# Lessons from Small-Scale Fish Farming in South West and West Shewa Zone, Oromia Region, Ethiopia. A Review

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**Abstract:** *For the past 13 years, the National Fisheries and Aquatic Life Research Center (NFALRC) have intervened with small-scale fish farming trials in South West and West Shewa zones of Oromia Region, Ethiopia. Opportunities and challenges of the trial, farmers' awareness, and attitude towards small-scale fish farming and its economics have already been studied and documented. However, the studies were not comprehensively reviewed, synthesized, and presented to inform further intervention. This paper is meant to fill this gap. Desk review of those studies and others supported by prior experience of the author to intervention areas is the core approach followed. As a result, seven key lessons were learned: the need for redefining core challenges of small-scale fish farming, gender inclusion in small-scale fish farming, need for a revision of public sector-led formal extension service delivery linked to the change in the conventional extension approach followed by NFALRC, emphasis on awareness creation on fish farming, the importance of participatory approaches and the need for repeating research trials in the economics of small-scale fish farming. Among these, awareness creation, the use of participatory approaches, and changes in conventional extension service delivery by NFALRC should be given priority.*

**Keywords:** Aquaculture, By-product, Fish farming, NFALRC, Oromia Region



## 1. Introduction

The fish farming system in Ethiopia is mostly extensive with some small-scale and semi-intensive systems of production among a few practicing farmers (Rothius *et al*., 2012). An extensive farming system is a case where fingerlings are literally stocked in ponds with virtually no feed supply, pond management, or other packages necessary for fish farming (Rothius *et al*., 2012). In this case, the ecosystem inside the pond provides food for the fish (Lekang, 2013). However, in a Semi-intensive system, there is some sort of supplementary feed and pond fertilization support in addition to the natural feed obtained from the pond ecosystem (Edwards and Demaine, 1998). Semi-intensive fish farming is currently being practiced by very few subsistence farmers as observed from field experience. Estimated size of more than 1,300 fish farmers in Ethiopia is subsistence types with a pond size of about 100-300m$^2$ (Rothius *et al*., 2012).

Fish species being cultured in many fish farming sites of Ethiopia are mainly Tilapia (Nile Tilapia and Redbelly Tilapia) followed by African Catfish and Common Carp (Chalacheww, 2010; Daba, 2010; Yared *et al*., 2011; Alayu *et al*., 2015; Hiwot *et al*., 2016). These are commercially important fish species available in Ethiopia. In addition to those mentioned above, the species, being cultured at NFALRC also includes Crussian carp and goldfish (NFALRC, 2010).

Evidence from some studies in Ethiopia shows that in areas where there was no prior experience of fish farming, the first challenge those who intervene face is a lack of awareness about the activity. Thus, improving community awareness is necessary to start out the same and improve its adoption (Hiwot *et al*., 2016; Tena, 2021). The second challenge is the lack of inputs for fish farming, basically fish feed (Hiwot *et al*., 2016; Tena Alemu, 2021).

Fish farming is a management-intensive business. The need for intensive and skilled management comes from a high level of capital invested in the facilities and a high level of operating capital required for a competitive and profitable business (Yemi and Deji, 2012). The importance of studying the economic viability of fish farming is that it is one of the components of sustainability in the sector (Yemi and Deji, 2012). Hence it is termed as "economic sustainability". If fish farming is to be sustainable without any incentive, it has to be economically viable (Hishamunda *et al*., 2007).

From 2008 onwards NFALRC commenced small-scale fish farming trials using six farmers from South West and five farmers from West Shewa zones of the Oromia region, observing the availability of year-round river and farmers' willingness to participate in the trials. Land allocated for constructing fish ponds was bush land or land used to prepare livestock fodder and grassland. Then, ponds of an average size of about 100-200 $m^2$ area were constructed with the cost first covered by the farmers themselves and refunded by the center. After the ponds are filled up with water they were stocked with tilapia fingerlings only (mono-culture) and other fish species such as common carp and African catfish mixed (polyculture). Fish farming inputs and associated training were then provided to experts and farmers. Finally, having seen the home consumption benefits reaped and promoted by the adopters, other farmers also joined the trials and showed more demand from time to time.

At the beginning, what to feed the fish was the basic challenge faced by farmers who commenced the trials. Hence, they provided potato leaves, bread scrambles, and other homemade food leftovers, wheat bran, or noug cakes in dried forms (Yared *et al*., 2018).This feeding habit then became common when Sebeta I fish feed, prepared from a mix of industrial by-products: noug cake, brewery waste, and wheat bran was not supplied timely by the center (Yared *et al*., 2018). Based on personal observation and field experience on the sites, commercial-grade fish feed was not accessible and affordable to fish farmers. Alema Koudijs Feed PLC is currently the only animal feed processing factory producing fish feed, both for Nile Tilapia and African Catfish on a limited scale (Koudijs, 2019).

