



Pre-Extension Demonstration of Integrated-Aquaculture (Fish-Chicken-Vegetable) at Arbegona and Gedeb Woredas, Southern Ethiopia

Mekonen Debara*, Merkine Bekele, Bereket Haji

Agricultural Technology Transferring and Communication Research Directorate, Southern Agricultural Research Institute, Hawassa, Ethiopia

Email address:

mekonendebara@gmail.com (M. Debara)

*Corresponding author

To cite this article:

Mekonen Debara, Merkine Bekele, Bereket Haji. Pre-Extension Demonstration of Integrated-Aquaculture (Fish-Chicken-Vegetable) at Arbegona and Gedeb Woredas, Southern Ethiopia. *Research & Development*. Vol. 2, No. 4, 2021, pp. 97-102.

doi: 10.11648/j.rd.20210204.13

Received: October 16, 2021; **Accepted:** November 18, 2021; **Published:** November 24, 2021

Abstract: Aquaculture is the production of aquatic organisms mainly fish, under controlled environment. Integrated aquaculture is one type of aquaculture by which it is integrated with other agricultural activities mainly, crop production and Livestock rearing. This demonstration work was done at Arbegona district of Sidama region and Gedeb district of Gedeo Zone, Southern Ethiopia from June 2017 to December 2020 to demonstrate the practice of integrated aquaculture using 6 farmer ponds and 2 farmers training centres, FTCs) ponds. The area of the fish ponds was 100m². Nile tilapia seed with average stocking density of 10g were stocked in to ponds with a stocking density of 3 fish per square meter. Thirty Koek koek dual purposes Chicken were used to fertilize each fish pond. Two types of vegetables (Head cabbage and Carrot) were produced using fish pond water and pure river water. Data on final fish yield, egg production and vegetable yield were collected and cost profit analysis was done to compare and show the advantage of integrated aquaculture production over non-integrated aquaculture production. Farm visit was conducted during harvesting stage of the fish, vegetable and chicken using participant and neighboring farmers around the demonstration site. Farmers' perception was collected from participant farmers. The quantitative data on yield, cost profit analysis and farmers perception collectively showed that integrated aquaculture production is better than non-integrated aquaculture production in overall farm yield and profitability. Based on this demonstration result, it can be concluded that integrated aquaculture should be practiced in other districts of Sidama region and Gedeo Zone to improve farm productivity around farmers' garden.

Keywords: Integrated-Aquaculture, Sidama Region, Gedeo Zone, Ethiopia

1. Introduction

Aquaculture is the production of aquatic organisms, mainly fish.

Integrated aquaculture is one type of aquaculture by which fish farming is integrated with other agricultural activities mainly crop production and Livestock rearing.

Lack of nutrients is one of the major problems in traditional aquaculture and this nutrient shortage can be improved with integrated aquaculture practice [2, 3]. Integrated aquaculture mainly focuses on utilization of waste material released from one type of agricultural activity as an input for the other agricultural activity. For instance,

livestock waste material especially, Chicken manure can be used as fish pond fertilizer [6, 1], and fish ponds waste, which is waste water, is used as a source of fertilizer for crop production. The average fish production obtained from integrated aquaculture is higher than the fish production obtained from traditional aquaculture due to the livestock manure fertilization accelerates the fish growth and yield [2, 11, 12]. The water released from fish ponds contains nutrients required by plants like nitrogen excreted from the fish. This water can be used as source of nutrient for crop production mainly, vegetables. Thus, it is possible to integrate fish, livestock and vegetable production by using the poultry manure as fertilizer for fish ponds and fertile

water from the fish ponds as a source of nutrient for vegetable production so as to reduce the overall input cost of agricultural production and to diversify agricultural products. Among the commonly reared livestock, chicken is mostly selected for integrated aquaculture due to its advantages mainly chicken litter is used as both fish pond fertilizer and fish feed as well as it has relatively high nutrient composition than other livestock manures [16, 5].

Integrated aquaculture has various advantages like reduce food insecurity, improves nutritional balance of household farmers, used for additional income generation, used to recycle nutrients, diversify agricultural products and it has no adverse effect on environment [7, 4, 23, 18-21, 10, 15].

