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Pre-scaling up of integrated fish-poultry-horticulture-production system in east Wollega zone and Buno Bedele zone, Oromia region, Ethiopia

Addisu Hailu, Alemayehu Abebe, Daba Tuge and Megersa Endebu
Oromia Agricultural Research Institute, Batu Fish and Other Aquatic Life Research Center, Batu, Ethiopia

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Abstract
Integrated poultry-fish-horticulture farming system is rarely practiced in Ethiopia but potential method of food production to mitigate problems facing vulnerable farmers in the country. The current research activities were aimed to pre-scaling up and test the feasibility of the integrated farming system in East Wollega and Buno Badele Zone of Oromia region at a small-scale farmers level. The farm was implemented at selected site based on basic research information. Productivity of the farm was compared against productivity reported in the basic research and the farmers practice. Potential to produce diversified food and generate income at small scale farmers' level was evaluated. Productivity of the three components was found to be comparable to or better than the productivity obtained at basic research and farmers practice. Moreover, diversified products were produced on small area at a lower input cost in sustainable base. The local community accepted the practice as a technology. Government and other stakeholders have to support extension of the practice at applicable areas. Since the integrated technology have positive feedback from farmers we recommend to Livestock and Fishery Offices at district and zonal level in collaboration with other stakeholder should work on the wider scaling up of this technology.

Keywords: Fish, poultry, vegetable, waste recycle, east Wollega, Buno Bedele

1. Introduction

1.1 Background and Justification

Fish raised in semi-intensive, freshwater systems provide the major proportion of farmed, global production (FAO, 1995) [11]. Global fish production peaked at about 171 million tonnes in 2016, with aquaculture representing 47 percent of the total and 53 percent if non-food uses (including reduction to fishmeal and fish oil) are excluded. The African aquaculture production has only contributed less than 2 million tonnes, around 2.5 percent of the global aquaculture (98.7% from inland aquaculture and 1.3% from marine and coastal aquaculture (excluding aquatic plants). The per capita aquaculture production (excluding aquatic plants) in Africa is still inferior the global standards with the highest figure in northern Africa was 5.3 kg/capita, 0.5 - 1.0 kg/capita in western and southern Africa with the minimum figure 0.2 kg/capita in middle

Fish production is mainly by wild capture of tilapia (Oreochromis niloticus), followed by catfish (Clarias. gariepinus), Nile perch (*Lates niloticus*) and Barbus species. The total fish production potential is estimated to be 51,481tonnes/year. Of these, approximately, 50% of this is currently exploited annually. Stock depletion in some lakes has been reported. The demand for fish has increased recently. The total expected demand for fish in 2025 is estimated to be 118,000 tonnes, which is greater than the capture production potential. This calls for an increased focus on stocking and enhancement of water bodies based on sound genetic principles and development of aquaculture to produce fish to meet future demand (Gopalakrishnan, 2019) [13].

Fish-poultry-horticulture integrated productions plays an important role in the diet of the people of developing nations. When fish farm integrated with other agricultural sectors it diversifies farmers' income, create job opportunity, contributes for household food security and meeting future diets like protein, carbohydrate, vitamins and minerals demand. Integrated horticulture-fish production system is maximizing productivity and economic efficiency of smallholders' fish farmers through enhancing the productivity per acreage of land where fish production remained as the most important activity (Mukherjee, 1995) [16].

This type of integration can increase overall production intensity and economies on land, labor and water requirements for poultry, fish and horticulture. For example, one hectare of static water fish ponds can 'process' the wastes of up to 1500 poultry, producing fish in quantities of up to 10 MT/ha without other feeds or fertilizers. Also, since effluents are few, environmental impacts are minimal. The importance of poultry wastes in aquaculture is relatively recent. In areas of traditional fish culture, ruminant and pig manure have predominated as pond fertilizers in some part of the country. Poultry manure was not used to any extent probably because small flock size and extensive management precluded collection. Vertical integration of the poultry industry by agribusiness has been stimulated by the biology and widespread acceptability of poultry, particularly chickens. Global trends in livestock production indicate that poultry, particularly layer and broiler chickens, are increasing faster than any other (FAO, 1989, 1990, 1991, 1993) [7-10].

Poultry production wastes have inherent qualities that make them particularly valuable for fish production compared to other livestock wastes. The small individual size of poultry also allows their confinement and production directly over fish ponds that implementing production boosting waste recycling technology which replaces fish feed and chemical fertilizer for fish ponds and vegetables. Most published data concern integration of fish culture with modern poultry systems which are typically inappropriate for resource-poor farmers. Village or backyard poultry systems predominate in areas where modern breeds and systems are absent, or co-exist in competition with them. Recent research indicates that integration of such poultry

and backyard fish culture can also bring benefits at little extra cost. Farmers in Oromia regional state practiced extensive fish farming in small ponds using Nile tilapia since 2008 and fish farms were interested but not supported with a package to attain the potential production level (Tugie, 2010) [19].