During the intervention, three successive studies were conducted by researchers from the center on fish farming challenges and opportunities, the economics of small-scale fish farming as well as awareness and attitude of farmers towards the activities (Hiwot et al., 2016, Yared *et al*., 2018, Abebe and Mesay, 2018). All the studies were conducted in the intervention areas. However, they were not synthesized to clarify the gaps and inform all possible local intervention options in an organized manner. The current review is done to fill this gap.

## 2. Research Methodology

This paper follows a conceptual analysis of studies made by Hiwot *et al*. (2016), Yared *et al*. (2018), and Abebe and Mesay (2018) through a desk review, supported by practical evidence. Though these studies are focal areas of the current review, other studies conducted on similar topics with implications to the current intervention areas were also revisited. Basic data points are then extracted from the three studies and categorized into themes, narrating the challenges to small-scale fish farming and partly lessons learned from their findings. The lessons are then backed up by personal experiences and further discussed accordingly.

## 3. Results and Discussion

### 3.1. Lessons from the surveyed intervention areas

#### 3.1.1. *Lessons from farmers' awareness and attitude towards fish farming*

A survey conducted by Yared *et al*., 2018 on farmers' awareness and attitude towards fish farming has shown that more information is necessary on the nutrition benefits of fish. As observed from the survey output, the nutrition and health benefit of fish compared to other livestock species was not properly understood among farmers. Detailed awareness of pond dynamics is also lacking. Meanwhile, the survey output indicated that farmers could be more motivated to start fish farming if they are aware of the unique benefits of fish consumption such as for their health and mental development of their young children. The study also depicted awareness and attitude differences among fish farmers themselves, calling for change. Such a gap may partly be

attributed to limitations in information coverage by the formal extension system. It is because formal extension in Ethiopia cannot address all farmers and at once. Thus, the farmer-to-farmer linkage is a more important and cost-effective way of disseminating information; creating better awareness and improving attitude towards fish farming (Kumar, 1999).

### 3.1.2. *Lessons from economic analysis of small-scale fish farming*

Several studies conducted on the economic viability of small-scale fish farming have shown that the activity is profitable provided the market and all relevant inputs are available at a given price. Among major factors limiting the profitability of small-scale fish farming, the fish feed was mentioned as one of the three: labor for pond construction and management, fish feed, and fingerlings (Hyuha *et al*., 2011). The same was found to be true in the respective order of importance for the study conducted by Abebe and Mesay (2018). Although some information is already available on the production cost of semi-intensive fish farming and profitability (Rothius, 2012; Abebe and Sileshi, 2015; FAO, 2017), these information cannot be recommended directly for NFALRC intervention areas. Thus, economic analysis on small-scale fish farming had to be conducted in those areas.

For the study, eight progressive fish farmers residing in two fish farming pilot project sites namely: Wonchi and Illugelan districts of South West and West Shewa zones were selected (Abebe and Mesay, 2018). For the purpose of analysis, fish farming activities were grouped into four major production stages namely: Pre-stocking, stocking, feeding together with pond management and harvesting. Based on the finding, the cost of labor for pond preparation and maintenance at pre-stocking stage was found to be the highest covering about 78% of the total production cost (Abebe and Mesay, 2018). The second and third highest production cost components of small-scale fish farming were found to be fish feed (Sebeta I), which is developed from industrial by-products, currently used by NFALRC and fish fingerlings. They covered part of the remaining 22% of the cost. Among others, fish feed alone covered around 14% of the total production cost (Abebe and Mesay, 2018). The low percentage contribution of the feed to the overall production cost was because of its relative cost-effectiveness to commercial fish feed (Alema Feed) and recommended for small-scale fish culture systems (Abelneh and Zenebe, 2017).

From the study, it was understood that labor, especially at the initial stage, is a crucial cost factor for small-scale fish farming. It is demanded at all levels of the production process (Abebe and Mesay, 2018).This reality is contradictory with the expected assumption cited in the strategic document prepared for small-scale fish farming and included in the National Aquaculture Development Strategy of Ethiopia (MoARD and FAO, 2009). In the document, it is stated that labor cost for small-scale fish farming is low as it would be organized locally for free. In reality, farmers don't necessarily organize family labor as the majority of them have small children who have not yet reached a working age (Abebe and Mesay, 2018). Fish fingerlings and Sebeta I fish feed are normally given to farmers from the National Fishery and Aquatic Life Research Center only for subsistence production and free of charge.

Thus, the analysis of production cost for small-scale fish farming was done assuming if farmers were to prepare Sebeta I fish feed taking industrial by-products from nearby factories and unit price of fish fingerlings currently set by the center and sold to flower farms from the center (Abebe and Mesay, 2018). During the whole project period, all costs associated with fish farming starting from land clearing, pond preparation, provision of fish fingerlings, filling water and lime application were fully supported or compensated by the center.

