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Integrated Fish - Poultry- Horticulture – Forage and Fattening Production System at Godino, Ada'a District, East Shoa Zone

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Abstract

Integrated fish-poultry-horticulture-fattening and forage farming is based on the concept that 'there is no waste', and waste is only a misplaced resource which can become a valuable material for the production of other products. A study was made to assess the production performance of the system in Ada'a district, East shoa zone.Chicken started to laying eggs at 20 weeks of age with the mean egg production of 76.7percent per day. Fingerlings of *Oreochromisniloticus* stocked in the pond and reached table size with an average weight of 226 gram within six months. Vegetable yields obtained from Potato, Gurage cabbage and Ball-headcabbagewere36,666; 5,500and 28,333 kg ha^{-1}respectively.Forage varieties of *Medicago sativa*, *Pennisetumpedicellatum* and *Pennisetum purpureum* were planted on the top of the dike for fattening of bulls.The study confirmed that the technologyis highly profitable and needs to be promoted as one of the strategies that can be adopted by small holder farmers of the country to increase farm returns per unit area of land.

Keywords: Fattening, forage, fish, horticultures, poultry and poultry litter

Introduction

Providing adequate food for a rapidly increasing human population is one of the greatest challenges in the world. The problem is particularly acute in countries like Ethiopia where, besides population explosion, natural and man-made calamities have aggravated the problem. In addition to increasing food production from agricultural land, it is necessary to sustainably exploit the aquatic ecosystems. By virtue of their high productivity these ecosystems can highly contribute towards the effort of food security. Ethiopia's fish resources could undoubtedly offer one of the solutions to the problem of food shortage in the country.

The ecological diversity and climatic variation of the country is to a large extent explained by its highly variable topography. These altitude extremes imply that Ethiopia is a country of enormous habitat diversity. Ethiopia, with its different geological formations and climatic conditions, is endowed with considerable water resources and wetland ecosystems, including river basins, major lakes, many swamps, floodplains and man-made reservoirs. Hence, thewater bodies support a diverse aquatic life including more than 200 fishspecies (Redeat, 2012). In reality, however, all these capitalized potentials and praises ended in vain contributing little to the well being of the country. While, capture fisheries is very common in most parts of the country, as a result fish production is highly exploited as the resource has been an open access. To alleviate this problem aquaculture technology must be an option that needs to be intensified.

Aquaculture is a part of agriculture, which deals with rearing of aquatic organisms, plants and animals including fish under controlled condition. Fish culture can be integrated with livestock and agronomy, especially vegetables using waste from one production as an input for the other and enabling the production of organic products. Pond management with fish, poultry and vegetables proved to be an excellent approach for sustainable production, income generation and employment opportunities for the resource poor rural households (Lemma, 2013). Addition of organic fertilizers like poultry litter to a fish pond, that is integrating poultry farm with fish, increases the water nutrients for better production of fish by resolving the problem of fish feed faced in aquaculture.

Currently, there is a need to find a suitable agricultural system to meet the increasing demand for food, and also maximizing the utilization of available limited resources without much wastage. In integrated farming system, waste from one component is used as an input for the next component. In this case, waste from poultry is used to fertilize the fish pond substituting feed supplements for the fish, and also improve the nutrient content of the water which is used to irrigate the horticulture during the water exchange. Hence, based on the potential advantages of such integration technology, a research was conducted to find a better approach of fish pond culture that can be practiced among farmers as a strategy for poverty reduction, ensuring nutritional security and diversifying income. The general objective of the activity was therefore, to maximize aquaculture-agriculture production on the same piece of land by way of creating synergistic interactions among different components.

Materials and Methods

Description of the study area

The activity was conducted in Ada'a district of Esatshoa zone Oromia region. The district is located in the Great Rift Valley and bordered on the south by Dugda Bora district, on the west by the West Shoa Zone, on the northwest by Akaki, on the northeast by Gimbichu district, and on the east by Lume district. The district has an altitude ranging from 1500 to 2250 meters above sea level (CSA, 2005). The minimum and maximum temperaturesare13^{0}C and 25^{0}C respectively (DZARC, 2017 unpublished data). The farming system of the district is characterized by mixed agricultural production system. Irrigationis mainly practiced with the main water source from “Wodecha” river.