One of the many major constraints of fish farming in Ethiopia is feed supply whereas many farmers rearing depending on grazing native pasture and use crop residues, animals like cattle, sheep, poultry, goat and equines (Endabu *et al.*, 2016) [6]. Integrated pond management with poultry, fish and vegetables was proofed to be excellent approach for sustainable production, income generation and employment opportunity of the resource poor rural households (Alam *et al.*, 2009) [2]. As previous study confirmed that fish integration farming system is profitable, it needs to more demonstrate as one strategy that can be adopted by small farmers in the country to increase farm returns from per unit area of land (Lemma, 2017) [15]. Therefore, this integrated farming was conducted for further scaling up at East Wollega and Buno Bedele Zone.

1.2 Objective

- To scaling up integrated Fish-poultry-horticulture farming systems in the study area.
- To create awareness and enhance knowledge of farmers in integrated farm technologies
- To enhance better linkage with Farmers, Researcher, Development Agent and others stakeholder.

2. Materials and Methods

2.1 Descriptions of the study area

The pre-scale up of integrated Fish-poultry-horticulture farming systems were conducted in Wayou Tuka district ofEast Wollega zone and Chora district of Buno Badele Zone of Oromia Region, Ethiopia. Wayou Tuka district is 298 km far from the capital Addis Ababa to the West on the way to Nekemt, situated in Farmers' Training Center (FTC) of Warababo Migna peasant association at 902'N and 36040'E, at an altitude of 1910 m.a.s.l. The area is categorized in to mid altitude (locally known as Badda daree) agro-ecology, receiving bi-modal type of rainfall with main rain from June to August. Production system of the area is mixed agriculture where the farmers produce field crops such as maize, wheat, barley and rear livestock such as cattle, goat, sheep and chicken all in traditional methods (data at local district offices).

Buno Badale Zone is one of Oromia Regional States that newly established since 2009 E.C. This area is under Ilu Aba Bora Zone before the area is categorized in two Zones. The large number of populations in the area is engaged in Agriculture as primary economic sector. In addition to this cash crop coffee take a large proportion in the local market. The activity was conducted in Chora Districts Tulu Mute Peasant Association. The area is 12km far from Chora Districts asphalt road in the direction of Ilu Aba Bora Zone and 28km far from Badele Town. Chora district found at 8 23'N and 36 07'E, at an altitude of 2,000 m.a.s.l (CDBOA, 2018). The farming system of Chora district was characterized by mixed farming system, comprising both cropping and livestock production. It is mostly known for its vegetation coverage, suitability for coffee, crop livestock and bee production (CSA.2015) [4].

2.2 Site selection for the technology

The major factors considered in site selection were availability of year-round water with the quality required by fish (optimum temperature and pH), site suitability for pond construction, horticulture and poultry management and accessibility of the site for majority of farmers to share knowledge for the communities. After checking the site to qualify the required criteria for the technology, discussions were made with government officials, community administrative, experts and farmers.

In East Wollega Zone the site within Farmers Training Center (FTC) was selected for the technology transfer based on the interest of local community to learn the management of integrated fish-poultry-horticulture farming. In other case from Buno Bedele Zone, Tulu Mute Passant Association was selected for the technology transfer based on the interest of local community to learn the management of integrated fish-poultry-horticulture farming. As the technology is aimed to solve nutritional insecurity, the selected site was accessible for women, vulnerable households, youth and other local societies to easily learn the technology.

2.3 Fish pond construction and fish production

The three farming components, fish, poultry and vegetable were conducted in integration simultaneously by communities' participation. To establish the integrated farm one rectangular shaped earthen pond was constructed in each selected research areas with water inlet, outlet and overflow was excavated on a gentle slope land near to water source to secure the permanent water supply through gravity flow. The pond has an area of $150m^2$ (15m X 10m) and $225m^2$ (15m X 15m) in East Wollega Zone and Buno Bedele Zone, respectively.

In both research site before stocking the pond with the fishes, the bottom and the walls of the pond was treated with lime to kill potentially harmful microorganisms especially parasites. The lime also helps to increase the alkaline reserve in water and mud which prevents extreme changes in pH, neutralizes the harmful action of certain substances like sulfides and acids and promote biological productivity. Two weeks after liming, the pond was filled with water from the irrigation system via the supply canal. Poultry house in each the integration were also stocked with pullets.