Compared with the results of other similar studies, the benefit to cost ratio of the current intervention is higher than smallholder fish farming in the case of Nigeria (Yemi and Deji, 2012) Zambia (Kapembua and Samboko, 2017) and China (Phiri and Yuan, 2018) but lower than that of a study conducted in Oyo State, Nigeria (Tunde *et al*., 2015; Ashley *et al*., 2017) and Iran (Maaruf and Akbay, 2020) to mention some. From the study result, it is understood that cost-reducing technologies are important to ensure economic success out of fish farming. This should primarily focus on the reduction of labor costs for

pond construction and maintenance by maximizing the use of locally existing natural water bodies, which could be used as ponds. Fish feed should be the next issue that demands more attention. The output of the economic analysis, conducted in the study area, leads us to recommend farmers either to develop their own feed from locally available resources or apply an integrated fish farming system to get relatively better off.

Regarding the overall profitability of small-scale fish farming, the benefit to cost ratio of all respondents engaged in the activity was positive and above one. As indicated in the paper by Abebe and Mesay (2018), the overall mean value of the benefit to cost ratio was 1.49, indicating that a one-Birr investment in small-scale fish farming would result in a profit of 0.49 Birr, provided there is a consistent market, existing technologies and inputs are used. The authors of this study finally concluded that fish farming in the project areas is still economically viable on a small scale but not satisfactory as a business of choice to most other farm business enterprises selected and used for comparison (Table 1).

**Table 1: Profitability comparison of different livestock, and crop enterprises in Ethiopia**

| S/No | Type of farm business | Benefit to cost ratio |
|---|---|---|
| 1 | Smallholder dairy farming | 1.20 |
| 2 | Aquaculture | 1.49 |
| 3 | Highland maize production | 1.59 |
| 4 | Durum wheat production | 1.60 |
| 5 | Chickpea | 1.60 |
| 6 | Mid-altitude maize | 1.70 |
| 7 | Tef | 1.79 |
| 8 | Commercial dairy farms | 2.00 |
| 9 | Lentil | 2.26 |

Source: Author's compilation from Abebe and Mesay (2018)

### 3.1.3. *Lessons from the potentials and challenges of smallholder fish farming*

The study by Hiwot *et al*. (2016) tried to assess overall potentials and challenges for smallholder fish farming in the intervention areas. As a result of the study, cost of commercial fish feed and its inaccessibility, lack of awareness on fish farming, poor extension, and advisory service delivery, lack of adequate expertise on fish farming, absence of private sector investment in the subsector, and embedded food culture of the local community were identified as primary challenges. However, the potentials for smallholder fish farming, operating in small-scale, are also identified such as availability of sufficient land, water and, some technical staff with fishery background. Three key lessons learned from the survey output were:

- Availability of water and land should not be the sole criteria in selecting sites for small-scale fish farming trials. I.e. also use other suitability mappings and species compatibility using multi-criteria analysis
- Participatory problem identification and joint planning, as well as promotion of fish as part of farm household's recipe, should be done before introducing fish farming trials
- The challenges to fish farming have to be redefined in a participatory manner and synthesized in a way to provide optimal solutions unlike the formal method used to gather information related to those challenges from farmers.

## 3.2. Overall lessons from small-Scale fish farming in the intervention areas

### 3.2.1. *Challenges to be clearly defined for small-scale fish farmers*

The challenges faced by farmers in promoting fish farming practices are so diverse and complex. Hence, they need to be clearly defined. Moreover, it needs a systemic understanding of their origin, root cause, and effect relationships. Multi-dimensionality of the challenges leads us not to forward a single faceted solution to the overall problem (Hiwot *et al.,* 2016). Hence, a closer look at these challenges shows that they are interrelated. It is thus important to synthesize similar cases into a comprehensive framework. Experiences drawn from the project sites show that challenges related to smallholder fish farming could generally be grouped as: Social, Economic, Technological and Institutional (Figure1).

