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Assessment of Integrated Aquaculture Intervention System in Amhara Region, Ethiopia

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Abstract

Although integrated aquaculture has the potential to contribute to food security, it is still among the neglected sectors in Amhara regional state, Ethiopia. This study was designed: (1) to assess the performance of existing integrated aquaculture intervention and its contribution for farmers, (2) to evaluate the current pond management practices, and (3) to identify major obstacles that hinders integrated aquaculture practices. The data was collected from 11 purposively selected aquaculture potential districts of the region. The quantitative and qualitative data were analyzed by using descriptive statistics supported by exhaustive narrations. The study found that only 20.8% of the surveyed aquaculture ponds were functionally good. From these ponds, 25% of the aquaculture owners earned an average of 513.6 ETB per fish pond. However, these aquaculture adopters start harvesting after three to four years of fish stocking in irregular ways. Such irregularities in harvesting arises from farmers' minimal knowledge on post-harvest processing and lack of fishing nets. In this regard, 80.4% of the surveyed pond owners felt as they had not benefited from aquaculture adoption compared to their expectations. Based on the level of inputs used and degree of management, the current aquaculture practice in Amhara region inclined towards extensive type. In conclusion, aquaculture development remains at an infancy stage despite years of adoption in the region.

Keywords: Aquaculture, pond management, stunting growth, knowledge gap, income generation

JEL Code: O44, Q00 and Q22

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1. Introduction

Ethiopia is a land-locked country with approximate 7400 Km2 surface area of water body and 7185 Km of river network (Eshete and Zemenu, 2012; Erkie et al., 2016). In addition, water harvesting dates back to the pre-Axumite period (560 BC), Lalibela Rock hewn churches (over 800 years ago), and castles in Gondar (15th and16th century) with a strong attachment to the ancient Orthodox churches (Habtamu, 1999) (Habtamu, 1999). During these periods, water was harvested and stored in ponds and tanks for agriculture, water supply and ritual purposes (Habtamu, 1999; Fitsume et al., 2014).

In Ethiopia, fishery has been subject to some funny and impressing incidences. First, fisheries have been organized under the Ministry of Defense, when most of the fish production relied on the Red Sea. Later, it joined the Ministry of Agriculture, and now the Ministry of Livestock and Fisheries. Second, even if Ethiopia is rich in diverse fish resources, water and environmental resources, it is found at the bottom of the aquaculture producers list (Abebe, 2016). A study by Gordon et al. (2007) has estimated aggregated demand growth for fish in Ethiopia to be 44% over ten years. As cited in Hussein et al. (2012), the early documents of FAO (1990) indicated that the national per capita fish consumption is about 0.21 kg/person/year. However, in fish producing areas of Ethiopia this figure changes and is estimated about 8.5 kg/person/year.

Although Ethiopia has huge fresh water and fish resources, conducive climatic conditions, huge labor and unsatisfied local demand for fish, aquaculture development in the country is lagging behind compared to other agricultural activities (Zewdie, 2016). In the country, the demand for fish grows exponentially every year, while the supply from the capture fisheries has consistently lagged behind the growth rate of demand for fish (Rothuis et al., 2012). Thus, the current increasing market demand for fish in Ethiopia can be met only when the capture fishery is supplemented by the culture fishery (Ashagrie et al., 2008; Berihun and Goraw, 2010). Therefore, aquaculture adoption is clearly necessary to bridge such gaps (Olaoye et al., 2014).

Aquaculture serves as a best alternative for over-exploited natural aquatic resources (Agbebi, 2011). It can reduce the pressure on the natural ecosystem and maintain ecological balance (Kassahun, 2012). Thus, aquaculture is carried out not only for increasing the availability of fish for food, but also to conserve the natural stock and thereby protect the biodiversity (Dereje et al., 2015).

Disappointingly, given favorable physical and hydrographic conditions (suitable geographic relief, good rainfall, and sufficient freshwater availability), aquaculture production is negligible in Ethiopia. In addition, it remains more potential than in actual practice (Sileshi, 2015), despite the fact that the country's environmental and socio-economic conditions support its development (FAO, 2014).