Integrated aquaculture is widely practiced in many countries [17, 9, 13]. However, it is found at a very low level in Ethiopia as compared to other agricultural activities. This is also true in the study area of this demonstration work. However, there is suitable environment (soil type, climate and water source) in these areas. The most important factors inhibiting aquaculture development in Southern Ethiopia are lack of constant water source, high cost of feed, stunted growth of tilapia and lack of knowledge around farmers. Farmers who have water source and produce vegetables around their home are also enforced to use fertilizers or other organic manure to improve their crop yield. These farmers can produce fish simultaneously using the available water around their garden and can practice integrated aquaculture. Moreover, in Sidama and Southern regions of Ethiopia, the population density per unit area of land is high and then farming land is decreasing from time to time. To overcome this problem, diversifying agricultural activities which needs small area of land like integrated aquaculture is necessary especially, for farmers with small land and have good water source around their garden. Different works verified the

advantages of integrated aquaculture in Ethiopia and thus it needs to be widely practiced throughout the country [11, 3, 14, 8, 12, 22]. Therefore, this pre-extension demonstration work was aimed to demonstrate the benefit of integrated aquaculture production by using chicken litter as fish pond fertilizer and fertilized fish pond water as nutrient source for vegetable production.

2. Materials and Methods

2.1. Site and Farmer Selection

This demonstration work was done at Arbegona district of Sidama region and Gedeb district of Gedeo Zone, Southern Ethiopia from June 2017 to December 2020. Information was given to woreda heads and experts concerning the practice of integrated aquaculture. Farmers' selection was done together with the district experts based on the required criteria basically, availability of fish ponds, availability of land for vegetable production, availability of good water source for the fish ponds and farmer interest. A total of four sites, i.e three farmer pond sites and one farmer training centre (FTC) pond site were selected at each district.

2.2. Implementation Procedure

2.2.1. Training

Before implementing actual demonstration, training was given to a total of 30 farmers and 18 district experts (i.e 15 farmers and 9 experts from each district) on the concept and application of integrated aquaculture. Among the trained 30 farmers, six of them were participated in the actual demonstration work and the rest were used as copy farmers for further expansion of the technology.

Table 1. Training Participants.

District	farmers		Development agent and experts		total	
	male	female	male	female	male	female
Gedeb	12	3	7	2	19	5
Abegona	15	0	6	3	21	3
Total	30		18		48	

Source: taken during training 2019 in both districts.

The practice of integrated fish, chicken and vegetable production demonstrated using Nile tilapia fish, KoeK koek dual purpose chicken and two types of vegetables (Head cabbage and Carrot). Vegetables were produced using fish pond water and pure river water. Fish ponds were fertilized using chicken litter. Fish pond water and pure river water were used as treatments for vegetable production. Fish and Chicken were produced once in a year and vegetables were produced for two cycles per year. Vegetable yield was compared for the two types of water sources i.e fish pond water and pure river water. Cost profit analysis was conducted to analyse the profitability of integrated aquaculture. Farmers' preference was collected and field visit day was organized to demonstrate integrated aquaculture.

2.2.2. Pond Preparation and Fish Seed Stocking



Figure 1. Fish pond and poultry house at farmer and FTC in Arebegona and Gedeb districts.

Appropriate site was selected and one earthen pond with

an area of 100m² was prepared at each site. Water was filled and crop residue compost and livestock manure added to make fertile the pond water. Nile tilapia seed was multiplied at Loke fish site of Hawassa Agricultural Research Centre. Fish seed with average size of 10g were stocked in to ponds with a stocking density of 3 fish per square meter.

2.2.3. Chicken Rearing

One chicken house (3m*3m) was prepared at each site. A total of 250 Koeck koeck pullets were purchased from Debre-Zeit City and distributed to participant farmers and FTCs. Among these, 150 pullets were supplied to Arbegona district and 100 for Gedeb district participants together with feed and water accessories.



Figure 2. Participant farmers supplied with Chicken (Arbegona district).



Figure 3. Participant farmers supplied with Chicken (Gedebdistrict).

2.2.4. Vegetable Production

Two types of vegetables (Head Cabbage and Carrot) and six plots of land (1m*3m) were used at each site. Two types of water sources (i.e fish pond and river water) were used for

vegetables. Three plots were randomly allocated to fish pond water and three to river water. Equal amount of water was supplied to each plot using water cane twice a day.



Figure 4. Vegetable production using fish pond water at Gedeb district.