Site and farmer selection

A number of formal and informal discussions were conducted with the beneficiaries, development agents and local government officials to select site and farmers. Various factors were considered in selecting farmers. Some of these factors were attention to physical factors, including environmental conditions of the farm area (availability of continuous source of water, water quality, soil types, weather condition, etc.), adaptability of commercial fish species and different horticultural crops to the area, existence of beef and poultry breeds, availability of local materials/inputs for the integration and market accessibility.

Design of the integration

Design of the integrated farming system is described in figure 1.

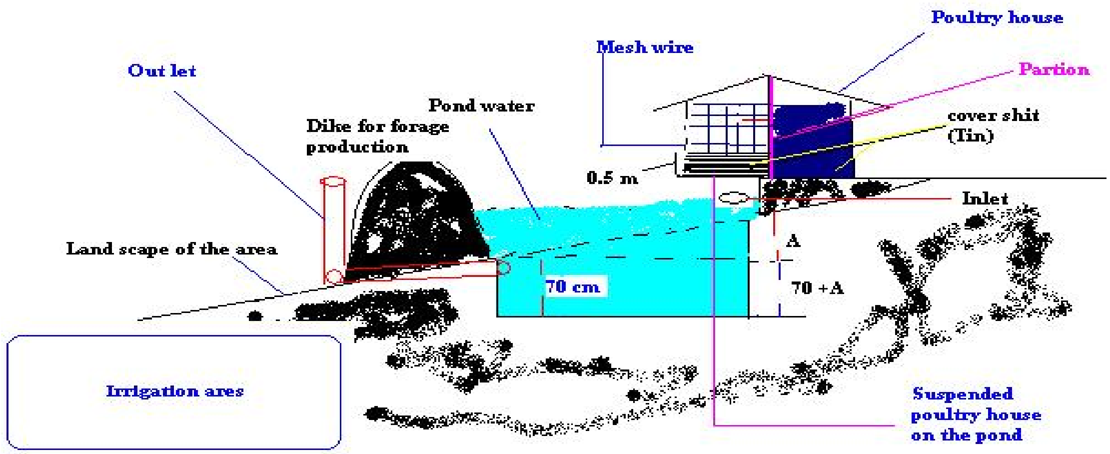

Figure 1: Design of the integrated farming system

Poultry house construction and production

Poultry house was constructed from locally available materials after the fish pond was excavated. Walls of the house were built from eucalyptus wood and plastered by mud (Fig 2).The roof of poultry house was covered by iron sheet. The house had two compartments. The first half of the house which is 1.5 m X 6 m lying on ground and used for a nighttime resting place for the chicken and also used as a place to lay egg (Fig.2b). The second half of the house with area 1.5 m X 6 m is open to air and light, hanging over part of the fish pond and used as feeding and drinking place for the chicken during day time (Fig.2a). This part of the house lying over the pond is covered by mesh wire to protect chickens from different predators.

