Mixed Agriculture: Economic Analysis of Rice Farming and Aquaculture in Lahijan Township, Gilan province, Iran

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Abstract
Iran agriculture sector is still following its old-fashioned methods which some rectifications and modifications are needed to improve. This academic study is tailored to compare an economic analysis based on production function estimation on two separated groups of integrated rice-fish culture (IRFC) and rice monoculture (RM) farms in Lahijan Township, Gilan province, North of Iran. The study location has high potential for integrated farming because of its temperate climate, rainfall and enough water accessibility. As a cross-sectional study, 63 farms of IRFC and 91 farms of RM were observed in 2015 crop year to fill 154 questionnaires about farmers' livelihood, production inputs and crop yields of rice and fish, totally. Collected data made the estimation of productions functions on OLS method to 3 different functions in each group as follow: cobb-douglas, generalized quadratic and translog. In consideration of econometric criteria and production function basic assumptions, translog and generalized quadratic production functions accepted as the best for IRFC and RM farms, respectively. Afterwards, inputs elasticities assessed and comparison between the two groups resulted IRFC method is more qualified than RM in usage of production inputs. In addition, collected data analysis revealed that IRFC farmers' livelihood level (e.g. education) is completely different from RMs. In conclusion, public and private sectors, should support local farmers of RM to learn techniques, which can easily effect on their current life style and the next generations by transforming traditional agriculture method to the sustainable one, more than IRFCs. They can reduce the usage of pesticides and herbicides in order to save their environment, health care, income and etc.

Keywords: Integrated rice-fish culture production function, cobb-douglas, generalized quadratic, translog, input elasticity.

Introduction
Rice is a basic food in Asian, but it is not complete in nutrition and consumer should add it to protein, to obtain food security. Nevertheless, integrated rice-fish farming offers a solution to this problem by contributing to food, income, and nutrition. Not only the adequate supply of carbohydrate but also the supply of animal protein is significant through rice-fish farming. (Ahmet et al. 2011) Fish, particularly small fish, are rich in micronutrients and vitamins, and thus human nutrition can be greatly improved through fish consumption (Larsen et al. 2000; Roos et al. 2003). The importance of these crops brings many scientific pieces of research on this subject. Although, integrated rice-fish culture (IRFC) has been popular in some Asian countries, it has not a strong background in Iran. The most important crop in the north of Iran is rice, in case of quantity and value. RM farming is more popular than IRFC in Iran. RM farmers believe that their fathers' methods are the best and they are not familiar enough with IRFC. The first utilization of IRFC method was in 1985, under the supervision of Iran fisheries organization, in Mazandaran province, north of Iran. The second try has done by Gilan University of agricultural science, in 1990, which brings significant results such as optimize dispersion of four types of fish, high-level of crop productivity, and etc. While many reports suggest that integrated rice-fish farming is ecologically sound because fish improve soil fertility by increasing the availability of nitrogen and phosphorus (Giap et al. 2005; Dugan et al. 2006). In addition, integration of fish with rice farming improves diversification, intensification, productivity, profitability, and sustainability (Ahmed et al. 2007; Nhan et al. 2007). From the other perspective, farming is a job and farmers try to maximize their profits. Choosing the most lucrative crops, which grow in a specific period, shows its importance. The marginal product value related to each unit of an input is a criterion to choose the method of farming. In other words, it is the point shows the amount of money added to farmer income.
because of using the last unit of production input to produce two corps simultaneously, equals to the opportunity cost. However, it is not easy to do because farmers are not familiar with production functions and the impacts of production inputs in the amount of their total yields and profit. Some farmers also believe that production functions are production technologies; however, technology is a constant assumption in production function estimation and should be recognized. In the present study, three different production functions estimated for each system as Cobb-douglas, generalized quadratic and translog, to analyze IRFC and RM economically. By these estimations and according to the econometrics criteria, the most efficient production functions were founded and the impacts of production inputs were analyzed by input elasticity. The aim of this study is to assess IRFC as a competitive alternative to RM. The hypothesis here is that integrated rice-fish farming can provide socioeconomic benefits to the households of poor farmers, and more broadly play a significant role in contributing to food security.