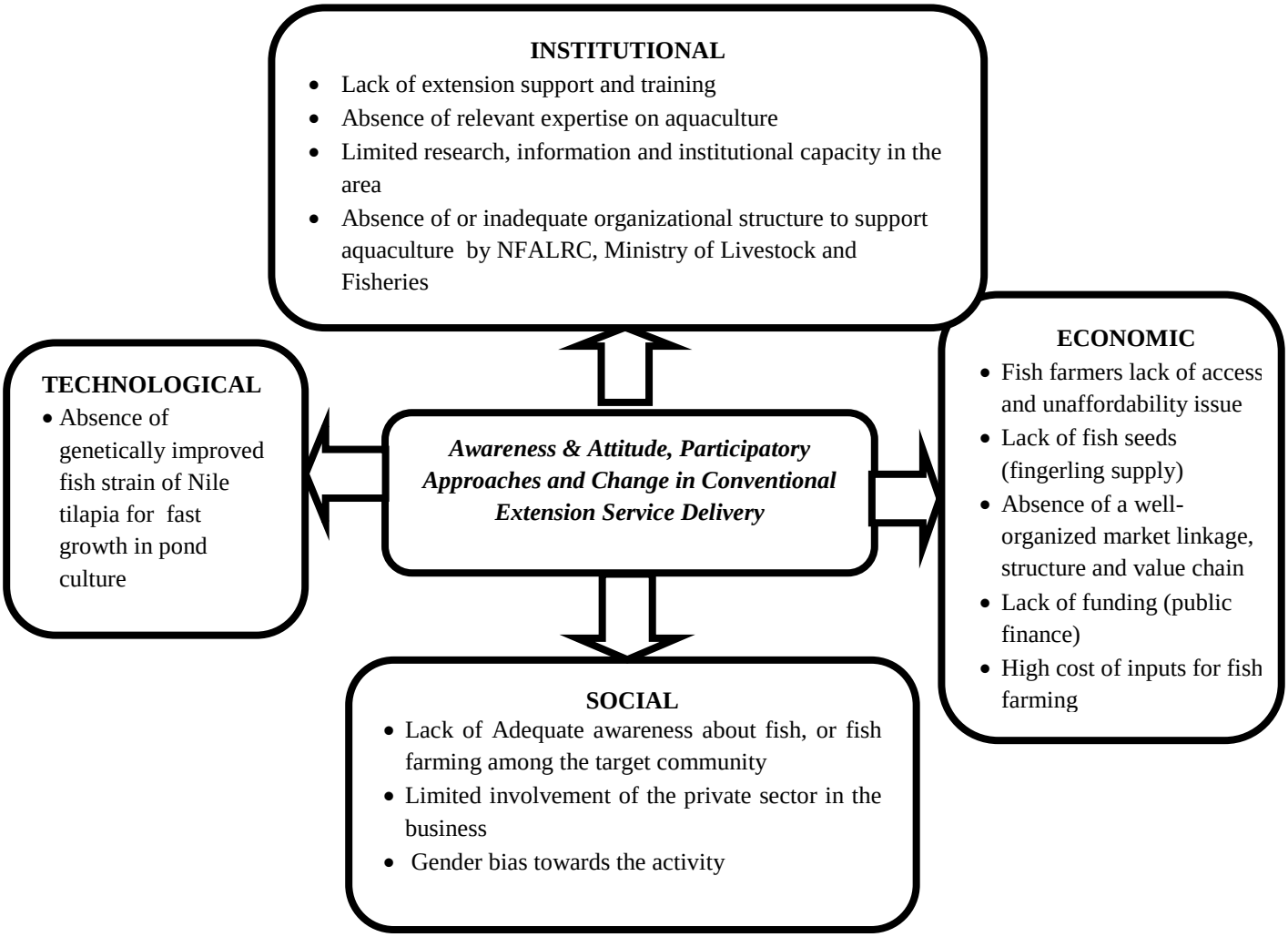


Figure1: Framework of challenges to smallholder fish farming in the study areas

### 3.2.2. *Consideration of Gender in small-scale fish farming*

Gender plays a central role in small-scale fish farming, which is expressed by the sharing of roles and responsibilities for mutual benefit. However, the gender literature on fish farming is often scattered. The dearth of literature indicates that both research and projects in fish farming value chains often fail to take the gender perspective into account (Kruijssen and McDougall, 2018). Failure to address gender issues is attributed to the fact that like the terminologies of "agriculture or farmer", smallholder fish farming is also perceived as a male-dominated activity. Men are normally and usually engaged in creating the foundation for activities such as allocating capital and doing physically demanding responsibilities.

Women have a significant contribution and impact on fish farming (Atdhe *et al*., 2009). For instance, they are sometimes involved in pond construction, fish feeding, liming regular supervision, medication, pond drying, cleaning, stocking, fish harvesting, sorting fingerlings, marketing, and seed supply. There are also cases where women are involved in gillnet making, mending, and transportation activities. (Brugere and Williams, 2017; Luomba, 2013, Das and Khan, 2016; Quddus *et al*., 2017). Despite this, they are usually invisible in policy due to the lack of comprehensive and timely data on women in fish farming (Hapke, 2012; Brugere, 2015).

Regarding the intervention areas, gender roles in fish farming were mapped. As a result, the participation of women in small-scale fish farming is not

significant, as for boys and girls. Based on the survey results of Hiwot *et al*., 2018 and Yared *et al*., 2018, women participate only in fish feeding, fish processing, sometimes pond management and cooking-related value addition activities. Despite their role, they are not actively engaged in formal trainings and workshops related to fish farming and processing as expected (Hiwot *et al*., 2018). This, in addition to several factors for their non-participation, shows a lack of gender consideration in fish farming. Enhancing women's participation, therefore, helps to increase labor productivity, reduce the cost of production associated with pond management and hence productivity of small-scale fish farming. As an implication, non-participation is indicative of an unused potential of fish feed preparation and feeding, which a very significant assignment in fish-farming.