Although different agents in Amhara region have constructed a number of aquaculture ponds, there is no updated information or documentations on their performance. In addition, the successes or bottlenecks of the currently implemented integrated aquaculture system have not been well articulated. This study has therefore aimed to assess the status of the existing integrated aquaculture intervention system; to identify farmers' practice of integrated aquaculture; and to identify major constraints affecting their integrated aquaculture practices.

2. Research Methodology

2.1 Description of the Study Area and Site Selection

Amhara regional state is located in the north western and north central part of Ethiopia. It consists of 12 administrative zones with one special zone and most have the necessary physical and hydrographic conditions to provide for aquaculture practice. From these zones, 6 of them were selected for integrated aquaculture intervention assessment (Table 1). Based on the presence of integrated aquaculture practices and their potentials, 12 districts were purposively selected for the study.

Table 1: Sampled zones and their respective districts

Sampled study areas	
Zone	**District /s**
South Gondar	Dera
West Gojjam	Jabi-Tehinan and South Achefer
Awi	Dangla
East Gojjam	Awabel, Enemay, Gozamen and Machakel
North Shewa	Angolela-ena-tera, Menz Mama and Menz Lallo
South Wollo	Mekane Selam

2.2 Sampling Procedure and Data Collection

The sampled zones and districts were purposively chosen to collect data related to integrated aquaculture. In this regard, the main criteria used for site and respondent selection were the existence of aquaculture practices. In the region, the number of aquaculture ponds are not substantial and almost all aquaculture ponds were sampled. Once the pond owners are identified, the required data were collected by preparing a semi-structured questionnaire, direct observation, focus group discussions (FGD), and key informant interviews. The questionnaires were designed to solicit information about the existing integrated aquaculture intervention system; farmers' practices on pond fish farming; and the major challenges for integrated aquaculture.

After pre-testing the validity of the questionnaire and the checklists, the data from 72 aquaculture pond owners (farmers) were thoroughly collected. In addition, many of the qualitative and supplementary data were collected from 36 key informants (including fishery experts) and 16 focus group discussions (FGD). In order to identify major constraints that affect aquaculture production in the area, 29 potential constraints were drawn up from FGD, personal discussions and literature review during pretesting. All these constraints focused from site selection to consumption and marketing. During data collection, respondents were asked to rate the extent of each problem using three scales Likert scale (severe, low and not a problem).

2.3 Methods of Data Analysis

Descriptive statistics such as mean, percentage, and standard deviation were computed on different characteristics of fish ponds and challenges encountered by aquaculture adopters. On the other hand, qualitative method of data analysis was used to narrate and supplement the quantitative data.

3. Results and Discussion

3.1 Pond Characteristics

Of the surveyed aquaculture ponds, the majorities (90.2%) were rectangular, and the remaining 9.8% were circular and triangular. According to Alayu (2011), all pond shapes can produce fish, but the rectangular ponds are more suitable compared to the circulars. This is mainly due to the fact that rectangular ponds can be easily fertilized within a short period of time. In addition, large surface area of the pond (rectangular) water can easily be exposed to sunlight and this facilitates the photosynthesis process. The size of rectangular fish ponds ranges from a minimum of 9 m^2 to a maximum of 2400m^2. In addition, the average size of the pond was about 282.9m^2 with a mean depth of 1.9m. However, there was a statistically significant mean difference in pond size and depth between North Shewa zone and other sampled zones. Specifically, the average size of the ponds in North Shewa is about 700.94m^2 with an average depth of 2.9 m.

Due to differences in physical and hydrographic conditions across the zones, the bottom of the ponds were covered in different ways. For instance, in North Shewa, East Gojjam and South Wello, most of the constructed ponds were earthen ponds. Whereas, in South Gondar, West Gojjam and Awi Zones almost all the ponds were covered by black polyethylene geo-membrane. In this regard, most of the constructed aquaculture ponds in the region are earthen pond (79.2%) and geo-membrane (20.8%). This result reveals that earthen ponds are more common in the study area than any other type of ponds. A study by Ifejika et al. (2007) recommended earthen ponds as a means to ensure maximum utilization of pond resources and increasing production. Similarly, Abbas and Ukoje (2009) asserted that earthen ponds are more common due to their high level of zooplankton and phytoplankton productivity.