A total of 290 fish's fingerlings Stocked in East Wollega Zone and a total of 463 was stocked in Buno Bedele zone with three fish species (Oreochromis niloticus, *Cyprinus carpio* and Claries gariepinus) were collected from Batu Fishery and other Aquatic Life Research Center and Koka reservoir using beach seine hauls and stocked in to the pond under integration. In East Wollega Zone the fishes were composed of 240 O. niloticus, 18 *C. carpio* and 32 *C. gariepinus* fingerlings.

In other case in Buno Bedele Zone the fishes were composed of 315 Oreochromis niloticus (68.03% stocking density), 120 *Cyprinus carpio* (25.92% stocking density) and 28 Clariesgariepinus (6.05% stocking density). Tilapias were considered as the major product in the fish component of the integration whereby mixed sex tilapias of the best performing Chamo among the local strains were used in these pre-scaling activities. The fishes were managed properly by exchanging water regularly, removing impurities, protecting fish from predators and maintaining inlet and outlet pipes up to the end of harvesting period.

2.4 Poultry house construction and production

Poultry farming is one of the three major components of the integration. Poultry house construction is one of the main activities for establishing this integrated farm. In both research areas the house having an area of 4 m X 3 m ($12\ m^2$), partitioned into two classes were constructed using locally prepared raw materials. The first class, half part of the house, 4 m X 1.50 m, was open to air enclosed by mesh wire around the poles and hanging over the pond while the second half part with

sealed wall footing on the ground (Figure 1). The hanging class was used for the poultry to stay during day time where they eat and drink from hanged feeders and watering containers. Bottom of this class supporting the chicken was covered by stronger mesh wire protecting chicken against predators and competitors, allows poultry droppings passing down to the underneath pond water.

The second class of the house footing on the ground serves for resting, night time stay and has nests for egg laying. In this integrated farm 30 pullets of Lohmann Brown breed were purchased from a commercial poultry producing company called Alema and stocked into the house and managed according to the company's recommendation. Commercial feed was provided to the chicken depending on their age, 80-110 g pullets feed per day for 9-20 weeks pullet and 110-120 g layers feed per day for the layers above 20 weeks of age. All management including regular provision of feed and water, egg collection and health care were accomplished according to the recommendation of the company.

Fig 1: Poultry house construction and fish production in East Wollega and Buno Bedele Zone

2.5 Vegetable production

Horticulture is the third component of the integrated farm. The plot selected for onion plantation was unfortunately degraded fallow plot. An area of 260m^{2}and 150m^{2}were cleared, ploughed. And prepared for plantation in East Wollega and Buno Badele zone respectively. Before transplanting the seedlings of vegetable to the site, the plots were flood irrigated twice by water coming out of the fish pond in order to enhance the fertility of the plot. Onion (*Allium cepa*) variety called "Adama red" was used in the integration based on its higher market demand, higher yielding performance and better adaptation to the site was planted at wayu Tuka East Wollega Zone. Whereas improved varieties of onion, cabbage and Tomato were planted at Chora district of Buno Bedele Zone with size of 5x10 m for each crop.

Seedlings of the onion, cabbage and tomato were transplanted to the plot according to the local farmers' practice, with the recommended spacing. However, chemical fertilizers were not applied to the vegetable at all. Instead, the vegetable plots were irrigated regularly every 5-7 days by the fertile water coming out of the fish pond under the integration. Weed removing and hoeing and all agronomic practice were carried out every 2 weeks at earlier stages and by observing the weed appearance and intensity in later age.

Management of the integrated farm (poultry, fish and horticulture) were carried out by selected individuals from the local farmers after they received training on the component management. Local farmers participated in pond preparation; poultry house construction, land preparation for horticulture, and also attended the theoretical trainings. Besides, farmers attended fish harvesting practice and food preparation from fish on the final demonstration at both selected site.

2.6 Method of data collection

Both primary and secondary data were collected. The primary data was collected from the research site during the implementation of the technology. In addition to this, the primary data was collected by oral interview and product record sheet. The secondary data was collected from agricultural offices, related research results, books, journals and CSA.

2.7 Method of data analysis

Both qualitative and quantitative methods of data analysis were used. The qualitative data were presented by organized Tables and narrations. The quantitative data were analyzed by using appropriate descriptive statistics like mean and percentages. Financial analysis was also carried out. Data generated from the various sources were presented as tables, figures or graphs.