#### 3.2.3. *Changing the conventional extension approach*

Ethiopia is one of the African countries with a greater number of extension personnel to farmers. the ratio which is 1:475. This exceeds that of Kenya, Malawi, and Tanzania having ratios of 1:1,000, 1:1,613, 1:2,500 respectively (Pablo *et al*., 2008; Davis *et al*., 2010). Despite these concentrations of extension personnel to farmers, the performance of the extension effort was not as satisfactory as expected. The previous studies conducted in the NFALRC intervention areas also evidenced that there is poor public extension support for small-scale fish farming trials.

The poor performance of the public extension system in fish farming of Ethiopia is partly attributed to the biased nature of extension service against the Livestock Sub-sector (Belay, 2003). Weak budget, human resources and equipment allocated to fish farming also contributed their part (Erkie *et al*., 2020). But, most of all it is due to the extension of information dissemination in the country which applies top-down and inflexible approaches to service delivery (Befekadu and Berhanu, 2000). The current review recommends alternative means of information dissemination through individual farmers and farmer organizations for successful information dissemination and service delivery in relation to small-scale fish farming. Therefore, it is a necessary to shift from an expert-led transfer of information and service delivery, currently applied by NFALRC, to more participatory approaches and use of farmer networks for fish farming-related information dissemination (Kumar, 1999; Yared *et al*., 2018).

#### 3.2.4. *Contextualizing economic viability of small-scale fish farming*

Private sectors' engagement in fish farming is nonexistent (Hiwot *et al*., 2018). Various studies conducted on the economic viability of small-scale fish farming claim that the venture is profitable provided market and all relevant inputs are sustainably available. Among major factors limiting the profitability of smallholder fish farming include labor for pond construction and management, fish feed and fingerlings (Hyuha *et al*., 2011). In the context of NFALRC intervention areas studied, low-cost pond construction, feed, and access to fish fingerlings need more emphasis in the business of small-scale fish farming.

Comparing outputs from some other studies, the benefit to cost ratio economic analysis study from the intervention areas is higher than that of Zambia (Thelma and Indaba, 2017), China (Phiril and Yuan, 2018), and Nigeria (Yemi and Deji, 2012) but lower than that of a study conducted in Oyo State, Nigeria, which is 1.69 (Ashley *et al*., 2017) and 1.9 (Tunde *et al*., 2015). Despite this, the economic analysis of small-scale fish farming studied in our pilot project areas does not provide a holistic picture of profitability at all times and in all places. This is because of contextual differences among varied implementation areas. For resource endowed farmers reduced cost of production factors and growing experience in fish farming implies more profitability than the number shown above. Thus, alternatives should be suggested for a higher benefit to cost ratios. For the sake of the researcher's confidence in stating overall profitability, more replicable and confirmatory studies are still needed across space and time.

#### 3.2.5. *Emphasizing towards awareness and attitudes of small-scale fish farming*

An assessment of the potentials and challenges of smallholder fish farming in the study areas shows that the awareness level of sample fish farmers on the practices was still low. This necessitated the

identification of fish farming practices that need more clarity to the farmers. A subsequent study conducted by Yared Mesfin *et al*., (2018) in one of the project sites, has also shown the same result, recommending on the improvement of farmers' understanding of pond dynamics and contribution of fish for nutrition security in multi-faceted ways. Still, knowledge and experiences gained by fish farmers, their overall awareness and attitude towards fish farming need to be assessed and documented.

### 3.2.6. *Participatory situation analysis before project start-up*

Before implementing projects related to smallholder fish farming, it is always necessary to start from a small number of farmers with detailed baseline data about the community, their problems, opportunities, and challenges in a participatory manner. One important lesson learned regarding appropriate site selection for smallholder fish farming intervention is about participatory situation analysis. In the pilot project areas, criteria used for selecting project sites were only, availability of land, water, labor, and farmers' willingness to implement new projects (Hiwot *et al*., 2016).

However, entry into fish farming not only demands farmers' willingness but also participation in the whole process of the activity i.e. from joint plans to implementation (Ejigu, 2004; Taha *et al*., 2004). But, unfortunately, this was not the approach used by NFALRC in the intervention areas. To circumvent upcoming challenges related to fish farming project implementation, it is, therefore, better to undertake detailed participatory situation analysis so that, project beneficiaries would have a sense of ownership and contribute to resolving day-to-day challenges on their own. Successful village-level fish farming interventions in many Asian countries followed a system of planning at grass root level which is part of a situation analysis and joint planning (Kumar, 1999).

