 percent were rated good (score of 4), and 5 percent were rated very good (perfect score of 5) (Figure 23). Pond farmers from the Eastern region and cage farmers from Volta received the greatest proportion of overall poor ratings.

Table 25. Proportion of farmers, by farm facilities and presence of roaming animals (%)

Region	N	Storage cabinet	Toilet	Changing room	Animals nearby
Ashanti	112	9	38	42	38
Brong Ahafo	191	5	34	33	31
Eastern-pond	80	13	30	36	43
Eastern-cage	61	5	46	39	25
Volta-pond	26	23	38	46	42
Volta-cage	11	9	27	36	36
All	**481**	**8**	**36**	**37**	**34**

Source: IFPRI/WRI household survey (2019). N=number of farmers

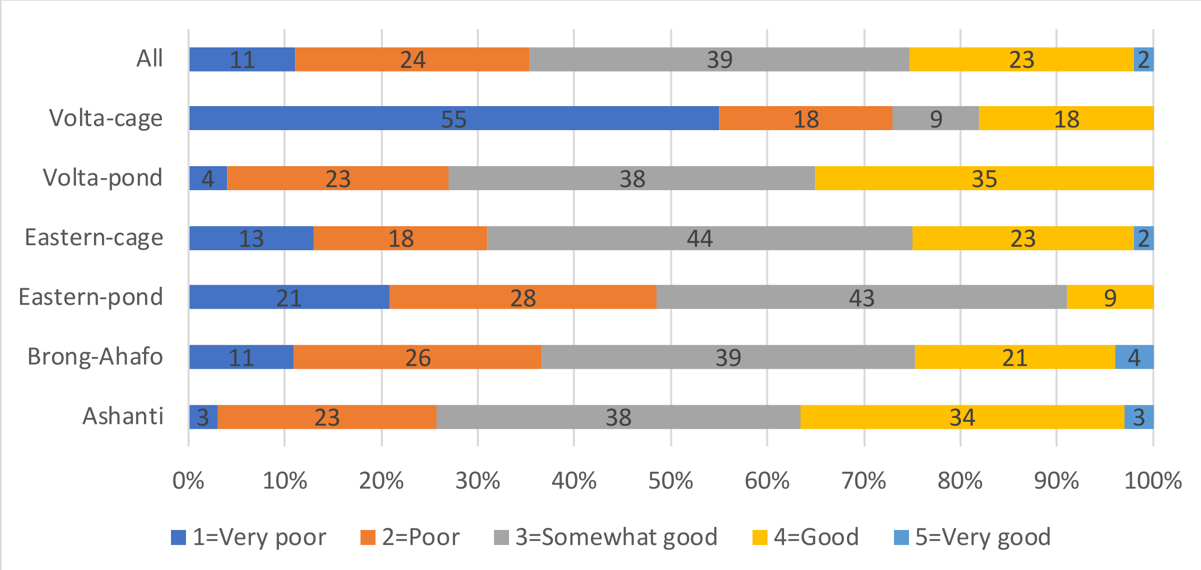
Figure 23. Proportion of farm facilities, by survey team's observed overall appearance (%)



Source: IFPRI/WRI household survey (2019).

About 35 percent of feed storage facilities observed were rated as poor or very poor, and 39 percent as somewhat good (Figure 24). Only 25 percent of feed storage facilities were rated good or very good. Cages in Volta and ponds in Eastern got the lowest ratings; more pond farms in Volta and Ashanti got higher ratings.

Figure 24. Proportion of farmers, by survey team's rating on feed storage facility (%)



Source: IFPRI/WRI household survey (2019).

3.7. Changes in production practices

Experimenting and changing management practices are crucial for farmers' learning and for farm improvements; however, few farmers reported having changed production practices since they started farming (Table 26). Among them, 24 farmers reported changes in their stocking rate, especially in cages: 57-60 percent of cage farmers had changed their stocking rate since they started farming. Overall, more cage farmers than pond farmers had changed their practices. Pond farmers in Ashanti were least likely to have changed their management practices. Most changes reported by cage farmers were in fingerling source, feed and feeding practices, and labor use. Table 27 shows the specific changes in practices reported by farmers.