Fish data for the parameters such as fish growth rate and survival rate (%) are calculated from initial number and weight (g) of stocked fishes, and final number and live-weight (g) of fish using the following formulas.

$$Daily\ Growth\ Rate\ (DGR\ g/day) = \frac{Final\ weight\ (g) - initial\ weight\ (g)}{Expermental\ Days}$$

$$Survival\ Rate\ (\%) = \frac{(Number\ of\ harvested\ fish)}{Number\ of\ stocked\ fish} x100$$

The survival rate of the O. niloticus, *C. carpio* and *C. gariepinus* was analyzed from the date of stocking to harvesting, during 381 culturing period at Wayou Tuka district East Wollega and 305 Chora district of Buno Badele Zone.

3. Results and Discussions

3.1 Training

Fish-poultry-horticulture integrated farming looks a simple and applicable candidate technology in all potential areas. Initially, awareness was created to the local farmers on the benefit and use of the integrated farming system. Training (Figure 2) was given to the beneficiary farmers, Experts and Development Agents on the technology before its implementation in both research areas. The farmers then attended and participated in every activity of the farm during the component preparation; pond, poultry house andhorticulture plot preparations. The integrated farm became the communal property of the beneficiary farmers where they learn the practice in the farming system and use the products for their own consumption and sell but keep every record as data. Besides training FREG member, DAs and experts participated on regular pre-scaling up of Fish-Poultry-Horticulture farming system

Fig 2: Training on fish-poultry-horticulture farming system at Wayou Tuka and Chora districts

The training covered for the total of 111 farmers, 16 development agents (DAs) and 21 fishery experts from selected districts in East Wollega zone and Buno Bedele Zone on current status of fishery production with special focus to aquaculture development, criteria to be considered during site selection for aquaculture, pond design and construction, poultry house and vegetable land preparation, fish and pond management. In addition to this, trainings were given on how to harvest fish from pond, and how to process gutted and filleted fish and how to prepare food from fish in the form of soup, fried and boiled fish. Extension agent and participant fishermen disseminate information shared from training to non-participant fishermen. Participatory training method was followed during implementation of training program for sharing knowledge's, skills and experience on integrated farm.

Generally, subsequent trainings were given for the beneficiaries at each stage of production starting from the farm preparation up to the harvest and consumption of the products.

Table 1: Training participants on integrated fish-poultry-horticulture farming system

Year G.C	Site	Farmers		Development Agent		Experts		Total
		Male	Female	Male	Female	Male	Female	
2016-2017	Wayou Tuka District of East Wollega Zone	40	18	6	2	4	0	70
2017-2018	Chora District of Buno Badele Zone	44	9	6	2	15	2	78
Total		84	27	12	4	19	2	148

Source: Own results, 2016-2018/19.

3.2 Field day

Field day was jointly organized in collaboration with Zone and Districts level Livestock and Fishery offices. Farmers, experts and development Agents participated on field day to create opportunities for stakeholders to see and learn from the demonstration promotions and evaluation the performance of technology and to get farmers feedback for better improvement. In two research site a total of 249 participants participated on field day. At each site one FREG having a members from 12-18 farmers and a total of two FREGs were established to popularize the technology.

Table 2: Participants of mini field day in four years

Year	Site	Farmers	*Das*	Experts	Researcher	Total participant
2015	Wayu Tuka district of East Wollega	49	*2*	8	2	61
2018	Chora district of Buno Badele	112	*20*	53	3	188
Total		161	22	61	5	249

Source: Own results, 2016-2018/19.

Brief explanation was given for the participants at each site on the objective of integrated farming system. Members of FREGs and non FREG members participated and evaluated the technology during the study periods. On the field work Fishermen, Administrators, Researchers, Experts, Development Agents and other stakeholders were invited to give feedbacks. All participants gave a positive response about the technology at each site.

Fig 3: participants on Filed day at Wayu Tuka and Chora districts

3.3 Fish Production

In both research areas there were three fish species, the Nile tilapia (Oreochromis niloticus), African catfish (Clarias gariepinus) and common carp (*Cyprinus carpio*) stocked into one pond as a poly culture under the integration system. In Wayu Tuka district the number at stocking were 240 tilapia, 32 catfish and 18 carps into a pond area of 150m^2 making a total fish density of 1.93fish/m2. The sizes of the fish at stocking were 29.13g, 44.69g and 53.86g for the tilapia, catfish and carp, respectively (Table 3). At Chora district of Buno Badele Zone the number at stocking were 315 tilapia, 120 catfish and 28 carps into a pond area of 225m^2 making a total fish density of 2.06fish/m^2. The sizes of the fish at stocking were 8.5g, 7.95g and 28.3g for the tilapia, catfish and carp, respectively (Table 3). In pond there is no supplementary feed was provided to the fish under integration throughout the culturing period. The fish was feeding upon the planktons and other organisms harbored in the integrated pond by the aid of poultry waste (Endabu *et al.*, 2016) [6]. Waste recycling in the integration system was the nobel idea concept. Poultry waste is either eaten directly by fish or fertilizes pond water to support the plankton community used by fish as natural organic feed (Endabu *et al.*, 2016) [6]. Nutrient