### 3.2.7. *Key lessons learned from NFARLC's intervention experiences*

Summarizing all points mentioned in this review, key lessons learned were: Need for revisiting the conventional transfer of technology mode of extension followed by NFALRC and impacting the formal extension service delivery, gender consideration, economic viability of small-scale fish farming, awareness and attitude towards fish farming, redefining root challenges of small scale fish farming and application of participatory approaches to start small-scale fish farming. A framework showing the relationship between these lessons is illustrated below (Figure 2).

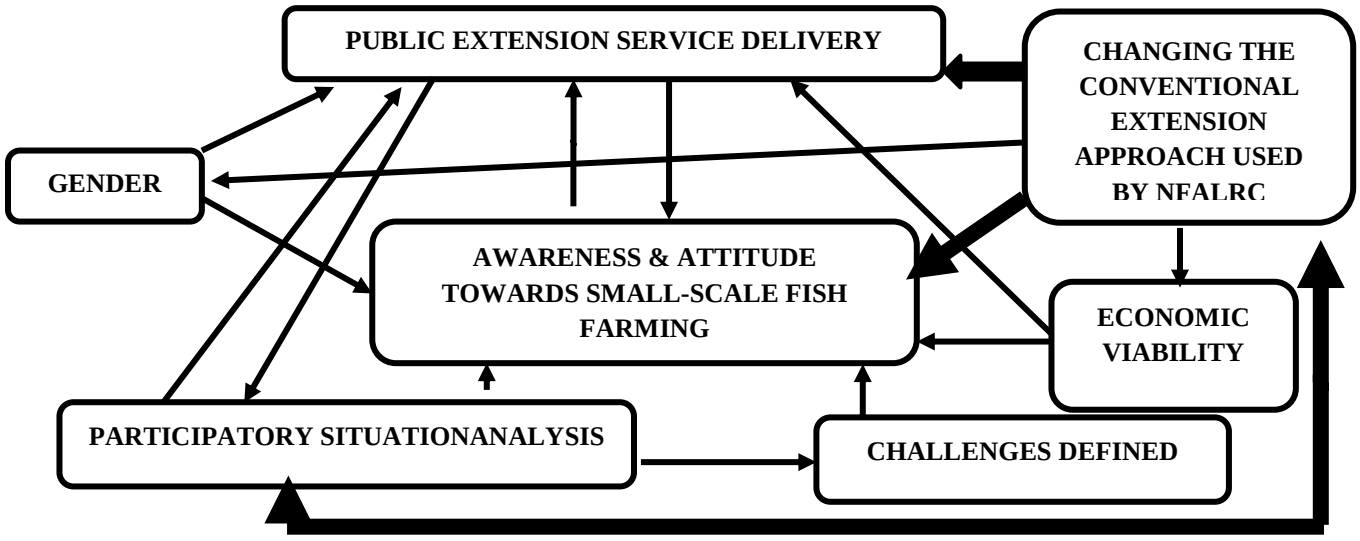


**Figure 2: Association of key lessons learnt**

## 4. Conclusion and Recommendations

The challenges of small-scale fish farming observed in the studied intervention areas are very complex and need a systemic intervention. A systemic intervention again needs redefinition of the challenges to identify their root cause. However, it is still possible to link some of the findings observed in the previous studies and design a framework to understand the lessons learned which might give a hint in finding solutions to those challenges. From the review, seven key lessons were learned and presented as a framework of concepts leading to a solution to those challenges as evaluated by the author. These lessons are entry points for future interventions in the study areas.

To come up with the challenges observed in the intervention areas, it is important to reconsider points cited in the framework of key lessons learned from small-scale fish farming in general and the three studies in particular. The framework of key lessons learned should be utilized as an input for a systemic intervention in small-scale fish farming of the study areas. For instance, points presented as a framework of key lessons learned and linked in bold line of Figure 2 could be used as entry points for systemic intervention. Among the key lessons, awareness creation on small-scale fish farming; use of participatory approaches, and a shift in the mode of extension service delivery by NFALRC should be given top priority for later interventions to the studied areas.

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**Conflict of Interest**

The authors declare that they have not sent this review article to any other journal for publication.

**Ethical Approval**

This Article does not contain any studies with animals performed by any of the authors.

## References

Abebe, C., and Mesay, Y. (2018). Economic analysis of fish farming in Wonchi and Illugelan districts of Oromia region, Ethiopia. Agricultural Economics Directorate, National Fisheries and Aquatic Life Research Center, Sebeta, Ethiopia. In press

Abebe, M., and Sileshi, A. (2015). *Tilapia aquaculture business model for Ethiopia: A feasibility study.* Retrieved from http://addischamber.com

Abelneh, Y., and Zenebe, T. (2017). Growth performance and economic viability of Nile Tilapia (*Oreochromis niloticus*), fed on formulated diets in concrete ponds. In: Fekede, F., Firew, K., Mesfin, D., and Gashaw, T. (eds.). *Proceedings of the 6th Annual National Review Workshop on Results of Livestock Research, December 2017, Ethiopian Institute of Agricultural Research, Addis Ababa, Ethiopia. pp. 235-246.*

Alayu, Y., Eshete, D., Spletthoff, P. (2015). *Business opportunities in the Ethiopian aquaculture subsector*. *Report No 10.* Retrieved from https://www.rvo.nl.

