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

Mohammed oumer, Dereje Tewabe, Erkie Asmare

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-December 2014. Rearin g 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/m². The results showed that on the two rice field 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 Sidhi, Jal Priya etc. may depth) are suitable for rice-fish farming. Fresh be taken (Sukanta et al., 2004) [5].

Risk–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 environmentally 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 Woreda which is found in Amhara Regional State in South Gondar Zone. It is situated at 11°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 125m²-350 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/m² (Table1).

<table>
<thead>
<tr>
<th>Sites</th>
<th>No of fish stocked</th>
<th>Fish size in gm</th>
<th>Fish length in cm</th>
<th>Deep water area</th>
<th>Total area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site A</td>
<td>350</td>
<td>50-60</td>
<td>13-14</td>
<td>200m²</td>
<td>0.015ha</td>
</tr>
<tr>
<td>Site B</td>
<td>217</td>
<td>50-70</td>
<td>13-14.5</td>
<td>125m²</td>
<td>0.11ha</td>
</tr>
<tr>
<td>Site C</td>
<td>217</td>
<td>50-65</td>
<td>13.5-14</td>
<td>125m²</td>
<td></td>
</tr>
<tr>
<td>Site D</td>
<td>600</td>
<td>50-70</td>
<td>13-15</td>
<td>350 m²</td>
<td>0.2ha</td>
</tr>
</tbody>
</table>

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.

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>
<thead>
<tr>
<th>Sites</th>
<th>Fish Stocked (g)</th>
<th>Harvested Fish (g)</th>
<th>% increment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site A (50-60g)</td>
<td>19,250</td>
<td>14,400</td>
<td>25.2</td>
</tr>
<tr>
<td>Site D (50-70 g)</td>
<td>36,000</td>
<td>57,000</td>
<td>58.3</td>
</tr>
</tbody>
</table>
According to the paper, it was possible to produce more than 15 kg of fish/100m² from deep water area (Table 2). 7.2 kg of fish/100 m² was also harvested at the early dry site. During harvesting time, we caught much fingerlings. Therefore, it was possible to harvest 720–1500 kg of fish/ha. The study 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

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

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, the data of fish production were not collected 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 suitable for the growth of Tilapia.

Table 4: Physico parameters of the study area.

<table>
<thead>
<tr>
<th>SITE</th>
<th>T⁰</th>
<th>DO</th>
<th>DO%</th>
<th>TDS</th>
<th>PH</th>
<th>Cond.</th>
<th>Sp. cond</th>
</tr>
</thead>
<tbody>
<tr>
<td>SITE A</td>
<td>25±1.49</td>
<td>4.98±0.76</td>
<td>63.5±3.33</td>
<td>0.067±0.077</td>
<td>6.8±0.353</td>
<td>0.1±0.131</td>
<td>0.103±0.0112</td>
</tr>
<tr>
<td>SITE B</td>
<td>26.8</td>
<td>8</td>
<td>93</td>
<td>0.23</td>
<td>7</td>
<td>0.3</td>
<td>0.278</td>
</tr>
<tr>
<td>SITE C</td>
<td>27</td>
<td>7.5</td>
<td>89</td>
<td>0.24</td>
<td>7</td>
<td>0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>SITE D</td>
<td>19.03±2.72</td>
<td>5.7±1.26</td>
<td>68±12.5</td>
<td>0.071±0.076</td>
<td>6.8±0.36</td>
<td>0.11±0.111</td>
<td>0.10±0.0966</td>
</tr>
</tbody>
</table>

4.4. Socio economic value

Attitude and perception of farmers about technology and marketability of fish price data were collected. The owners of site A and site D were sold their harvested fish at woreda hotels with 25 birr/kg and they got 300 birr and 1125 birr 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 50 cents/fingerling, he has got 110 birr.

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 culture 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/100 m²–15 kg of fish/100 m² or 720–1500 kg 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 6 months 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.

7. References

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5. Sukanta Kumar Sarangi HC, Sharma, Govind Sharma. Rice-Ash Farming System - A Review, Department of