rich water from fish pond is used to grow horticulture being an organic fertilizer (Hirpo, 2017) [14] and by-products from horticulture and fish offal being used as poultry feed to complete the loop in recycling.

At the end of the trial in 381 days, the Nile Tilapia - attained a mean body weight of 275.3 with mean daily growth rate of (DGR) 0.65g.day-1 in case of Wayu Tuka district. While in case of Chora district at the end of 305 days average body weight and daily growth rate (DGR) were 176.61g and 0.55g/day, respectively (Table 3). Different results on tilapia growth performance were reported by many authors. Negisho *et al*. [10] reported DGR of 0.57±0.01g with supplementary feed, which was less than the present study. In our current trial, the fish were depending on the recycling waste in the integration with minimal cost without providing any supplementary feed and chemical fertilizer. The fish growth rate in this trial (0.65g/day) and (0.55g/day) is close to the previous result of DGR 0.75g.d-1 reported by Endebu, *et al*. (2016) in the integrated ponds.

C. gariepinus and *C. carpio* attained mean body weight of 1283.6 with DGR of 3.25g/d and 1305.7 with DGR of 4.01g/d in 381 days, respectively. Whereas at Chora district *C. gariepinus* and *C. carpio* attained mean body weight of 552 with DGR of 1.62g/d and 389.6g with DGR of 1.25g/d in 305 days, respectively. The DGR of 4.01g/d attained by *C. carpio* in this trial was relatively on a better level compared to the 1.7g/d reported by Endebu *et al*. (2016) [6] in fish-poultry integrated farm. The difference was attributed perhaps due to higher initial weight and longer culture period in the current trial. The current result recorded for the DGR of carp is comparable with 4.04g.d-1 reported by Abdelghany and Ahmad (2002) [1]. Integration of poultry with fish farm enhances plankton's production and productivity in the ponds for the fish feed thereby increased fish productivity in ponds. Supplementary feed was not provided for the fishes cultured in the pond integrated with poultry throughout the culture period. The fishes used the phytoplankton, zooplankton, direct feeding of poultry manure and spilled off poultry feed. The survival rates of the fishes, O. niloticus, *C. gariepinus* and *C. carpio* were 98.75%, 100% and 72.22%, respectively in case of Wayu Tuka district. Whereas in case of Chora district survival rates of the fishes, O. niloticus, *C. gariepinus* and *C. carpio* were 95.24, 92.85 and 96.67, respectively. Generally, a total of 123 and 112.5 kg fish were produced in the trial pond during the culture period at calculated yield rate of 8 and 12.84 tonnes of fish per hector per year in case of Wayu Tuka and Chora districts, respectively. The contribution of fish as a protein source in securing nutritional balance of small-scale farmers is valued.

Table 3: Summary of fish data in the integration at selected site

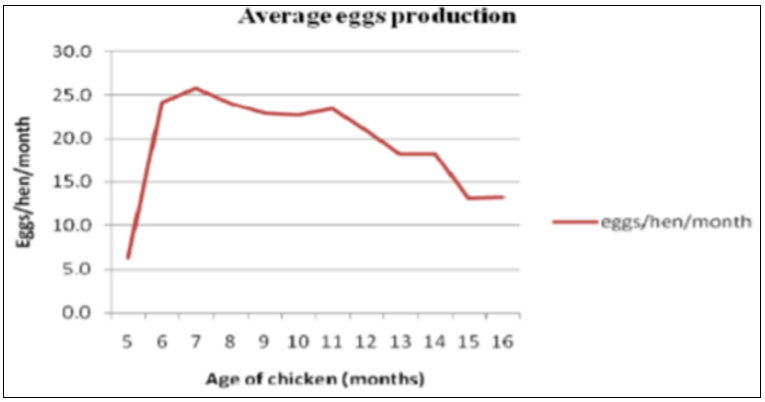
Wayu Tuka district of East Wollega Zone				
Parameters	**O. niloticus (N. Tilapia)**	***C. gariepinus* (African catfish)**	***C. carpio* (Common Carp)**	**Total**
Number stocked	240	32	18	290
Average weight at stocking (g/fish)	29.13	44.69	53.86	32.38
Culture period	381	381	312	-
Average weight at harvest (g/fish)	275.3	1283.6	1305.7	-
DGR ($g.d^{-1}$)	0.65	3.25	4.01	-
Number harvested	237	32	13	282
Survival rate (%)	98.75	100	72.2	97.2
Actual Yield/pond/culture periods (kg/pond)	65.25	41.08	16.97	123
Converted yield/ha/yr (kg)	4,167	2,623	1,323	8,113
Chora district of Buno Badele Zone				
Number stocked	315	28	120	463
Average weight at stocking (g/fish)	8.5	28.3	7.95	-
Culture period	305	305	305	-
Average weight at harvest (g/fish)	176.61	552	389.6	-
DGR ($g.d^{-1}$)	0.55	1.62	1.25	-
Number harvested	300	26	116	442
Survival rate (%)	95.24	92.85	96.67	95.46
Actual Yield/pond/culture periods(kg)	52.98	14.35	45.19	112.52
Converted yield/ha/yr (kg)	2817.88	7619.13	2403.54	12840.55