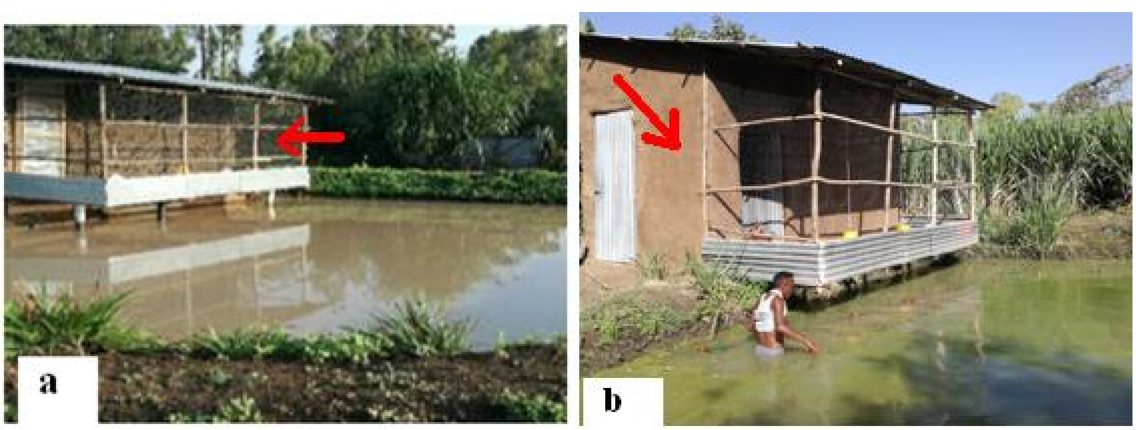

Figure 2:Constructed poultry house used for feeding and drinking during day time (a)used as a place to lay egg (b)

After the house was constructed, 30 Rhode Island Red (RIR) breed of poultry with three months of age were purchased and stocked in to the house part which is suspended on the top of the pond for egg production. The chicken are also used for the production of litter as the main feed for fish in the pond and as fertilizer for horticulture when the water is exchanged.Information on the volume of poultry litter per animal and the relation between fish and litter load is available. For this relation the reference of Hopkins and Cruz (1982) was used.

As a management, the chickens were fed with an adlib amount of commercial feed purchased from animal feed processing company in Bishoftu town. Grower phase for the chicken ranged from 9 to 20 weeks whereas the Layer phase was greater than 20 weeks. Health inspection was monitored daily throughout the experimental periods. The chicken started laying eggs at the age of 5 months. The eggs were collected every day, stored for sell, and used for household consumption in the family. Finally, aged hens were sold for meat at the local market.

Fish pond construction and production

Earthen pond of 99 m^2 surface area with 1.5 m depth and 5% slope was constructed (Fig.3). The pond was stocked with 500*Oreochromisniloticus*fingerlings with stocking density of five specimens/m^2. Sizes of the stocked fingerlings were ranged from 5-6 cm total length (TL) and 3-4 g total weight (TW). The fish were grown in pond under integration farming system with the necessary management practices (environmental monitoring as well as health inspection) for six months. The litter coming out from the poultry house and dropped in to the pond are diluted with water and used as fed for the fish. The fish also used natural feed like phytoplankton and zooplankton from the pond. Finally, those fish that reached table size were harvested and used for home consumption and supplied for market as income generation for the farmer.

Figure 3: Fish pond construction under poultry house

Horticultures production

Horticulture production activities were carried out a week after the fish and poultry were stocked. This was for the enhancement of nutrient in the pond for the production of horticulture that is directly integrated with the system. The horticulture species were Potato (*Solanum tuberosum*), Gurage cabbage and Ball-head cabbage (*Brassica oleraceavar. capitata)*.The horticulture verities were selected based on market demand, earliness of maturity and high yield performance in the area.

Procedurally the land was cleared, ploughed and then prepared for planting the horticulture at different phases on the total area of600 $m^2$for each crop. The horticultural crops were grown by water coming out of the fish pond and without adding any additional fertilizer. Management of the horticultural crops throughout the experimental period was done according to the earlier recommendations for each crop. Finally, the horticultural crops were harvested and made ready for local market and for home consumption. The remaining by-products of the crops were also used as feed for beef production.

Forage and beef production

The livestock feed Alfaalfa (*Medicago sativa*), Desho(*Pennisetum pedicellatum)* and Napier or Elephant grass (*Pennisetum purpureum)*) were planted at the edge(Dike) of the pond. The livestock feeds were also selected based on their adaption and yield performance in around t he study area. Other managerial activities of the forages were conducted throughout their growing period (up to harvesting).

One cross breed bull (Holstein Frisian crossed with local breed) with an age of four years (Fig.4) was purchased from the surrounding local market and treated for external and internal parasites with Accarcide and Albendazole, respectively.