The water sources for the ponds comes from the ground (48.6%), from streams (30.6%) and rivers (20.8%). Among the surveyed ponds, especially in North Shewa and East Gojjam zones, the pond water is recharged from the ground and the water is available year-round. Based on the agro ecology of the area, most of the ponds were stocked by Oreochromis niloticus or Nile Tilapia and common carp. In the mid- highland or temperate area of the region, O. niloticus is the main fish species preferred and recommended for aquaculture. Whereas, in the highland areas like, North Shewa and South Wello Common carp and O. niloticus are cultured in combination (polyculture) or separately (monoculture). Here, the main sources of fingerlings were BFALRC[2], Geray reservoir and Lake Haik in their order of appearance. In addition, ponds were stocked by BFALRC[3] (31.9%),

[2] Bahir Dar Fisheries and Other Aquatic Life Research Center
[3] National Fisheries and Other Aquatic Life Research Center

agriculture office with the recently separated livestock and fishery resource development agency (27.8%), NFALRC with zonal experts (11.1%) and district with zonal fish experts (16.7%).

Table 2: Different attributes of the ponds (N=72)

Attribute		**Frequency**	**Percent**
Shape of the ponds	Rectangular	65	90.2
	Circular	3	4.2
	Triangular	4	5.6
Water source of the pond	Stream	22	30.6
	Diverted from rivers	15	20.8
	Ground	35	48.6
Bottom seal of the pond	Earthen	57	79.2
	Geo-membrane	15	20.8
Who stocked the pond	BFALRC	23	31.9
	Agriculture office	20	27.8
	District with Zonal fish experts	12	16.7
	NFALRC with zonal expert	8	11.1
	Agriculture Office and BFALRC	9	12.5
Fish species stocked (N=66)	Nile Tilapia	29	43.9
	Common carp	17	25.7
	Tilapia and common carp	17	25.8
	Tilapia and catfish	3	4.6
Functionality of the pond	Good	15	20.8
	Medium	19	26.4
	Low	15	20.8
	Non-functional	23	31.9

3.2 Benefits from Integrated Aquaculture

Aquaculture can be integrated with animal husbandry and irrigation practices for better utilization of resources and ultimately for higher production and profits. If integrated aquaculture is properly executed, it can serve as a means for livelihood diversification. Therefore, such integration of fish farming with the existing agricultural practices is reputable in improving water management and generating additional income from fish farming. In this regard, there are farmers in East Gojjam (Enemay district) who get multiple benefits from integrated aquaculture.

Table 3: Amount of fish harvested and total earning

	N	Minimum	Maximum	Mean	Std. Dev.
Amount harvest in kg/ year	20	3	87	26.60	25.970
Amount consumed at home/kg/	20	2	56	13.28	16.442
Amount sold in kg/year	18	2	58	21.06	17.792
Total earned in ETB/ year	18	60	1700	513.61	410.064
Amount of fingerlings sold	7	100	600	374.17	231.093
Income from sale of fingerlings	7	100	350	214.29	85.217

Given these multiple benefits, however, only 25% and 27.8% of the pond owners try to harvest fish for sale and home consumption respectively. In addition, these farmers harvested an average of 13.28 and 21.06 kg/year/pond for home consumption and market respectively. As a result, 25% of the pond owners earned an average of ETB 513.61 per year per fish pond. However, due to poor pond management and stunted fish growth (see section 3.4 and 3.5), farmers start harvesting after three to four years of stocking. Such stunting fish growth probably came from fish reproduction in the ponds due to mixed-sex stocking. This over population through reproduction increases the competition for feed and space. Thus, most of the aquaculture pond seems as a multiplication pond than production. In desperation, farmers (75%) decided to discontinue their pond management practices once they had harvested their fish. The reason for this discouragement arises from farmers' financial comparison between the costs incurred from pond construction to harvest and its actual returns.

In the study area, most of the farmers originally aimed to sell their harvested fish than consuming them at home. In the absence of any fish markets, farmers become forced to harvest their fish for home consumption. However, these farmers have little knowledge about post-harvest handling and fish dish preparation. Because of these skill gap, farmers harvest their fish in an irregular or seldom way. Consequently, 80.4% of the aquaculture pond owners perceived as they have not been benefited from aquaculture adoption. Hence, sustainability of integrated aquaculture practice in Amhara region is now in question. However, there is one fascinating thing in Enemay district (East Gojjam Zone) that some farmers purchase fishes from pond owners. But these farmers are not basically purchasing fishes for the sake of consuming like other dishes, rather it is due to the belief that "eating fish serves as a medicine" for different diseases. In contrast with the case in Amhara region, Ifejika et al. (2007) asserted that in countries such as Nigeria and Egypt aquaculture is found to be profitable in terms of income generation and food security as well.