Field-days is an important methods to communicate farmers and other agricultural stakeholders of the improved technology and practices. It is effective method of teaching and powerful because of participants can observe side by side the benefits of new practices or technology as compared with traditional/local one. Therefore, in order to evaluate the performance and final outputs of the technology and to share lessons with different stakeholders' field day was organized on FTC and in the fields of farmers. On the field-day, farmers, development agents (DAs), experts, heads of agriculture and natural resource office from zone and districts, researchers from research centre, southern agricultural research institution and other stakeholders were participated.

Farmer's attitude towards the demonstrated technology was discussed through focus group discussion after field visit.

Farmers accepted the demonstrated technology because fish yield increased, reduction of fish feed cost, agricultural product diversification, water utilization efficiency, land utilization efficiency, agricultural by-products/waste utilization and overall input cost reduction. Moreover, farmers were highly interested on the integrated aquaculture due to the productivity improvement per unit area of land.

Table 2. Field visit day Participants.

location	Researchers		participants farmers		DAs		Experts	
	male	female	male	female	male	female	Male	Female
Gedeb	7	14	45	13	7	3	5	2
Total	21		58		4		7	

Source: taken during field day 2019 at Gedeb district.

2.3. Data Collection and Analysis

Final fish yield, egg production and vegetable yields were collected. Input costs and outputs or income from products were recorded. Using these input and output costs, partial budget analysis was conducted to analyse the profitability of integrated aquaculture production compared to non-integrated aquaculture. Farmers' perception was collected using selected parameters to compare integrated aquaculture with sole fish/chicken/vegetable production. For the collected

data, scores were given on a scale from 1 (very poor) to 3 (very good) for the criteria they set. The criteria they used for evaluation was recorded. Farmers' perception data were analysed using simple ranking method in accordance with the given value.

3. Results and Discussion

The mean final fish body weight of the Nile tilapia at Arbegona district was 133.7g and 160g at Gedeb district. The fish yield was

40.1kg per pond or 4011kg per hectare at Arbegona district and 48.0kg or 4800kg per hectare at Gedeb district.

The mean number of eggs production per farmer from the supplied 30 chicken was 900. The highest chicken mortality was 31% (11) occurred due to disease outbreak (New Castle)

at Gedeb district and the lowest was 3% (1) occurred due to management problem (Housing problem) at Arbegona district. The average mortality rate i.e the death of 5 chicken (17%) observed was due to new castle disease and housing problem.

Table 3. Chicken mortality.

No.	Woreda	Farmer/FTC	Initial number of stocked chicken	Number of died chicken	Mortality rate in percent	Reasons of mortality
		Firstfarmer	30	2	7	Housing problem
	Arbegona	Secondfarmer	30	1	3	>>
		Thirdfarmer	30	3	10	>>
		FTC	35	6	17	New Castle Disease outbreak
		Firstfarmer	30	6	20	>>
	Gedeb	Secondfarmer	30	10	33	>>
		Thirdfarmer	30	4	13	>>
		FTC	35	11	31	>>
	Totalmortality			5	17	

Source: chicken mortality data taken 2019 in both district.

3.1. Cost Profit Analysis of Integrated Aquaculture Demonstrated at Single Farmer Site

The cost of fish and egg sell at farm gate was 10birr per fish and 3birr per egg. The cost of Head cabbage was 4birr per plant and 600birr per quintal. The cost of chicken sell

was 200birr per chicken. The cost of Chicken house per farmer was 500birr. Using these costs of products, the cost profit analysis was calculated to analyse the profitability of integrated aquaculture production demonstrated.

Table 4. Cost profit analysis of the demonstrated integrated aquaculture products per farmer.

Income						
Items	Unit	unitcost	amount	Total cost	Second cycle production	Grand total income/cost
Fish	No.	10	300	3000.00	-	
Chicken	No.	200	26	5200.00	-	
egg	No.	3	900	2700.00	-	
Headcabbage	No.	3	486	1458.00	1458	
carrot	Qt	600	6	3600.00	3600.00	
				15958.00	5058.00	
A=Grandtotalincome						21016.00
Inputcost						
Items	unit	unitcost	amount	totalcost		
Fish	No.	10	300	3000		
Chicken	No.	200	26	5200		
egg	No.	3	900	2700		
Headcabbage	No.	3	486	1458		
Chickenhouse		500	500	500		
				10700		
B=Grandtotalcost						10700.00
Netprofit=A-B						10516.00

Source: data of cost profit analysis in 2019 both districts.