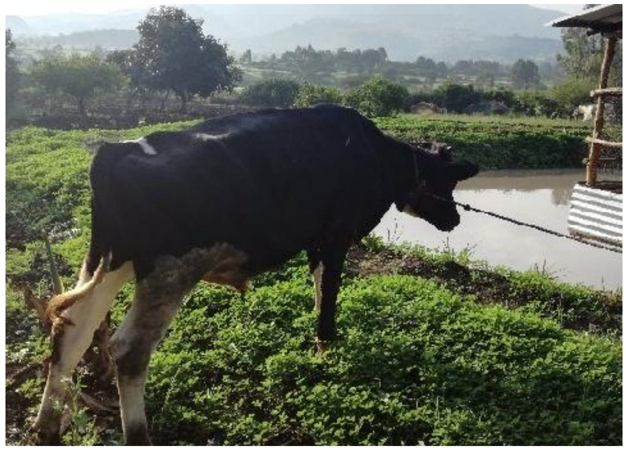

Figure 4: Crossbreed bull that integrated with the system

A preliminary feeding period of 21 days was given to allow the bull adjust to the environment followed by 90 days of fattening period. The feed resources used were from the forages planted around the dike and from by-products from the horticultures. The feeds were provided adlib.

Cost of production

Major cost items incurred on poultry, fish, horticulture, forage and beef in the integrated farming system are described in Table 1.

Table 1. List of items for integrated farming system

Items	**Integrated components**				
	Poultry	**Fish**	**Horticulture**	**Forage**	**Beef**
Fixed cost	House Construction Feeding trough Watering trough	Pond Construction Fishing gear	Land	-	Feeding and watering trough
Variable Costs	Chicken (Layer) Feeds Vaccines Labour Transport	Fingerlings Lime Labour Transport	Seeds Labour Pesticides Transport	Seeds Labour	Bull Medicament

Fixed costs: Fixed costs in the component of integrated farming system consists of those costs incurred for the construction of poultry house and fish pond, land, feeding and watering troughs as well as fishing gears as described in Table 1.

Variable costs: Variable costs were incurred for the purchase of animals, feeds, labour payment and other inputs, etc. (Table 1). Since, small-scale farmers employ only family labour for production activities cost of labour did not form an important variable cost. Transport costs were other variable costs which can be quite high if the producer lives far away from the input suppliers and the market where his products could be sold. However, this was not the case in the study area due to its proximity to the market in Bishoftu town. While feed is the major variable cost item in pond culture alone, this was not the case in the integrated system as there were no supplementary feeding for fish except poultry.

Data analysis

Fish growth performance was expressed in terms of daily growth rate using length - weight data taken monthly during the experimental period. The fish growth performance was presented in graphs. Fish, egg, horticulture, forage and fattening production data were analyzed using EXCEL and presented using tables.

Results and Discussion

Egg production

With the aim of improving poultry productivity, Rhode Island Red breed was imported to Ethiopia since 1950's (Haftu, 2016).A total of 30 pullets of 90 days of age were purchased and stocked from the local market. In the system chicken started laying eggs at the age of 20 weeks. On average a hen was laid 23eggs (76.7%) per month.

The study showed that egg laying becomes uneconomical after the chickens reach the age of 15 months (Fig.5). The production was decreased due to the physiological change of the hen.