Table 26. Proportion of active farmers who have changed their practices since start of fish farming (%)

Region	Specie	Finger-ling	Feed	Water mgt	Chem-ical	Stock-ing	Site	Cage/ pond size	Pack-aging	Finger-ling size	Labor
Ashanti	3	5	9	0	0	7	0	0	0	3	10
Brong Ahafo	11	6	9	1	1	21	3	4	1	6	7
Eastern	9	24	21	2	1	35	7	4	8	10	15
Pond	4	6	14	4	0	0	2	0	2	6	7
Cage	14	36	26	0	1	57	12	6	12	12	22
Volta	26	44	44	6	4	52	15	18	15	16	35
Pond	10	20	30	0	0	22	0	0	0	0	10
Cage	36	52	48	8	5	60	20	24	20	22	44
Total	**10**	**15**	**16**	**1**	**1**	**24**	**4**	**4**	**4**	**7**	**13**

Source: IFPRI/WRI household survey (2019).

Table 27. Specific changes on production practices reported by farmers.

Indicator	Actual changes in production practices reported by farmers
Species	The most common change reported by farmers was from tilapia-only to mixed tilapia-catfish farming
Fingerling source	Most respondents have changed source of fingerling. Farmers gave different responses, but the most common was the change from ARDEC or Crystal Lake to another source; a few also shifted from a private hatchery to ARDEC. This implies that farmers had various options on sources of fingerling and had shifted from one hatchery operator to another.
Fingerling size	Most farmers reported increased size in fingerling bought (from 1, 2, or 5 grams to 5, 8, or 10 grams).
Feeds	Farmers gave different responses. The most common was changing from Raanan feed to another brand, but some farmers also changed from other brands or on-farm feed production to Raanan feed.
Water management	Few farmers reported any changes. For those who changed, reported changes were changing water more regularly, using filtration process by activated charcoal, and treating water in hatcheries
Chemical use	Few farmers used chemicals or drugs and reported changes in their usage. For those who changed, reported changes were adding antibiotics in starter feed, going from Aqua Cold to Probiotics, and stopping the use of oxytetracycline
Stocking	Some farmers decreased their stocking density, but others increased their stocking density.
Packaging and transport	The most common responses were changing from tank to double bagging, interchanging container or fish tank and double bagging, and from using car to boat or vice versa
Labor	Most common changes reported were increasing the use of hired labor and changing the laborers being hired

Source: IFPRI/WRI household survey (2019).

4. Summary and Concluding Remarks

This paper describes the baseline data collected in May–July 2019 from 603 small-scale tilapia farmers in four major tilapia-producing regions in Ghana: Ashanti, Brong Ahafo, Eastern, and Volta. We summarize below the positive trends, followed by the negative trends and areas that need further improvements.

First, the aquaculture sector in Ghana has experienced rapid growth mainly due to the improved local Akosombo strain developed and released in 2005 and the local availability of high-quality feeds. As many as 45 public and private hatcheries or fingerling producers were identified during the assessments done in 2019. These elements form a good foundation for the sector, but additional considerations are needed to ensure that this growth is sustainable, resilient, and inclusive of the rural poor.

Second, most farmers had access to fingerlings and were generally satisfied with their quality. Moreover, most farmers reported getting the fingerling size they preferred, and reported no issue in terms of the fingerling size or source. The survival rate (during the time of the survey in May–June 2019) was also surprisingly high, although it is expected to be much lower in more recent months, especially among cage farmers, because of the fish disease spread in Lake Volta. Some remote areas in the four regions also continued to lack access to quality fingerlings. Moreover, recent evaluation by WorldFish of the Akosombo strain also showed that its performance is getting poor and that the strain needs to be revived. In the short term, supporting more hatcheries or nurseries in remote areas could also help increase farmers' access to quality fingerlings from the existing Akosombo strain. In the long term, investments in reviving the Akosombo strain, particularly improving its productivity and disease resistance, coupled with stricter enforcement of fish seed regulations, come as top priorities to sustain growth in the sector.

Third, most farmers had access to local feeds and were generally satisfied with their quality. At least five feed importers were also identified serving some farmers who could afford relatively more expensive imported feeds than local ones. Most farmers reported high costs of feeds, and suggested that aquaculture projects could focus on finding cheaper sources of ingredients and feeds.

Fourth, the majority of tilapia farmers experienced positive profits, despite wide variability in production and profits. On average, a farmer received a profit of 3.24 cedi per kilogram of tilapia produced or a 27 percent profit margin for every kg of tilapia produced. These encouraging figures indicate that farmers who adopt good aquaculture practices can achieve respectable profits. Moreover, the majority of pond and cage farmers indicated that they expect higher production trends overall in the coming three years.

