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Evaluation of integrated fish-rice farming in the Nile irrigation and drainage project areas, south Gonder, Ethiopia

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Abstract
Rice–fish culture is an integrated approach to food production and can increase food and income. This system can be practiced with little investment and can maximize the use of existing resources. It is one way to increase the economic benefits from rice fields and at the same time develops freshwater fisheries. Rice–fish culture has been practiced in 28 countries on six continents. Egypt is the largest rice producer among Middle Eastern and African countries, and Egyptian rice yields are some of the highest in the world.
The study area is known as the Fogera Plains and used to be a livestock production area until recently. The area gets flooded during the wet season and is not accessible. Farmers along the coasts of Lake Tana are also fishermen and use traditional way of fishing using papyrus boats. Rice production has been introduced some five years ago in the Fogera plains and currently about 4,516 ha of land is under rice cultivation using the X-Jigna variety.
In relation to above synthesis, rice-fish integrated field experiments were performed at the Fogera Plains from July 2014-December2014. Rearing fish fry and growing until they attained a weight of 50 grams and more. Stocking Nile Tilapia fish fingerlings, at a rate of 2 fish/m^2. The results showed that on the two rice filed 720kg/ha and 1500kg/ha can be harvested through integrated rice and fish culture. The physical parameters showed good environment for fish survival and growth.

Keywords: Rice-Fish integrated farming, water quality, Nile Tilapia.

1. Introduction

Integrated rice-fish farming is thought to have been practiced in Thailand more than 200 years. In Japan and Indonesia, rice-fish farming was developed in the mid-1800s. An early review on rice-fish culture showed that by the mid-1900s it was practiced in 28 countries on six continents: Africa, Asia, Australia, Europe, North America and South America (Matthias *et al*., 2004) [4].
Common carp was then the most popular species, followed by the Mozambique tilapia (*Oreochromis mossambicus*). In Malaysia the snakeskin gouramy (*Trichogaster pectoralis*) was favored, and Nile tilapia (*Oreochromis niloticus*) was used in Egypt. Other species mentioned include buffalo fish (*Ictiobus cyprinellus*), the Carassius (*Carassius auratus*), milkfish (*Chanos chanos*), mullets (*Mugil* spp.), gobies (family Gobiidae), eels, murrels or snakeheads (*Channa* spp.), catfish (*Clarias batrachus*), gouramy (*Trichogaster pectoralis*) as well as penaeid shrimps (*Penaeus* spp.) (Matthias *et al*., 2004) [4].
Risk elements in rice production in low lands can be eliminated by diversifying the system through introduction of fish culture. In the rainfed ecosystems of India rice-fish farming system is the best farming option considering the available resources and food habit of people. Rice and fish are grown in pond area and fruit crops like banana and papaya are grown in dikes.
Rainfed shallow water can be utilised rice crop sequence may be followed. Rice as nurseries for fresh water fish and prawn seed varieties like Jaladhi-1, Jaladhi-2, Jalmagna, production. Rainfed intermediate (0-50 em) and Utkal Prabha, Manika, Mahalaxmi, Panidhan, semi-deep water ecologies (50 to 100 em water FR-13A, Jal Lahri, Jal Nidhi, Jal Priya etc. may depth) are suitable for rice-fish farming. Fresh be taken (Sukanta *et al*., 2004) [5].
Rice–fish culture is an integrated approach to food production and can increase food and income. This system can be practiced with little investment and can maximize the use of

existing resources. It is one way to increase the economic benefits from rice fields and at the same time develops freshwater fisheries. Rice–fish culture has been practiced in 28 countries on six continents. Egypt is the largest rice producer among Middle Eastern and African countries, and Egyptian rice yields are some of the highest in the world. Nigeria has large and expansive areas of swampy landscapes and regularly flooded lowland areas that are suitable for rice–fish culture. In Nigeria, the extensive style of growing rice and raising fish simultaneously in the same field for the period of rice culture is gaining ground and attention in the swampy floodplains, and is contributing significantly to the diets and economic livelihoods of coastal (lowland) inhabitants *(Akegbejo,2010)* [1].
Rice-fish integrated farming systems are well known as environment friendly and one of the best options to increase fish production from limited water resources. This type of culture is less expensive where the energy resources are recycled in a sustainable manner stated that there exists a mutually beneficial relationship between rice and fish, so farmers have a higher rice yield, since fish devour pests that attack rice and control the growth of weed plants (Lemma *et al*., 2014) [3].
Although the fish rice integrated system has been demonstrated to provide necessary additional income and high quality protein, it is still in an exploratory stage in Ethiopia. In this context the present experiment was carried out to evaluate the integration of fish-rice farming in the Nile irrigation and drainage project areas, at south Gonder of Ethiopia.