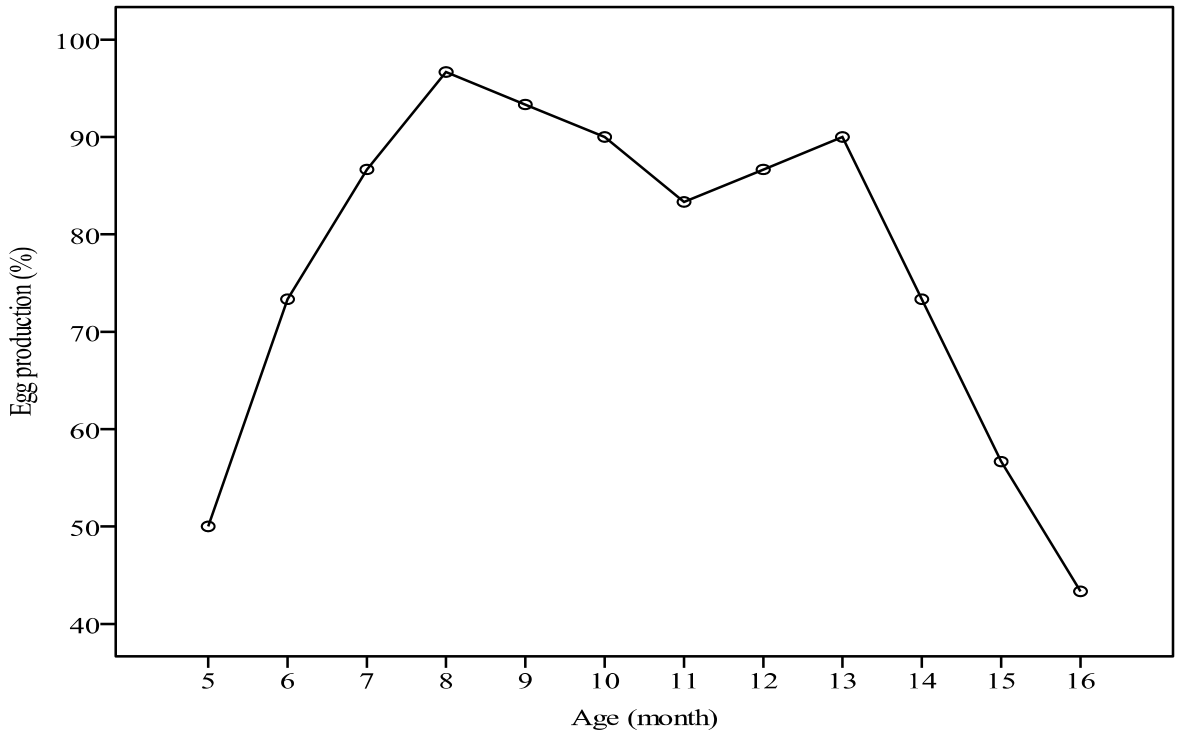

Figure 5: Trends of egg production in relation to age of the chicken

Chemical composition of the poultry litter was nutrient-rich and used as input/feed for fish production in aquaculture especially in integrated farming system with agriculture and aquaculture. The amount of poultry litter which was dropped to the fish pond contains more calcium and phosphorous which is also used for the production of horticulture as layers produce more excreta (Lemma, 2013).

Fish production

In this study, fish production totally depended on the recycling waste in the integration without the need for providing any supplementary feed. Initially 500 fingerlings of *O.niloticus* with a total initial weight that ranges from3-4gram were stoked. Finally the fish attained weight ranging from 110 to 305 gram, with an average of 226 gram within six months (Table 2 and Figure 6).

Table 2.Summary of fish growth performance

Initial weight range (in gram)	Final weight range (in gram)	Average weight (in gram)	Fish Daily Growth Rate (in gram)
3 - 4	110 - 305	226	0.71

The mean daily growth rate was 0.71 gram which is comparable with the work of Daba, *et al*., 2017); Negisho *et al.*, (2017),and Megerssa, *et.al*., 2016).