Fifth, the data were disaggregated by socioeconomic indicators, gender, and age group. A large majority of managers and owners had at least high school education, with a third of owners and a quarter of managers attaining at least a college degree. Most fish farmers owned fishponds and cropland. In Brong Ahafo and Ashanti regions especially, most farmers engaged mainly in crop farming and non-farm businesses as their main livelihood, with fish farming as a small contributor to overall household income and livelihood. Many farmers in these regions did not treat fish farming seriously as a business. Fishpond owners were generally more well-off than an average citizen in the community. Lack of access to credit and capital seems to be an issue for some fish farmers, but not to a majority of them. It seems that the profitability of fish farming is the major and urgent issue that needs to be addressed to promote real demand for credit and enable repayments. Farmers could benefit from training on good aquaculture practices to improve their productivity; they could also benefit from business management and marketing extension services to change farmers' attitude on fish farming and entrepreneurship.

In terms of women's inclusion, the data show that women were engaged in fish farming, but mostly in harvesting and post-harvest, and that their participation was much lower than men's. Nine percent of farm managers and owners were women, and an additional 9 percent of farms engaged women in some decision-making. Moreover, women contributed 16 percent of family labor and 5 percent of hired labor on farms. Factors contributing to low engagement of women in fish farming were time burden—juggling fish farming and domestic chores—and gender bias. At most, 25 percent of the respondents—mainly men—believed that fish farming is a man's job. This gender bias discouraged women from engaging in fish farming. Gender awareness campaigns could help to break this gender bias. Opportunities to involve more women will arise as the productivity and profitability of these farms improve. Greater profitability will likely provide greater incentive to shift family labor and greater capacity to hire more labor, which is especially important for women to better balance domestic and productive work.

With regard to the inclusion of youth, the data show that youth had a high level of engagement in fish farming. Youth represented 14 and 24 percent of owners and managers, respectively, but contributed 68 percent of the total family and hired labor on farms. Technical support and training for youth would have broad-based benefits to fish farms through effects on management and daily operations of farm labor. Youth are more likely to keep records and use mobile apps and technologies than older farmers, so capacity strengthening for youth offers a greater chance of transforming fish farming.

Sixth, despite these positive developments happening in the sector, many small-scale tilapia farmers had not farmed for the last two or more years. The reasons stated for discontinuing were lack of funds, expensive feeds, low demand for small fish, natural disaster, and labor availability. The underlying issue was the low productivity and profitability of the fishponds, which discouraged many farmers from continuing to stock and grow tilapia.

Seventh, farmers generally had poor management practices in addition to poor record keeping. Many did not change water, discharge or treat water, or maintain their fishponds. A vast majority of ponds and cages were poorly rated in terms of hygiene and sanitation, food safety, animal health management, and overall appearance and quality of facilities. These results were consistent in the farm and household survey and with earlier visits by ARDEC and University of Ghana experts to a few farmers to pre-test the certification protocol and survey questionnaires.

Eighth, the lack of record keeping made the collection of input use and production data very challenging. Initially reported data were off (or either too low or too high) from the expected or recommended levels. All survey data were verified again by WRI technicians and FC zonal officers by calling back the farmers and visiting them on their farms. Despite validation of study results in September 2019 and best efforts of WRI technical officers and FC zonal officers to verify the data collected, it was challenging to ascertain these figures because many farmers did not keep records. Figures presented in this report, though informative, should be treated as indicative. Under the TiSeed project, we will work closely with FC zonal officers to help monitor activities of farmers and support them in their effective record keeping. We will provide intensive training on record keeping, providing material and formatted sheets to record data, and develop a mobile app and platform to aid in this record keeping in addition to many other features of this platform.

Last, stakeholders pointed out that greater technical assistance and training can improve adoption of good aquaculture practice, and therefore productivity and profitability of fish farming. Historically, this type of support and capacity strengthening has been weak, and fish farmers continue to farm with limited know-how to properly and profitably manage their farms. Evidence in this paper points to the need for training and technical assistance to help solve some of the major problems facing small-scale fish farmers. In the coming two years, the TiSeed Project aims to test and focus on the effects of training and technical assistance, along with a specific pilot test on encouraging and training more women to go into fish farming.

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