On the other hand, only 9.7% of the aquaculture pond owners sold fish fingerlings (when over-populated) as a seed for other aquaculture users and mostly aspired by government. These (9.7%) fish farmers sold about 257 fingerlings per year per fish pond and generated ETB 214.29 per year per pond on average from fingerling selling (Table 4). This return might not be simple, but there is no private fingerling buyer in uninterrupted way. In the area, most of the farmers caught their pond fish in a labor-intensive way by using a net (locally called Zanzira) that has been distributed by health centers for malaria protection in rural area. The reason is that all aquaculture pond owners in the region have no any type of standardized fishing net. More surprisingly, some farmers totally drain out their ponds to harvest their fish without considering the fate of non-market sized fishes and fingerlings.

3.3 Is Aquaculture in the Region is Well Integrated?

In the study area, the aim of integrating aquaculture with other agricultural practices was to benefit smallholder farmers and to increase their water productivity at the backyard. In addition, it was also proposed to integrate aquaculture into the irrigation systems for more efficient water resource utilization. In this regard, a lot of water harvesting ponds and dams were constructed for this purpose. During this, there was a mistake that the constructed ponds/ dams were not prepared in a design that fish farming required like inlet, outlet and possibility to integrate. Rather, the constructed ponds were merely designed for water storage, supplementary irrigation and livestock watering (Figure 1).

Figure 1: Performance and design of aquaculture ponds

A study conducted by Akalu et al. (2010) confirmed that water from these ponds are largely used for domestic purposes, livestock watering and supplementary irrigation, particularly for horticultural crops. The study also asserted that about 45% of the water was used for seedling and fruit production, 50% for livestock watering and 5% for domestic use. As depicted in Figure 1 the aquaculture ponds are constructed at a site difficult to integrate with horticulture and livestock. Therefore, when the pond’s water becomes drained out, the water merely drained either to the rivers or to idle land, which are difficult to plough. Similarly, there are also many potential aquaculture ponds (Appendix 1) in North Shewa, which are constructed on communal lands. These ponds have no any properly constructed inlet and outlet and makes the future integration practices troublesome. Based on the surveyed aquaculture ponds, it might be misleading if we say ‘there is integrated aquaculture practices in Amhara region’.

3.4 Pond Management and Current Status of Aquaculture in the Region

Fish feed types that farmers frequently used are poultry and cow manure (55.6%), residuals from human feed and grinded maize (19.4%), non-marketable residue of horticulture crops (12.8%), and nug cake and wheat bran (8.2%).

However, our study also found that 76.1% of the pond owners feed their fishes irregularly. This is also exacerbated by the fact that ponds are constructed far from home, while, some others are constructed on communal lands in a communal basis like, ponds in North Shewa (Appendix Figure 1) and South Wollo. Due to such problems of communality and discouragement, 23.1% of the sampled aquaculture ponds did not get any type of fish feed. In addition, most of the farmers do not regularly monitor the overall performance of their ponds. Because of these, farmers do not know whether there is market sized fish in their ponds or not.

On the other hand, some ponds are not exposed to direct sunlight due to the shades of trees and their branches around the ponds (Figure 2). In addition, there are ponds that are full of grass, frog and submerging plants due to drastic reduction in volume of water and siltation during runoff. As Table 2 shows, out of the surveyed fish ponds only 23.7% of them were functionally good (Appendix Figures 1, 2, and 3), whereas more than 31% of the ponds became totally nonfunctional and discontinued. According to the FGD and key informant discussions, poor fish consumption habits and weak pond management are the two contributing factors to the failure of aquaculture in the area. Based on the level of input used, feeding frequency and type and the degree of management, the current aquaculture practice of the region inclined towards extensive type. Such extensive type aquaculture practices are known for their poor pond management and poor integration and consequently negligible returns. However, this finding is in contrast to the finding of Berihun and Goraw, (2010) that semi-intensive aquaculture has been developed in the Amhara region.