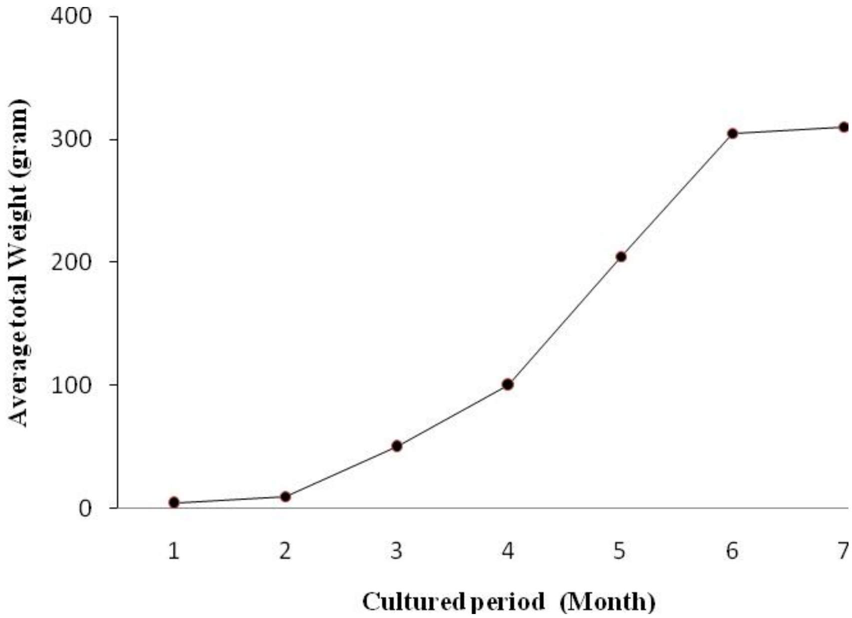

Figure 6: Average growth performance of *Oreochromis niloticus* in the system

On the other hand, the growth performance of the fish in this study was faster than the fish culture with in a pond only that reached table size in more than six months. Poultry litter has short digestive tract, 80% of chicken manure represents undigested feedstuffs (Chen, 1989).The litter was also used as fertilizer with the aim of promoting pond productivity of phytoplankton and zooplankton. In integrated poultry-fish farming, the protein rich chicken dropping was made available to the fish either directly or indirectly via the primary producers in the aquatic food web (Oladosu *et al*., 1990), which in most cases reflects the productive capacity of the ponds. It also contains non-digested feed metabolic excretory products and residues resulting in microbial synthesis which can be utilized to replace reasonable parts of feed stuff used in conventional fish production cost (Falayi, 1998; Fashakin *et al.*, 2002).

Horticultures production

The yield obtained from Potato, Gurage cabbage and Ball- head cabbage were 2200, 330 and 1700 kg /600 m^2 respectively(Table 3).The yield obtained from Potato, Gurage Cabbage and Ball- head cabbage that integrated with fish werealso separately analyzed and swap over to the yield per hectare. Productivity of potato in this activity was 36,666 kg ha^{-1} (Table 3), which was higher than the national productivity of 7.2 ton ha^{-1}(Bereke, 1994).Production of Gurage Cabbage was 5,500 kg per hectare (Table 3), and the production of cabbage in this study was much higher than the production in previous studies 4400 kg ha^{-1} (Megerssa Endabu *et al*, 2016)and 2210 kg ha^{-1}(Lemma, 2013).

Table3.Yield of different variety of horticulture

Type of Vegetable	Plot area (in m^2)	Estimated yield (in kg)	Estimated yield (in kg ha^{-1})	Sale (in Eth. Birr)
Potato	600	2200	36,666	11,000
Gurage Cabbage	600	330	5,500	4,455
Ball- head cabbage	600	1700	28,333	5,950

The total yield of28,333kg ha^{-1} obtained from Ball-head cabbage was less than the production of 33,800 kg ha^{-1}in previous studies (Demoz, 2016).

Forage and fattening production

All forages were grown on the top of the dike with the moisture that they get from the pond. The dry matter yield of the forages (*M.sativa, P.pedicellatum* and *P.purpureum*)summarized in the Table 4.

Table 4. Yield of different variety of forage

Type of forage	**Plot area (m^2)**	**Estimated yield (kg)**	**Estimated yield (kg ha^{-1})**
Medicago sativa	152	120	14,000
Pennisetum pedicellatum	152	141,36	9,300
Pennisetum purpureum	37.5	82.5	22,000

In general, in Ethiopia low productivity of livestock is mainly because of poor feed quality (FAO, 2010).To combat the livestock feed shortage, the use of indigenous forage plants as a feed source is recommended. The total production of *M. sativa* harvested for hay by cutting at 6 cm height at first flowering stage (Fig.7a) and the total production performance was about 14 ton/hectare dry matter per year from seven cuts. *Pennisetum pedicellatum* was harvested on 3 months after planting, that the grass reached about one meter high and yields was 22 tones (dry matter) per hectare per year (Table4).