This net profit can be considered as a minimum profit because the mortality occurred due to chicken disease outbreak, loss of vegetable yield due to reduced cost because of heavy rain resulting to excess yield in the areas and minimum time taken for egg production due to unsuitable environmental condition suddenly happened collectively reduced the overall cost of product obtained from integrated farming. If these situations were not happened, the net profit would have been higher than this obtained value.

3.2. Farmers' Perception

Farmers were made evaluation and they selected the technology depending on their criteria's from the initial trial. The criteria's were fish yield improvement, reduction of fish feed cost, agricultural product diversification, water utilization efficiency, land utilization efficiency, agricultural by-products/waste utilization and overall input cost reduction. The ranking procedure was explained for participant farmers and each selection criteria was ranked

from 1 to 3 (1=poor, 2=good, 3=Very good). Then farmers were given the chance to rank both integrated aquaculture with sole fish/chicken/vegetable production based on the criteria's listed by them. The evaluations mean scores value

of integrated aquaculture was greater than that of solefish/chicken/vegetable production at both locations (Gedeb and Arbegona districts).

Table 5. Farmers' perception using the selected parameters.

Location	Variety	Evaluation criteria									Rank
		Fyi	Rffc	Apd	Wue	Lue	Pipual	Abp	Oaier	Mean	
Gedeb	Integrated aquaculture	2.5	2	2.87	2	2.9	3	3	3	2.6	1
	Sole fish/chicken/vegetable	2.1	2	1.2	1	1.3	1.5	2	1	1.3	2
Arbegona	Integrated aquaculture	2.8	2	2.67	2	3	3	3	3	2.7	1
	solefish/chicken/vegetable	2.65	1.9	1.1	1	2.3	1.5	1	1.2	1.6	2

Source: data of farmers' perception in 2019 both district.

Note: Fyi (Fish yield improvement), Rffc (Reduction of fish feed cost), Apd (Agricultural product diversification), Wue (Water utilization efficiency), Lue (Land utilization efficiency), productivity improvement per unit area of land, AbP (Agricultural by-products) and Oaier (Over all input cost reduction).

4. Conclusion and Recommendation

The yield, cost profit analysis and farmers' perception indicated that integrating fish with other agricultural activities mainly small livestock like chicken and crops produced at a small area of land like vegetables has various advantages over mono-culture or a single type of agricultural production. Under suitable environmental conditions like absence of disease outbreak, presence of good market price and good integrated production management; the net profit that can be obtained from integrated farming can be higher than the profit obtained in this demonstration work. Moreover, most districts of Sidama region and Gedeo Zone are suitable for integrated aquaculture production due to availability of permanent water sources used for fish production. Therefore, this integrated aquaculture practice should be expanded to other districts of Sidama region and Gedeo Zone for better land and water resource utilization and productivity improvement per unit area of land.