Figure 2: Pond management in West Gojjam zone

3.5 Major Challenges for Integrated Aquaculture Development

A serious problem observed in one zone might not be a problem for the others due to its locational sensitivity. Given the strong endeavor of the government towards aquaculture development in Amhara region, the most commonly observed determinants of integrated aquaculture development are discussed below.

3.5.1 Site Selection

As Table 4 shows, 38.8% of the aquaculture adopters said that site selection and inlet/outlet related issues are among the severe problems, which negatively affects the performance of their ponds. In this regard, the site of some aquaculture ponds are not selected based on their physical and potential suitability for integrated fish farming. Rather, these sites are selected based on their convenience for the experts. Therefore, farmers start pond construction without any critical consideration of the suitability of the site for pond construction, its possibility to integrate with other agricultural practices and its water sources. In addition, some ponds have been constructed without any outlet and inlet; therefore, farmers are forced to fill their pond by renting and purchasing a water pump and fuel respectively. Such recklessly constructed ponds become a curse for the barefooted farmers by accruing an extra cost. There is also an evidence from Korata kebele in South Gondar zone that, out of the 10 constructed ponds since 2010, all ponds become dried or out of service at this time.

3.5.2 Farmer Selection

The successes and failures in aquaculture depend on the real purposes that farmers prepare their ponds. In fact, there are many farmers who construct fish ponds as a means to generate cash income from fish sale, for home consumption, and to integrate with other agricultural practices at their backyard. In this situation, farmers are found to be very much dedicated to pond management and monitoring to maximize benefits from their ponds. However, there is also a situation where "opinion leader"[4] farmers to be selected by fishery experts. As defined by Rogers (1983), these farmers are more exposed to all

[4] *Opinion leadership* is the degree to which an individual is able to influence other individuals' attitudes or overt behavior informally in a desired way with relative frequency.

forms of external communication, more educated, have somewhat higher social status, wealthier, owning large landholding and more innovative. However, they might not be devoted for managing their ponds because of the fact that they do not worry about the risk of losses. Therefore, they merely dig the ponds for the sake of financial and equipment support like geo-membrane, cement and water pump from the government as an incentive.

Moreover, farmers adopt aquaculture without convincing their family members and themselves about its advantages. They rather adopt aquaculture for the purpose of getting public acceptance and reward either in kind or cash like, local leadership and other benefits. However, when they could not get what they immediately stop their pond management practices (Figure 3). During the study, we also found ponds that are full of frogs, debris and overcrowded fingerlings with a stunting growth without giving any benefit up to six years. The existence of such frogs creates feed competition among the fishes and the frogs, which in turn causes stunting in the fish growth.

Figure 3: Pond’s geo-membrane used as a thatch for home at Awi Zone

3.5.3 Input Availability

The crucial aquaculture inputs in the study area are geo-membrane, fingerlings and fishing nets. In this regard, there is a lot of geo-membrane dumped at every agriculture office, but farmers strongly complain on the shortage of this input. However, the dumped geo-membranes are not given for pond owners either free or low cost. Therefore, most of the ponds, especially in South Gondar and West Gojjam become nonfunctional because of water shortage and leakage.

There are also two contradictory things that shortage of fish fingerling for aquaculture and at the same time, stunted fish growth due to over population. For instance, there are a lot of huge ponds and dams, which have not been stocked with fish yet in the region due to shortage of fingerlings. On the other hand, the other ponds are suffering from stunted fish growth because of overpopulation (Table 4).

Out of the sampled aquaculture adopters, 40.3% and 43.3% of them are facing with a problem of fish over population and stunted fish growth respectively. In addition, 55.2% of pond fish farmers reported that fingerlings are not technically transferred to other ponds to solve the problem of over population. On the other hand, fishing net is among the determinant factors for aquaculture development in the region. As Table 4 shows, 74.6% of the pond fish farmers categorized fishing net as a severe problem. Except Enemay district in East Gojjam, all farmers have adopted aquaculture without having fishing net. Therefore, if farmers want to harvest fish for home consumption or market, they have two options: the first option is catching their fish by using mosquito net locally called Zanzira and rickety clothes. The second option, which is practiced by most pond owners, is not to harvest until they get their own fishing net or until the water drained out or dried.