Figure 7: *Medicago sativa* (a), *Pennisetum pedicellatum*(b) and *Pennisetum Purpureum*(c) on the top of the dike

Pennisetum pedicellatum grass is also serves for land rehabilitation around the pond dike in addition as fodder for fattening in the integration (Figure7b). *Pennisetum purpureum* was a fast growing; deeply rooted perennial grass that grows up 3.5 meters tall in the study area (Figure 7c). The grass is an important fodder plant in the cut-and-carry system for fattening in the area. The grass also takes many nutrients from the soil (Lukuyu *et al*., 2007).The dry matter yield of *M. sativa*, *P. pedicellatum* and *P. purpureum* were 14,000, 9,300 and 22,000 kg ha^{-1} respectively. Forage production from the integration and the byproducts of the horticulture were used as feed for beef production and the farmer can get huge profit without adding any other cost for supplementary feed (Table 5).

Partial budget analysis

The products from the integrated farms were sold to local market and also consumed at home by the family members. The monetary values of consumed products were also estimated to obtain the estimated the profitability of the farms as a source of income. Production cost and revenue generated from the products are presented in Table5.

Table 5. Summary of partial budget analysis of fish - poultry - fattening - horticulture and forage production in the study area

Parameters	**Production cost (in birr)**	**Revenue**		**Profit (Birr)**
			Amount (in birr)	
Fish production				
Fingerling purchase	250			
Estimated labor cost	150			
Fishing net depreciation	200			
Pond depreciation cost	300			
Total	**900**	Fish selling (120 birr/kg x 88.3Kg)	**10,596**	**9,696**
Poultry (egg) production				
Pullets purchasing	3600	Revenue from egg production(25*30*12 *3.5)	31,500	
Poultry feed purchase	13,800	Estimated value of poultry at the end of the trial(Cull out hen)	4,500	
Poultry feeders & equipment	750	Estimated value of equipment	350	
Estimated labor cost	4,800			
Poultry house depreciation	600			
Total	**23,550**		**36,350**	**12,800**
Horticulture production				
1. Land preparation, weeding, harvestingetc for potato	1,140	Selling of potato	11,000	
Purchase of potato seed	600			
Total	**1,740**		**11,000**	**9,260**
2. Land preparation, weeding, harvestinggetc for Gurage Cabbage	900	Selling of Gurage Cabbage	4,455	
Purchase of Gurage Cabbage seedling	500			
Total cost	1,400		4,455	3,055
3. Land preparation, weeding, harvestingetc for Ball- head cabbage	1,050	Selling of Ball- head cabbage	5,950	
Purchase of Gurage Ball- head cabbage seedling	800			
Total	**1,850**		**5,950**	**4,100**
Over whole cost for horticulture	**4,990**		**21,405**	**16,415**
Forage production				
Medicago sativa	350	Includes seed production	3000	
Pennisetum pedicellatum	150		2500	
Pennisetum purpureum	100		1000	
Total	**600**		**7500**	**6900**
Fattening				
Bull purchase	4,000	Selling of bull	11,000	
Estimated labor cost	1,000			
Total	**5,000**		**11,000**	**6,000**
Total cost of the whole integrated farming system				
For the whole integration	**35,040**	From the whole integration	**86,851**	**51,811**

The total farm area occupied for the whole integration system was used 1040.5 m^2 (around 0.1 hectares). The total estimated costs of fish, poultry, horticultures, forage production and for fattening were 900; 23,550; 4,990,600 and 5,000 Birr, respectively. The revenue obtained from the harvested fish, poultry, from harvested all horticultural crops, forage and from fattening were 10,596; 36,350; 21,405; 7500 and 11,000 Birr, respectively (Table 5). In general, the total cost that required to establish the farming system was 35,040 Birr and revenue generated from the system was 86,851 Birr and the total profit was 51,811 Birr (Table 5).