2. Objectives
- Evaluate the adaptation and growth performance of fish in rice-fish integrated farming.
- To create and strengthen linkage among main actors, especially the farmers, extension workers, researchers and market chain actors.

3. Materials and Methods
The study was conducted on farmer's field at Fogera Wereda which is found in Amhara Regional State in South Gondar Zone. It is situated at11 °58 latitude and 37 °41 longitude. Woreta is the capital city of the Woreda and is found 625 Km from Addis Ababa and 55 Km from the Regional capital, Bahir Dar.
The study area were geographically located at 11 °54.4'46.3"N to 11 °57'03.0"N and 37 °41'23.9"E to 37 °42'32.2" E at elevation 1787-1812m. The area gets flooded during the wet season and is not accessible. Farmers along the coasts of Lake Tana are also fishermen and use traditional way of fishing using papyrus boats. Rice production has been introduced some five years ago in the Fogera plains and currently about 4,516 ha of land is under rice cultivation using the X-Jigna variety (Fogera PLS, 2005) [2].
Training were given to farmers and woreda experts to rise awareness about integrated fish-rice farming system. Different sized plastic buckets and fish boxes were used to place fish during sampling and perform total harvest. GPS was used to know geographical location of the study area.
Weighing balance and measuring board were used to measure the growth of fish. Physico parameter were done to check the water quality of the fish rice field. Field research was conducted for a period of six months “between” July 2014 to December 2014.

3.1. Fish density vs. size experiments
Site selection were done with the woreta agriculture office experts to prepare the experimental rice field at four farmers. Each study sites have semi-deep water ecologies ranging from 125m^2-350 m2 and they were located at about 1787-1812m above from the sea level. After the water flow direction identified, Slight modification of rice field were made and fencing on the out flow side. Rearing fish fry and growing until they attained a weight of 50 grams and more and Stocking tilapia fish fingerlings, at a rate of 2 fish/m^2 (Table1).

Table1: Sites and No of fish stocked

Sites	No of fish stocked	Fish size in gm	Fish length in cm	Deep water area	Total area
Site A	350	50-60	13-14	200m^2	0.015ha
Site B	217	50-70	13-14.5	125m^2	0.11ha
Site C	217	50-65	13.5-14	125m^2	
Site D	600	50-70	13-15	350 m^2	0.2ha

3.2. *Rice–Fish Systems*
In this study rice fish integration were done at open rice field which had naturally semi-deep water ecologies. Only slight modification were done and the out flow direction closed by wire mesh net and bamboo. It was assumed that fish graze at open area of rice field and back to semi-deep water ecologies when the water level decreases.

4. Result and discussion
4.1. Fish Adaptation
51.4% and 63.3% of the fish adapted from the stocked site A and site D respectively. Among the study area site A was dry early around at October (Fig 1). Two of the sites (Band C) were destroyed during high flood occurrence.

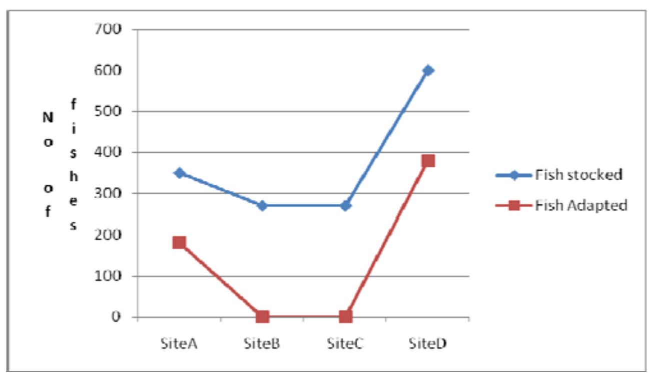

Fig1: Fish stocked and adapted from all sites

4.2. Fish stocked and harvested
At all site those fingerlings stocked sized between 55-60g (13-14.5cm) shows 80-150g (15-19cm) at harvesting time. Growth increment ware 25.2% and 58.3% for site A and Site D respectively. During harvesting time much number of fingerlings were caught at site D.