Method and Material

Study Area
The study was undertaken in Gilan province located in the north of Iran, specifically in Lahijan township and its sub city Siahkal. (Fig. 1) Geographically, Gilan is identified as the most important region for rice and fish farming because of its low-lying rice fields, mild climate, and fertile soil. 52% of its farm fields are located in Sefid-rud river border. River border low-lying farms are cultivated in IRFC system, and the others are RM farms. According to the statistics released by Gilan-OIJ\(^1\) and Gilan-IFO\(^2\) there are 167, and 35 IRFC farms, respectively in Lahijan and Siahkal that totally are about 180-ha\(^2\) area in 2015.

Figure 1: Map of study area.

Data Collection Method
Sample farms location were all in river border to keep samples homogenously, by bringing farmers equality in water qualification. To sample IRFCs, 65 farms selected; 54 in Lahijan and 11 in Siahkal, and 90 farms selected in RM system. All selections were by random sampling.
A semi-structured questionnaire was designed for interviews and 5 Interviewers had friendly chats with farmers in their houses and/or farm sites. They asked different questions regarding farm activities and recorded farmer answers in several visits. This method of data collection helped farmers to feel friendly and improved the correctness, accuracy and validation of their answers. A total of 155 questionnaires were filled and the validation of collected data checked by crosschecking interviews with the conducted key informants.

\(^1\)Gilan Organization of Agriculture- Jahad.
\(^2\)Iran Fisheries Organization.
**Table 1**: Data collection methods and sample size for target groups

<table>
<thead>
<tr>
<th>Target Group</th>
<th>Farming System</th>
<th>Sample Size</th>
<th>Data collection method</th>
<th>Information gathered</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>IRFC</td>
<td>65</td>
<td>Questionnaire interviews</td>
<td>Individual features (farmer age, gender, education) Professional features (farm management, scale, experiences) Numerical data (fish types dispersion, inputs amounts, technology, yield amount and yield price)</td>
</tr>
<tr>
<td>2</td>
<td>RM</td>
<td>90</td>
<td>Questionnaire interviews</td>
<td>Individual features (farmer age, gender, education) Professional features (farm management, scale, experiences) Numerical data (input amounts, technology, yield amount)</td>
</tr>
</tbody>
</table>

**Production Function Variables**

To estimate production functions, it is needed to identify product inputs, firstly. The inputs of RM system are listed as following:

\[
Y = \text{Total amount of rice yield (kg/ha)}
\]

\[
X_w = \text{Total amount of water (lit/ha)}
\]

\[
X_{\text{farm}} = \text{Farm scale (ha)}
\]

\[
X_{\text{sd}} = \text{Total amount of seed planted in farm (kg/ha)}
\]

\[
X_{\text{hr}} = \text{Total human labor (person-hour)}
\]

\[
X_f = \text{Total amount of fertilizer (kg/ha)}
\]

\[
X_p = \text{Total amount of pesticide (lit/ha)}
\]

\[
X_m = \text{Technology and machinery (hour)}
\]

In addition to the mentioned inputs, there are some other in IRFC system as below:

\[
Y^* = \text{Total farm production value (Rial/ha)}
\]

\[
X_{\text{fish}} = \text{Total number of baby fish in farm (number/ha)}
\]

\[
X_{\text{ff}} = \text{Fish food (kg/ha)}
\]

\[
P_1 = \text{Rice yield price (Rial/kg)}
\]

\[
P_2 = \text{Fish yield price (Rial/kg)}
\]

\[
Y_1 = \text{Total amount of rice yield (kg/ha)}
\]

\[
Y_2 = \text{Total amount of fish yield (kg/ha)}
\]

It is worth mentioning, \(Y^*\) factor in IRFC is the farm production value, which defined to homogenize yield factor regarding two crops of fish and rice in IRFC system. Where,

\[
Y^* = (P_1 \times Y_1) + (P_2 \times Y_2)
\]

There is no \(X_f\) (fertilizer) in IRFC system because fish excreta work as a high-quality animal fertilizer in paddy fields. The feeding behavior of fish in rice fields causes aeration of the water.

Moreover, farmers use river water to irrigate their farms and paddy fields, which is completely free of charge. Therefore, farmers do not measure the amount of water usage. To manage this parameter as the most important factor in both farming systems, the water usage measured by the formula below:

\[
D^4 = A^5 U^6
\]

\(^1\)I.R. Iran currency.