Table 4: Major challenges for aquaculture

Problems for integrated aquaculture	**Extent of the problem**					
	Severe		**Low**		**Not a problem**	
	N	**%**	**N**	**%**	**N**	**%**
Site selection and outlet problem	26	38.8	19	28.4	22	32.8
Overstocked fish population	27	40.3	14	19.4	26	36.1
Fingerlings transfer problem	37	55.2	17	25.4	13	19.4
Have not appropriate fishing gears	50	74.6	7	10.4	10	14.9
Nonexistence of fish feed	17	25.7	28	42.4	21	31.8
Stunting fish growth	29	43.3	20	29.9	18	26.9
Low farmer's and expert's interest	43	63.2	24	35.3	1	1.5

3.5.4 *Fish Feeding Habit*

Even though some farmers add fish feeds to their ponds in a seldom ways, there are many farmers who do not totally feed their fishes due to lack of awareness. Surprisingly, these farmers also perceived as fish will grow as long as they are in a pond water. They do not even realize that best performance would be obtained if the fishes have a balanced diet. Among the fish feeders, they frequently used cow manure as a fish feed but the way they apply was not efficient. These farmers put a sack with a full of cow dung at a side in the pond for lots of months without replacing and refreshing the water. This might produce fish pathogens, bad smell, reduced water quality, diminishing phytoplankton and zooplankton abundance and depleted oxygen as well. In one or the other way, all these problems can directly affect the growth of fish at the pond.

Table 5: Challenges for aquaculture

Problems for integrated aquaculture	**Extent of the problem**					
	Severe		**Low**		**Not a problem**	
	N	**%**	**N**	**%**	**N**	**%**
Low return	35	52.2	22	32.8	10	14.9
Weak extension and follow-up	40	58.8	25	36.8	3	4.4
Market problem	41	60.3	17	25	10	14.7
Skill and knowledge gap	51	75	13	19.1	4	5.9
No immediate benefit	48	71.6	18	26.9	1	1.5
Aquaculture is not profitable	19	47.5	20	50	1	2.5
Non-existence of role model aquaculture ponds	42	72.3	12	18.5	6	9.2

3.5.5 Experts' and Farmers' Interest towards Aquaculture

Despite the fact that there are some motivations and attempts to promote aquaculture, it is still the neglected sector compared to other agricultural activities. For instance, the budget, equipment and human resource allocated for this sector is very low. Unlike the situations observed in crop related activities, trainings and extension support related to fishery sectors is negligible. This finding is also consistent with the report of Akpabio and Inyang, (2007). In addition, Kurwijila (2004) also illuminate how the government itself marginalize the fisheries sectors in the context of food and nutrition security.

During data collection, extensive discussions were held with livestock and fishery experts about the attentiveness of the government towards the fishery sector. In almost all the surveyed districts, fishery experts have no fishery specific background; rather they were delegated from either animal production or natural resource disciplines. In addition, the key informant interview shows that most of the delegated fishery experts are either those who have poor performance on the other disciplines or pregnant women, who are prepared to get birth.

On the other hand, most of the farmers selected to adopt aquaculture had no any previous fisheries related experiences. In the region, farmers might learn a skill on how to handle cattle from their environment. However, aquaculture adopters could not acquire a fish farming experiences from its neighbors. A study by Ifejika, et al. (2007) also emphasized how fishing experience is crucial to the success of aquaculture by reducing management problem. On the other hand, the endeavors on skill and awareness creation related to aquaculture were insignificant and this hinders aquaculture development. Similarly, there is no model farmers who are benefited from aquaculture. Moreover, farmers were not benefited as they expected before the intervention. All these factors make farmers less committed to pond management and hence expansion of aquaculture becomes steady.