Table 2: Percentage of increment of fish stocked

Sites	*Fish Stocked (g)*	*Harvested Fish (g)*	*% increment*
Site A (50-60g)	19,250	14,400	25.2
Site D (50-70 g)	36,000	57,000	58.3

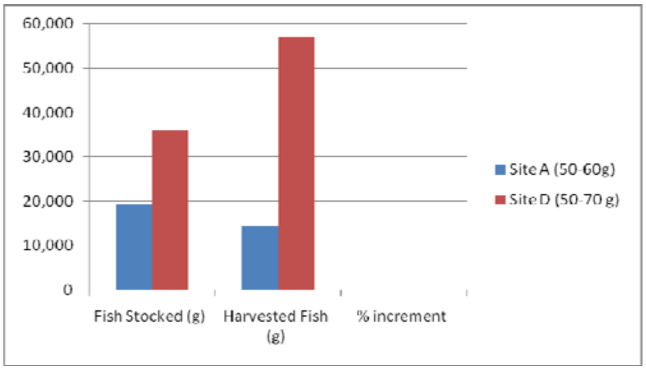

Fig 2: Fish stocked and harvested from sites A and D.

According to this paper it was possible to produce more than 15 kg of fish/ $100m^2$ from deep water area (Table 2). 7.2kg of fish/100 m^2 also produced at the early dry site. During harvesting time we caught much fingerlings. Therefore in this study it was possible to harvest 720-1500kg of fish/ha. The total weight of fish harvested was 33.339 kg (Table 3) from the trenches and it was estimated at 833.475 kg per hectare (Lemma *et al*., 2014) [3].

Integrated rice–fish production analysis of five farms in Ondo state Fish yield (kg/ha) 2500 2410 2435 2320 2215 (Akegbejo, 2010) [1]. The total fish production contributed from weeds, plankton, insects, organic detritus etc. is estimated to be about 250 kg ha-l in rice field (Sukanta *et al.*, 2004) [5]. The results showed that despite of 3-5% loss of the rice cultivating area due to "trench" as fish hiding place, rice yield increased up to 9% in addition of 529 kg ha-1 fish from rice-fish integrated farming than cultivating rice alone

Table 3: comparison of Fish yield (kg/ha) at rice fish integration

No	Fish yield (kg/ha)	Fertilized/non fertilized	Researchers
1	720-1500	No fertilized	Present study
2	833.475	fertilized	Lemma *et al.* 2014 [3]
3	2215-2500	fertilized	Akegbejo, 2010 [1]
4	250	No fertilized	Sukanta *et al.*, 2004 [5]
5	529	fertilized	T.B. Gurung *et al.*, 2005

4.3. Physical parameters

The water quality data were taken monthly for all experimental site, but due to high flood occurrence and escape of fish physical data were not taken for site B and C. The third site was taken physical data until the area became dry (Table 4). The range of temperature, pH value, DO and Cond. values were observed is suitable for the growth of Tilapia.

Table 4: physico parameters of the study area.

SITE	T^0	DO	DO%	TDS	PH	Cond.	Sp. con
SITE A	25±1.49	4.98±0.76	63.5±3.33	0.067±0.077	6.8±0.353	0.1±0.131	0.103±0.0112
SITE B	26.8	8	93	0.23	7.2	0.3	0.278
SITE C	27	7.5	89	0.24	7	0.201	0.2
SITE D	19.03±2.72	5.7±1.26	68±12.5	0.071±0.076	6.8±0.36	0.11±0.111	0.102±0.0966

4.4. Socio economic value

Attitudes and perception of farmers about the technology and marketability of fish price data were collected. The owners of site A and site D were sold their harvested fish at woreta hotels with 25birr/kg and they got 300birr and 1125birr respectively. In addition to the marketable size much of fingerlings were sold for horticulture farms which is found in Bahir Dar and 220 fingerlings were sold with 50cents/fingerling, he has got 110birr.

According to their attitude they are very happy with the technology and egger to continue fish farming, the neighbor of those farmers also aimed to start rice fish farming for the coming rainy season.

5. Conclusion and Recommendation

5.1. Conclusions

- In developing countries like Ethiopia with substantial water logged areas, rice-fish culture may contribute to solve food insecurity issues and poverty alleviation.
- The enormous resources available in the Fogera flood plain areas could be used for the development of integrated rice-fish cultures which can assure the food insecurity of the country. The present results indicate that integrated rice fish culture is highly profitable for small scale farmers.
- Based on this study, 7.2 kg of fish/$100m^2$-15 kg of fish/$100m^2$ or 720-1500kg of fish/ha can be produced at the Fogera water logged areas
- The range of temperature, pH value, Do, TDS and Cond value were observed suitable for the growth of Tilapia
- During Harvesting time much of fingerlings were found, due to mixed sex stocked

6. Recommendations

- During site selection water logged areas that are waiting at least for 6months and the correct out flow direction should be selected carefully.
- Interaction between rice production and fish production (fertilizer, pesticides, soil quality, etc.) should be scaled up in a wider scale
- Monosex (male tilapia) should be stocked
- Fencing materials should be hard and durable
- The trial should be tested with supplemental feed
- The integration of rice fish should be tested with clarias gariepinus species

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