Source: Own computation from data results, 2016-2018/19.

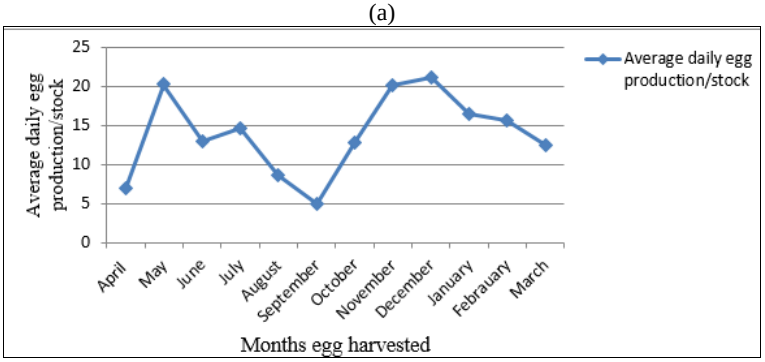
3.4 Egg production

The Lohmann brown pullets in the integrated farm started laying eggs two months after stocking in June 2016, at age of 22 weeks at Wayu Tuka district. After the egg production reached the peak in August 2016, it gradually decreased associated with age factor (Fig. 4a). This result was similar to the result reported by (Hirpo, 2017) [14]. The production of egg decreases in later ages and becomes uneconomical after chickens reach the age of 18 months due to change in their physiology. Some irregularities and decline in egg production observed when the chicken was fed with homemade cracked grains during shortage of commercial feed supply. Availability of commercial feed for poultry at rural areas was limited that the government has to support feed producers to avail the feed at all areas demanding the feed. Generally, 7,005 eggs were collected from the 30 layers in 12 months (Fig. 4a). The collected eggs were sold by the beneficiary farmers to the local people at price rate of 2.75 Birr per egg. The contribution of eggs as a protein source for the local people and the income from the selling to the beneficiary farmers are also valued. In case of Chora district Lohmann brown pullets in the integrated farm started laying eggs after eleven week after stocking in January 2018. As indicated Figure 4b, the production of egg fluctuation was observed when the chicken was fed different source of commercial feed. Commercial feed supplied by Genesis L.P.C so poor compared to Alema poultry fed supplier. During August and September 2018 egg production were decreased due to usage of homemade cracked grains as a chicken fed during those months due to budget shortage to purchase of commercial feed supply. Generally, 2,811 eggs were collected from the 30 layers in 12 months (Figure 4b). The

collected eggs were sold by the beneficiary farmers to the local people at price rate of 3.78 ETB per egg at Chora district.



(a)



(b)

Source: Own compution from data results, 2016-2018/19

Fig 3(a, b): Average egg production per hen per month in the integration far

3.5 Vegetable production

Adama red onion (Allium cepa) was grown in the plot (260m^2) and obtain 281kg from plot, estimated to 10,800kg/ha when extrapolated to hectare base at Wayu Tuka district. The obtained yield was ranked to a better production level when compared to the yield obtained using chemical fertilizers in some previous trials in Ethiopia (Desaleng and Aklilu, 2003) [5] In case of Chora district Adama red onion, tomato and cabbage were grown in the plot of each (50m^2) and yield obtained were 52, 29.5 and 10 kg, respectively. When converted to hectare yield obtained from onion, tomato and cabbage were 10,400, 5,900 and 2,000 kg respectively.