3.5.6 Extension and Follow-up

The monitoring and follow up on the progress of aquaculture is not beyond stocking ponds by fingerlings. However, the activities from pond construction to consumption and marketing are left for farmers who do not have any technical knowledge about fish farming. Due to these problems, farmers have stopped the pond management to the extent that the ponds become dried up and fishes become feed of birds (Figure 4). Due to this, some farmers in Dangla and Dera districts use their pond's polyethylene geo-membrane as a thatch for their house by drying up their ponds (Figure 3). In addition, most of the experts hurry for crop and livestock related activities, however, in the extension system, aquaculture has lesser attention. This might associate with the local experts' knowledge gap about fisheries related issues. There was also an evidence from the field day that some farmers (non-adopters who were invited to visit aquaculture ponds) were surprised when they saw fishes in the ponds because they only know that fish can survive only in lakes and rivers and not in ponds.

3.5.7 Capacity Building on Aquaculture

The newly established fisheries and livestock development office, especially at the district level is not well equipped with budget, human resources, and equipment. In addition, farmers do not get adequate theoretically and practically trainings before and after pond construction. Therefore, many of the farmers start fish farming without having knowledge from pond management to fish dish preparation and consumption. Such unplanned and baseless adoption makes farmers reliant of fish experts for every simple thing that could work by the farmers themselves.

Figure 4: Aquaculture pond affected by leakage

The district level fishery experts themselves could not get a hands-on training. As a result, these fishery experts might not be capable in providing technical supports for the aquaculture adopters. In addition, districts' fishery experts do not involve through the whole procedures of demonstration researches and this hinders them from updating themselves.

3.5.8 Market and Consumption

As Table 5 shows, 60.3% of the sampled aquaculture owners reported that market is a severe problem for them to intensify aquaculture. The problem is that strong market linkage for those aquaculture adopters who do not consume fish is not available. This finding is also in consistent with the finding of Akpabio and Inyang, (2007). These authors reported that pond fish farmers are mostly located in rural area, whereas about 95% of the customers with adequate purchasing power are around the urban areas. In addition, poor roads, poor electricity and lack of vehicles with refrigerated compartments, are the problems for effective marketing of fishes from aquaculture. The other challenge for aquaculture development is that farmers have no adequate experience or skill to eat fishes. Thus, even for small catches, farmers start looking for market elsewhere. However, as mentioned above, the market for such small and irregular catch does not exist when required. Thus, farmers become discouraged to continue in such a manner.

3.5.9 Rewards from Aquaculture

Most of the sampled fish ponds were constructed and stocked in between 2002 and 2016 but 83.4% of the pond fish owners could not harvest fish yet. Hence, the majority (71.6%) of the aquaculture pond owners considered absence of immediate benefits from pond fish farming as a severe problem. In this case, households become more committed to the activity that have immediate returns. There is also an evidence from Dera, North Achefere and Dangila districts that farmers fill their ponds with soil and growing amazing banana. Therefore, it poses a great discouragement for pond fish farmers and for aquaculture development in the region.

3.6 Aquaculture and its Bright Prospects

The estimated potential land for large and medium scale irrigation in Amhara region is about 650,000 - 700,000 hectares. In addition, there is about 200,000 - 250,000 ha of land, which have the potential for small scale irrigation (less than 10% has been develop). All these indicates the magnitude of water resources available for irrigation and aquaculture development (Mohammed et al., 2006). Thus, the potentials for aquaculture development in Amhara region are readily available. One of the best indicators of the Government’s preparedness to develop the fisheries sector is the recently established Ministry of Livestock and Fisheries as a standalone organization (Abebe, 2016).

In the second growth and transformation plan (from 2016 to 2020), the focus area of the government is irrigation and aquaculture-based development. In addition, the current trend in floriculture development creates an opportunity for integrating fish farming with floricultures' water harvesting pond. There are also many man-made dams or ponds for supplementary irrigation and floriculture sites that require hundred thousand of fish fingerlings at once. Therefore, the current declining catch from capture fishery and increasing demand for fingerling opens the room for aquaculture expansion. Moreover, the unreserved effort of Bahir Dar fisheries and other aquatic life research centre on hatchery multiplication, production and demonstration can also be considered as a good prospect (Appendix Figures 1, 2, and 3).

4. Conclusions and Recommendations

Amhara region has a great potential for aquaculture development but it remains as an opportunity than a tangible benefit for the farmers. In the region, integrated aquaculture was introduced starting from 2002 by using O. niloticus and common carp fish species. The aim of the intervention was to integrate aquaculture with other forms of agricultural practices. However, it could not become successful and expanded as planned due to some technical and management related inefficiencies. Thus, the development of integrated aquaculture practices in the region is still at its infancy stage. Such stagnant growth in aquaculture can be attributed to various constraints starting from site selection to fish consumption and marketing.