References

- [1] Adewumi, A. A., I. K. Adewumi and V. F. Olaleye, 2011. Livestock waste-menace: Fish wealth-solution. *African Journal of Environmental Science and Technology* Vol. 5 (3), pp. 149-154.
- [2] Alam, M. R., M. A. Ali, M. A. Hossain, M. S. H. Molla, and F. Islam, 2009. Integrated approach of pond based farming systems for sustainable production and income generation. *Bangladesh J. Agril. Res. Institute*. pp. 577-584.
- [3] Alemu Lema and Abera Degebassa, 2013. Comparison of chemical fertilizer, fish offal's fertilizer and manure applied to tomato and onion. *African Journal of Agricultural Research* Vol. 8 (3), pp. 274-278, 24.
- [4] Angel, D. and S. Freeman, 2009. Integrated aquaculture (INTAQ) as a tool for an ecosystem approach to the marine farming sector in the Mediterranean Sea. In D. Soto (ed.). *Integrated mariculture: a global review*. FAO Fisheries and Aquaculture Technical Paper. No. 529. Rome, FAO. pp. 133-183.
- [5] Beaven and Besiline, 2013. Comparative Study of Maize Bran and Chicken Manure as Fish Feed Supplement: Effects on Growth Rate of *Oreochromis Niloticus* in Pond Culture Systems, *International Journal of Aquaculture*, Vol. 3, No. 623-29.
- [6] Bwala, R. L. and E. Omoregie, 2009. Organic Enrichment of Fish Ponds: Application of Pig Dung vs. Tilapia Yield. *Pakistan Journal of Nutrition* 8 (9): 1373-1379.
- [7] Chaudhari L. P., 2003. Sustainable use of natural resources for integrated aquaculture and agriculture: an Indian overview. In: CamardaD. (ed.), GrassiniL. (ed.). *Local resources and global trades: Environments and agriculture in the Mediterranean region*. Bari: CIHEAM, 2003. p. 187-195 (Options Méditerranéennes: Série A. Séminaires Méditerranéens; n. 57).
- [8] 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. *International Journal of Fisheries and Aquatic Studies* 2017; 5 (4): 377-382.
- [9] FAO, 2001. Integrated agriculture-aquaculture. A primer. FAO Fisheries technical paper 407. World Fish Center.
- [10] FAO, 2014. The state of world fisheries and aquaculture part I: World fisheries and aquaculture, Rome, Italy.
- [11] Kebede Alemu, 2003. The growth performance of *Oreochromis niloticus* L reared in fresh water ponds loaded with varying levels of Poultry manure. *SINET: Ethiop. J. Sci.*, 26 (1): 17-23.
- [12] Lemma Abera Hirpo, 2017. Evaluation of integrated poultry-fish-horticulture production in Arsi Zone, Ethiopia. *International Journal of Fisheries and Aquatic Studies* 2017; 5 (2): 562-565.
- [13] Mlejnkova, H., Sovova, K., 2012. Impact of fish pond manuring on microbial water quality. *Acta univ. agric. et silvic. Mendel. Brun.*, 2012, LX, No. 3, pp. 117-124.
- [14] Mohammed Ibrahim Garade, Tadesse Megersa and Haile Ketema, 2016. Poverty Alleviation through Integrated Pond Fish Farming with Poultry and Vegetables Production at Small Scale Farmers' in Dilla Zuria Woreda, Southern Ethiopia. *Journal of Poverty, Investment and Development*. Vol. 24.
- [15] Nguyen Van Huong, Tran Huu Cuong, Tran Thi Nang Thu and Philippe Lebailly, 2018. Efficiency of Different Integrated Agriculture Aquaculture Systems in the Red River Delta of Vietnam. *Sustainability* 2018, 10, 493; doi: 10.3390/su10020493.

- [16] Niwooti Whangchai, Wittaya Tawong, Supranee Wigraiboon, Tomoaki Itayama, Takashi Kuwabarac and Norio Iwami, 2008. Effects of manure fertilizer on off-flavor substances in water and sediment from Tilapia ponds. 8th International Symposium on Tilapia in Aquaculture 2008, 173.
- [17] Ofori, J. K., 2000. Status and trends in integrated agriculture-aquaculture in Ghana, p. 36-37. In E. K Abban, C. M. V: Casal, T. M. Falk and R. S. V: Pullin (eds.) Biodiversity and sustainable use offish in the coastal zone. ICLARM Conf. Proc. 63, 71 p.
- [18] Ogello, E. O., F. T. Mlingi, B. M. Nyonje, H. Charo-Karisa and J. M. Munguti, 2013. Can integrated Livestock-fish culture be a solution to east Africa's food insecurity? A REVIEW. African journal of food, agriculture, nutrition and development. Volume 13, No. 4.
- [19] Prein, M., 2002. Integration of aquaculture into crop-animal systems in Asia. ELSEVEIR. Agricultural Systems 71 (2002) 127-146.
- [20] Pretty J. N., Morison J. L., Hine R. E. 2003. Reducing food poverty by increasing agricultural sustainability in developing countries. Agriculture, Ecosystems & Environment 95, 217-234.
- [21] Rahman, H. Md., Md. Abu Zafar, Md. Afzal Hossain and Abu Syed Md. Kibria, 2018. Present status of integrated aquaculture in some selected areas of Nilphamari District in Bangladesh. International Journal of Fisheries and Aquatic Studies 2018; 6 (2): 290-295.
- [22] Samson Debebe Sime, 2017. Studies on growing fish farming practices in selected districts of SNNPRS, Ethiopia. American-Eurasian J. Agric. & Environ. Sci., 17 (2): 155-160.
- [23] Shoko, A. P., A. Getabu, G. Mwayuli and Y. D. Mgaya, 2011. Growth performance, yields and economic benefits of Nile tilapia, *Oreochromis niloticus* and kales, *Brassica oleracea* cultured under vegetable-fish culture integration. Tanz. J. Sci. Vol. 37.