The advantage of having horticulture component in the integration can be seen as alternative way of vegetable production for home consumption and also as a source of income, minimizing input cost and environmental pollution. The vegetable crops yield were obtained by using waste water from fish pond without purchasing the chemical fertilizer, which minimized input cost in the production system. The system also minimized environmental pollution caused by waste from poultry farm and fish pond, rather recycled the waste to produce food.

3.6 Partial budget analysis

Simple calculation was made to know the economic feasibility of the integrated farm comparing input costs against outputs in money value. Labor costs were estimated depending on local wage payment to workers. The poultry house and fish pond construction works were done by beneficiary farmers while they participate in all stages of the technology implementation, but the value was estimated in terms of money (Table 4). Depreciation values of the poultry house and fish pond were considered in production costs. The products from the integration were used for local consumption after they were estimated in terms of money. Revenue generated from the selling of eggs, fish and Vegetable (Table 4) was used. The hens and equipment's were also estimated for their current value in terms of money at the end of the trial for financial analysis.

As depicted in Table 4, integrated farming system, the total estimated cost of production in the fish, poultry and vegetable components were 2,470ETB, 14,030ETB and 1,290ETB, respectively with a total estimated production cost of 17,794ETB at Wayu Tuka district. The revenue obtained from all harvested fish was estimated to 7,050ETB while the revenue generated from poultry and onion production was 21,483.75 and 2,240ETB, respectively. A total of 30,774 ETB was generated as revenue. The profit obtained from the three components sum up to 12,984 ETB per season (Table 3).

Table 4: Partial economic analysis of fish, egg and onion production in Wayou Tuka district of East Wollega Zone

Fish			
Production cost	**Amount(ETB)**	**Revenue generated from fish**	**Amount(ETB))**
Fingerling purchase (variable)	870	Fish selling 25-birr x282	7,050
Estimated labor cost	600		
Annual fishing net depreciation	300		
Annual pond depreciation cost	400		
Opportunity cost of land (rent)	300		
Total cost in fish component	2470	Total profit (revenue-cost)	4,580

Poultry			
Production cost	**Amount(ETB)**	**Revenue generate from poultry**	**Amount(ETB)**
Pullets purchasing	2700	Revenue from egg production	19,263.75
Poultry feed purchase	8000	Estimated value of poultry at the end of the research	2,100
Poultry feeders and equipment's	480	Estimated value of equipment's	120
Estimated labor cost	1800	Total revenue from poultry	21,483.75
Poultry house depreciation cost	800		
opportunity cost of land(rent)	250		
Total cost in poultry	14,030	Total profit (revenue-cost)	7453.75
Vegetable			
Production cost	**Amount(ETB)**	**Revenue generated**	**Amount(ETB))**
Estimated cost for land preparation, weeding	600	Selling of onion (280*8ETB)	2,240
Purchased of onion seedling	400		
Purchased of pesticide	90		
Opportunity cost of land	200		
Total cost for vegetable production	1290	Profit from this component	950
Total cost of production	17790	Total revenue	30,774
Total profit in the system			12,984

Source: own computation from data, 2015-2018/19.

Similarly, in Buno Badele Zone, Chora district, Tulu Mute Peasant Association the economic feasibility of the integrated farm was calculated by comparing input costs against outputs in money value. The total estimated cost of production in the fish, poultry and vegetable components was 3,676ETB, 16,650ETB and 1,350ETB, respectively with a total estimated production cost of 21,376ETB. The revenue obtained from all harvested fish was estimated to 11,794ETB while the revenue generated from poultry and vegetable production was 18,245.58 and 1,422.5ETB, respectively. A total of 42,228ETB was generated as revenue. The highest profit was obtained from fish and egg production. The profit obtained from the three components sum up to 20,392 ETB (Table 5).

Table 5: Partial budget analysis of fish, egg and vegetable production in Chora district of Buno Badele Zone