Ashley, D., S.S., Olaye, O.J. and Adelaja, O.A. (2017). Analysis of the profitability of small-scale fish farmers in Oyo State, Nigeria. *Malasian. Journal of. Animal. Science*. 20:11-24.

Athde, V., Nebiyuleul, G., Catherine, R., and Cristine, O. (2009).*Gender analysis of aquacuture value chain in North East Vietnam and Nigeria. Agriculture and Rural Development Discussion Paper.* Retrieved from https://openknowledge.worldbank.org

Befekadu, D., and Birhanu, N. (2000). *Annual Report on the Ethiopian Economy*. *Vol 1, Report No. 2.* Retrieved from https://www.semanticscholar.org

Belay, K. (2003). Agricultural Extension in Ethiopia: The Case of Participatory Demonstration and *Training* Extension System, *Journal of Social Development in Africa*. 18(1): 49-83.

Brugere, C. (2015). *Gender audit and recommendations for mainstreaming gender in the EAF Nansen Project. Report No.* Retrieved from http://www.fao.org

Brugere, C., and Williams, M. (2017). *Profile: Women in aquaculture*. Retrieved from

https://genderaquafish.org/portfolio/women-in-aquaculture/

Chalachew, A. (2010). Pond fish farming in practice: challenges and opportunities in the Amhara Region. In: Seyoum, M., and Brook L. (eds.). *Proceedings of the third National Conference on "Management of Shallow Water Bodies for Improved Productivity and Peoples' Livelihoods in Ethiopia." 20-21 February, the Ethiopian Fisheries and Aquatic Science Association (EFASA), Bahir Dar, Ethiopia, pp. 60-68.*

Daba, T., Alemayehu, A., and Megersa, E. (2010). Potential of integrated fish-poultry vegetable farming system in mitigating nutritional insecurity at small scale farmer's level in East Wollega, Oromia, Ethiopia. *International Journal of Fisheries and Aquaculture Studies*. 5: 377-382.

Das, J. and. Kahn, M.D.S. (2016). Women and aquaculture in Bangladesh: The unpaid labour. *Bangladesh Electronic Journal of Sociology*. 13: 115-125.

Davis, K., Swanson, B. Amudavi, D. Mekonen, D. Flohrs, A. Riese, J. Lamb, C., and Zerfu, E. (2010). *In-depth assessment of the public agricultural extension system of Ethiopia and recommendations for improvement. Discussion paper No 01041.* Retrieved From https://www.ifpri.org

Edwards, P. Demaine, H. 1998. *Rural Aquaculture: Overview and Framework for Country Reviews.* http://www.fao.org. Retrieved: November 1, 2021.

Ejigu, J. (2004). Farmer participatory research: experience from Farm Africa. In: Fasil, R., Hailu, D., Mohammed, H., and Adam, B. (eds.). *Proceeding of a Workshop on: Farmer Research Group (FRG): Concepts and Practices, Melkassa, 20-21, October, Melkassa Agricultural Research Center, Melkassa, Ethiopia. 41-50.*

Erke, A., Brehan, M., and Haimanot, M. (2020). *Assessment* of integrated aquaculture intervention system in Amhara Region, Ethiopia. *Ethiopian Journal of Economics*. 28(2): 1-27.

Food and *Agriculture* Organization and Ministry of Agriculture and Rural Development. (2009). *National Aquacuture Development Strategy of Ethiopia*. Retrieved from https://www.scribd.com/

Food and Agriculture Organization. (2017). Women's *empowerment in aquaculture: Two case studies from Indonesia.* Retrieved From https://fish.cgiar.org/

Hapke, H.M (2012). Capturing the complexities of globalization in fisheries: Gendered division of labour and difference. In: Williams M.J., Porter, M., Choo, P.S., Kusakabe, K., Vuki, V., Gopal, N. and Reantaso, M.B (eds.). *Proceeding of Papers from the 3rd Global Symposium on Gender in Aquacuture and Fisheries: Moving the Agenda Forward. Shanghai, 21-23, April, Shanghai Ocean University, Shanghhai, China*, pp. 75-92.

Hishamunda, N. (2007). Reseasons for failures and ingredients of success. In: Leung, P.S., Lee, C.S., and O'Bryen, P.J. (Eds.), *Species and System Selection for Sustainable Aquaculture*. New Jersey: Blackwell Publishing.

Hiwot, T., Kibru, T., and, Adamneh, D. (2016). Potentials and Challenges of Smallholder Fish Farming in Ethiopia: The Case of South West and West Showa Zones, Oromia, Ethiopia. *Journal of Science and Sustainable Development*, 4: 53-60.