From the survey conducted in the study area, the farmer didn't get more than 5,000 Birr profit from the traditional farming practice and before the technology was introduced. The huge difference in the profit was due to the fact that, in the integrated system, thewaste from one commodity was used as an input for the other. Results in this study concur with the previous study undertaken using integration of three commodities, namely fish, horticulture and poultry (Lemma Abera, 2013 and Daba Tugie, *et al*., 2017)

Conclusion and Recommendations

Integrated fish farming system entails increasing the productivity of water, land and associated resources while contributing to increased fish production. This maximizes land utilization within a specific area, as it also utilizes land which would have otherwise been idle. It also makes one system of farming to benefit from the other. Fish convert plant and animal waste into high quality protein and simultaneously enrich pond mud for use as fertilizer on horticulture land.

From the study, it was concluded that the integration of different commodities (Fish, poultry, fattening, horticulture, and forage) results in the use of a waste from one component as an input for the next part so that and the farming system could be an economical and viable one for improvement of the livelihood of smallholder farmers. Hence, the technology recommended that it further promoted as it was found to be one of the strategies that can be adopted by small holder farmers of the country to increase farm returns from per unit area of land.

References

Bereke Tsehai (1994). The utilization of True Potato Seed (TPS) as an alternative method of potato production. Ph.D. Thesis, School of Graduate Studies of Wageningen University, Wageningen.

Chen F. (1989). Chicken Farming in integrated fish farming Regional Aquaculture, Centre

Wuxi China. NACA Technical Manual. 11: 4-30.

Daba Tugie, Alemayew Abebe and Megerssa Endebu(2017). Potential of integrated fish-poultry-vegetable farming system in mitigating nutritional insecurity at small scale farmer's level in East Wollega, Oromia, Ethiopia, *Int. J Fish. and Aq. Studies*. 2017; 5(4): 377-382.

FAO (Food and Agriculture Organization) (2010). Food and Agriculture Organization of the United Nations. Rome, Italy.

Haftu Kebede (2016).Exotic Chicken Status, Production Performance and Constraints in Ethiopia: A Review. *Asian Journal of Poultry Science, 10: 30-39*.

Hopkins, K. and. Cruz E., (1982).The ICLARM-CLSU, integrated animal-fish farming project: final report. Vol. ICLARM Technical Reports 5. Freshwater Aquaculture Center-central Luzon State University and International Centre for Living Aquatic Resources Management, Nueva Ecija, Philippines. 96 p.

Lemma Abera (2013). Integrated poultry, Fish and horticulture In: *Trends in the conservation and utilization of Aquatic resources of the Ethiopian Rift valley*, paper presented at the 5th Annual Conference of the Ethiopian Fisheries and Aquatic Sciences Association (EFASA), Hawassa, Editors: Brook Lemma, Seyoum Mengistou, Elias Dadebo (EFASA) Editor), Zenebe Tadesse and Tadesse Fetahi 178-204.pp.

Lukuyu, M., Romney, D., Ouma, R. and Sones, K. (2007). Feeding dairy cattle: A manual for smallholder dairy farmers and extension workers in East Africa. SDP/KDDP, Nairobi,Kenya. 62 pp.

Megerssa Endabu, Daba Tugie and Tokuma Nagisho (2016).Fish growth performance in ponds integrated with poultry farm and fertilized with goat manure: a case in Ethiopian Rift Valley, *Int. J Fishery Sc. & Aqua*. 3(2):040-045.

Oladosu G., Ayinla O., Onuoha G., Mecdom J.(1990).Performance of *Clarias gariepinus* in a polyculture with *Orechromis niloticus* under the integrated broiler chicken fish farming. NIOMR Technical/paper. p. 65.

Redeat Habteselassie (2012) Fishes of Ethiopia, Annotated Checklist with Pictorial Identification Guide.250pp.

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