Fish			
Production cost	**Amount (ETB)**	**Revenue generated from fish**	**Amount(ETB)**
Fingerling purchase (variable)	926	Fish selling 35-birr x442	22,100
Estimated labor cost	1000	Total profit (revenue-cost)	11,794
Annual fishing net depreciation	700		
Annual pond depreciation cost	700		
Opportunity cost of land	300		
Total cost in fish component	3676		
Poultry			
Production cost	**Amount(ETB)**	**Revenue generate from poultry**	**Amount(ETB)**
Pullets purchasing	3150	Revenue from egg production	10,625.58
Poultry feed purchase	10,000	Estimated value of poultry at the end of the research	7500
Poultry feeders and equipment's	500	Estimated value of equipment's	120
Estimated labor cost	2000	Total revenue from poultry	18,245.58
Poultry house depreciation	1000	Total profit (revenue-cost)	1,595.58
Opportunity cost of land	250		
Total cost in poultry	16,900		
Vegetable			
Production cost	**Amount(ETB))**	**Revenue generated**	**Amount(ETB))**
Estimated cost for land preparation, weeding and harvesting	350	Selling of vegetable(onion, tomato and cabbage respectively) (52*15+29.5*15+10*20ETB)	1,422.5
Purchased of seed vegetable	400		
Purchased of pesticide	300		
Opportunity cost of land	300		
Total cost for vegetable production	1350	Profit in vegetable	72.5
Total cost	21,376	Total Revenue	42,228
Total profit from the system			20,392

Source: Own computation from data results, 2017-2018/19

In both research areas total land area occupied by the integration system was less than 500m^2 (0.05ha). This plot, according to information from the local farmers on their practice, can yield 250-500kg maize per year, which is estimated to a total amount in money of 1250-2,500ETB at current price. Though the farmers do not consider the labor of land preparation, cultivation, weeding and harvesting as a cost, it can be estimated to 1200ETB to produce maize in the plot. The profit farmers expect from that small plot of land according to their traditional practice do not exceed 1,300ETB per year under conducive weather conditions. This traditional way of production is efficient (about 52% return on their initial investment) but produce little product per unit area and risky as it depends on natural rain.

The integration of fish, poultry and horticulture farming is also promising technology to generate income for household on a small plot of land having access to water source. The technology was finally demonstrated to the local community and government officials at different administrative levels. The beneficiary farmers, local communities and administrative

bodies understood the benefits of the integrated farming system in terms of its sustainability, contribution to income generation, poverty reduction, easiness of the farm to be managed by women, children, handicapped and old people. It was finally accepted as a technology to be scale out in all potential areas.

3.7 Farmers' feedback

Among 25 farmers respondents interviewed at Wa you Tuka district 96%, 92%, 72%, 72% and 88% had respond that integrated farm is effective due to need low cost, good for income generation and food security, time effective, easily managed and implemented and allow to utilize land and wastes efficiently, respectively(Table 6). In case of Chora district from total 22 farmers interviewed 54.55%, 90.91%, 68.18%, 45.45% and 95.45% had respond that integrated farm is effective due to need low cost, good for income generation and food security, time effective, easily managed and implemented and allow to utilize land and wastes efficiently, respectively.

Table 6: Farmers feedback on the technology

Parameter	East Wollega (N = 25)			Buno Bedele (N = 22)		
	Item	Frequency	Percentage	Item	Frequency	Percentage
Low cost for establishment	Yes	24	96	Yes	12	54.55
	No	1	4	No	10	45.45
Good for income generation and food security	Yes	23	92	Yes	20	90.91
	No	2	8	No	2	9.10
Time effective	Yes	18	72	Yes	15	68.18
	No	7	28	No	7	31.82
Easily managed and implemented	Yes	21	72	Yes	10	45.45
	No	4	16	No	12	54.55
Efficiently utilized Land and wastes	Yes	22	88	Yes	21	95.45
	No	3	12	No	1	4.55

Source: Own results, 2015-2018/19.

In general, the result of assessment feedback revealed that integrated technology was highly preferred by farmers in the study area as the technology is not complicated, use locally available raw material and easy to implement. After pre-scaling up, the wider scaling up/out activities will be owned and huddled by respective Zones and districts office of livestock development in collaboration with different key actors in the area with close supervision by Batu Fish and Other Aquatic Life Research center.

4. Conclusions and Recommendations

In the integrated poultry-fish-vegetable farming system, waste from one component is used as input for the other component in the system to produce income and food for people. The system worked at the around the same site with all the components (poultry, fish and vegetable) delivering the expected products at lower costs of inputs on relatively small plot of land as compared to the traditional farming system. Products obtained from the integration diversified the farmers' that help to generate income and used for consumption. Moreover, the system is cost effective and efficient enough to make money at small scale farmers' level on relatively small plot of land. The technology is also a very good resilience approach to produce sustainable food for victimized farmers of climate change in areas having access to water sources.

As the fish culture in general and the integration system in particular is new practice in Ethiopia, attention should be given by local administrative bodies, regional and federal governments and concerned institutions to extend the technology into potential areas. Generally, since integrated farm technology have positive feedback from farmers and economically feasible in the study area, we recommend to Livestock and fishery offices at Districts and Zonal level in collaboration with other stakeholder should work on the wider scaling up of this technology.

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