Hyuha, S.T., Bukenya, O.J, Twinamasiko, J., and Molnar, J. (2011). Profitability analysis of small scale aquaculture in central Uganda. *International Journal of Fishery and Aquaculture*, 2:15

Kruijssen, F., and McDougall, C.L. (2018). Gender and aquaculture value chains: A review of key issues and implications for research. *Journal of Aquaculture*. 2017: 1-10.

Kapembua, T.N., and Sambako, P. (2017). *Assessing the profitability of small-scale aquaculture fish production in Zambia.* Working Paper No. 123. Retrieved from http://pubs.iclarm.net/

Koudijs, 2019. *Koudijs Feed for Tilapia and Catfish*. Retrieved from https://www.koudijs.com.

Kumar, D. (1999). *Trickle down system (TDS) of aquaculture extension for rural development.* Report No. 1999/23. Retrieved from https://www.fao.org/

Lekang, O.I. (2013). *Aquaculture Engineering*. Hoboken, NJ: Blackwell Publishing.

Luomba, J.O. (2013). Role and place of women in aquaculture: A case study of Ukerewe District, Tanzania. *International. Journal of. Aquaculture*. 3: 101-104.

Maaruf, H.T., and Akbay, C. (2020). Economic Analysis of Fish Farming in Northern Region of Iraq. *Journal of Agriculture and Natural Resource Sciences*. 23(5): 1257-1269.

NFALRC (2010. *Ethiopian Institute of Agricultural research (EIAR): National Fisheries and Aquatic Life Research Center, Center Profile*. Retrieved from http://197.156.72.153>xmlui>bitstream>handle

Pablo, S., Precious, G., Kevin, S., and Alexander, L. (2008). *HIV/AIDS, Climate change and disaster management: Challenges for Institutions in Malawi. Working paper No. 4634*.Retrieved from https://openknowledge.worldbank.org

Phiril, F., and Yuan, X. (2018). Economic profitability of Tilapia production in Malawi and China. *Journal of Aquaculture Research and Development.* 9(5): 1-7.

Qudus, M.A., Jui, N.Z. Rahman, K.M.M., and Rahman, M. (2017). Gender Role in Pond Fish Culture in Terms of Decision Making and Nutrition Security. *Bangladesh Journal of Agricultural Economics*. 38(1): 55-71.

Rothius, A., Duijn, A.P.V., Dejen, E., Kamstra, A. Pijl, W.V.D. Rurangwa, E., and Stokkers, R. (2012). *Business opportunities for aquaculture in Ethiopia*. The Hague: Wageningen UR.

Taha, M., Hailu, D., and Mengistu, N. (2004). Overview of the existing research and extension system of ATARC. In: Fasil Reda, Hailu Dadi, Mohammed Hassan and Adam Bekele (Eds.). *Proceeding of a Workshop on: Farmer Research Group (FRG): Concepts and Practices, Melkassa, 20-21, October, Melkassa Agricultural Research Center, Melkassa, Ethiopia. pp. 101-110.*

Tena, A. (2021). Awareness of community on fishery and aquaculture production in central Ethiopia. *HSOA Journal of Fisheries and Aquaculture*. 6(1): 1-8.

Thelma, N.K. and S.P. Indaba. (2017). *Assessing the* profitability *of small-scale aquaculture fish production in Zambia.* Report No. 123. Retrieved From https://pdf.usaid.gov/

Tunde, A.B., Kuton, M.P., Oladipo, A.A., and Olasunkanmi, L.H. (2015). .Economic analyze of costs and return of fish farming in saki- east local government area of Oyo State. Nigeria. *Journal of. Aquaculture Research and. Development.* 6:2.

Yared M., Abebe C., Mesay, Y., and Getnet, W. (2018). Awareness and attitude of farmers towards aquaculture. The case of Wonchi Woreda, Oromia, Ethiopia. In press.

Yared, M., Mesay, Y., and Abebe, C. (2018). Challenges for small-scale fish farming in South West and West Shewa Zones of Oromia. In: Fekede B., Firew, K., Gashaw, T., and Mesfin, D. (eds.).*Proceedings of the 7th Annual National Review Workshop on Results of Livestock Research, Holeta Agricultural Research Center, Holetta, Ethiopia. pp. 319-331.*

Yared, T., Fasil, D., Aschalew, L., and Gashaw, T. (2011). Development of small-scale fish farming for livelihood diversification in North Shewa zone, Amhara regional state. In: Brook L. and Abebe G. (Eds). *Proceeding of the third Annual Conference on "Impacts of Climate Change and Population on Tropical Aquatic Resources", 3-6 February, Haramaya University, Haramaya, Ethiopia. pp. 67-83.*

Yemi, A.S., and Deji, A. (2012). *Measuring Profitability in Small-scale Aquaculture Enterprises in South West Nigeria. IIFET, 2012*. Retrieved from https://ir.library.oregonstate.edu/