Among the bottlenecks for integrated aquaculture, the extension and follow up system has serious problems and the involvement of experts is not beyond stocking the ponds. In addition, pond management and fish consumption habits are the two limiting factors for integrated aquaculture in the region. Due to such skill gaps, farmers' pond became overcrowded by fish fingerlings with a stunting growth. Thus, most of the aquaculture pond seems like a multiplication pond than production ponds. In general, most of the constructed fish ponds are not functional and the most of them are on the way to discontinue. Owing to these facts, the current practice of aquaculture system in Amhara region can be categorized as an extensive type with poor management and poor integration. Therefore, due to inefficient intervention system (mostly due lack of commitment), the returns from integrated aquaculture intervention in Amhara region is not promising. In addition, if the current intervention system does not revamp, the sustainability of integrated aquaculture practice in Amhara region will be in question.

Thus, if aquaculture is expected to provide a high-quality food, self-employment and cash income for the smallholder farmers, the following issues require due attention:

- Before starting pond construction, adequate pre-intervention trainings from site selection to consumption must be provided
- The initial cost of pond construction may not be affordable for subsistence smallholder farmers. Therefore, giving pond construction inputs like geo-membrane and other equipment either as an incentive or on a loan basis is necessary.
- Use locally available feed staffs such as poultry excreta, animal manure, wastes after human consumption and others should be used to cutoff feed costs.
- Intensive follow up and endeavor for pond management are vital to minimize problems of the ponds.
- Promoting a multipurpose extension by integrating aquaculture development with other forms of agricultural practices
- Transfer fingerlings to fish production ponds to reduce feed competition and over population of the ponds.
- Proper promotion and marketing of harvested fish will attract farmers and guarantee its future sustainability.
- Build capacities of pond fish famers through training on pond management
- Assign appropriate and knowledgeable fishery professionals to support farmers from pond site selection to fish production and consumption.

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Appendices

Appendix Figure 1: Aquaculture ponds constructed at communal lands in North Shewa Zone

Appendix Figure 2: Aquaculture ponds at South Gondar Zone

Appendix Figure 3: Aquaculture ponds at East Gojjam Zone

Criteria for identifying Level of Aquaculture Intervention and Its stage of Development
Level of Aquaculture Intervention
Limited Aquaculture Intervention (Extensive Aquaculture)
Human intervention is concentrated on reproduction of the stock
Simple ponds affected by leaking
Mainly fill during rainy season
Water control is difficult
Stocking density is too low

Fish production relies merely on the natural productivity of the water which is only slightly or moderately enhanced
The production is only for local use
Fishes' health is not under control
Quantity and quality of the stock is unpredictable
The number of harvested fish is variable and based on the:
Climate conditions (water temperature, dissolved oxygen, salinity, pH etc), and
Available field for the aquaculture activity
Costs are kept low and capital investment is restricted
Low yields of approximately 250 kg/ha
Intermediate Aquaculture Intervention (Semi Intensive Aquaculture)
Fingerlings and food-fishes are produced separately
If mixed fingerlings transferred
Fingerlings received high quality feed daily
Fishes' growth is at predictable rate
Ponds are filled by pumping
Significant intervention in all aspects of production process
Harvesting is more predictable and efficient
Processing is managed to produce high quality product
Production cost is usually moderate
Yield is higher than the case in the extensive system, above 10,000 kg/ha/year
High Aquaculture Intervention (Intensive Aquaculture)
Water could recirculate continuously
12% of the water replaced each day
More or less constant internal and external environment
High level of intervention with low uncertainty
commercial feeds

Stages of Aquaculture Development
There are three stages of aquaculture development namely,
Low (infancy) stage of aquaculture development
Intermediate stage of aquaculture development and
High stage of aquaculture development
The level of intervention is an indicator for the stages of aquaculture development. Therefore, if the level of aquaculture intervention is limited, the stage development becomes low stage of aquaculture development.

Sources: Adopted and modified from (Altan, n.d.; Kaleem & Sabi, 2020; Shell, 1993)