\(^2\)The discharge.

\(^3\)The cross-sectional area of the portion of the channel occupied by the flow in.

\(^4\)The average flow velocity.
Production Function Model
A production function shows the correlation among production inputs and the amount of total yield. Its general form is $Y = f(K, L)$, which, $Y$, $K$ and $L$ refer to yield, capital and labor respectively. A production function is defined for non-negative amounts of inputs and yields, and it is always efficient. In another word, production function always shows the best combination of inputs to receive the maximum amount of yields. There are about 20 different of them, which are suitable for different usages. To choose the best production function for estimation, it is necessary to notice 4 basic assumptions: study hypothesis, study data, final estimation and previous studies.

The most efficient production functions are cobb-douglas, translog and generalized quadratic. Cobb-douglas has known as the most efficient production function in agriculture, especially for rice and wheat, in many studies. (Dawson et al. 1981; Azamzadeh et al. 2010; Taghizadeh et al. 2012) In addition, translog production function is efficient in agriculture production by consisting all neoclassical assumptions. (Azamzadeh et al. 2010) On the other hand, some studies on generalized quadratic production function show its efficiency in rice and wheat farming. (Koupahi et al. 2008; Aghdam et al. 2012) Theoretically, cobb-douglas in more limited than translog and generalized quadratic, so that, this study tries to compare these three to find the most efficient one. Table 2 shows the properties of them.

<table>
<thead>
<tr>
<th>Production function name</th>
<th>Function form</th>
<th>Input elasticity</th>
<th>Number of parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cobb-douglas</td>
<td>$Y = \alpha \prod_{i=1}^{n} X_i^{\beta_i}$</td>
<td>$\beta_i$</td>
<td>$n+1$</td>
</tr>
<tr>
<td>Translog</td>
<td>$\ln(Y) = \alpha + \sum_{i=1}^{n} \beta_i \ln(X_i) + \frac{1}{2} \sum_{i=1}^{n} Y_{ii} (\ln X_i)^2 + \sum_{i=1}^{n} \sum_{j=2}^{n} Y_{ij} (\ln X_i) (\ln X_j)$</td>
<td>$\beta_i + Y_{ii}(\ln X_i) + \frac{1}{2} \sum_{j=2}^{n} (\ln X_i))$</td>
<td>$1/2(n+1)(n+2)$</td>
</tr>
<tr>
<td>Generalized quadratic</td>
<td>$Y = \alpha + \sum_{i=1}^{n} \beta_i X_i + \frac{1}{2} \sum_{i=1}^{n} Y_{ii} (X_i)^2 + \sum_{i=1}^{n} \sum_{j=2}^{n} Y_{ij} (X_i) (X_j)$</td>
<td>$\beta_i + Y_{ii}(X_i) + \frac{1}{2} \sum_{j=2}^{n} Y_{ij} (X_j)$</td>
<td>$1/2(n+1)(n+2)$</td>
</tr>
</tbody>
</table>

Data analyzing
According to the matter of the study, three production functions were estimated in each farming systems of IRFC and RM, separately. These estimations were done by Eviews software and OLS method. Over 90% of farmers produce Hashemi rice\(^7\) and the standard mixture of common crab, grass crab, silver crab, and big head.

Results
In addition to production function estimation, some data about individual and professional features were analyzed. As the farmer individual features, the study brings some result in farmers' ages, education and gender from collected data. All these analyses results are available below:

Individual Features Analyses
Age
Most of the farmers in both IRFC and RM systems were in 31-50 age group, respectively 62.9% and 48.3%. The less frequency was in IRFC, equals to 14.5% in upper than 51, and 12.9% in lower than 30, for RM system. (Table.3).

\(^7\)Hashemi is a popular main rice crop in Iran.
Table 3: Farmers’ age groups.

<table>
<thead>
<tr>
<th>Sys.</th>
<th>Frequency in age groups of</th>
<th>Variance (OF)</th>
<th>Standard deviation (O)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt;30</td>
<td>31-50</td>
<td>&gt;51</td>
</tr>
<tr>
<td>IRFC</td>
<td>%22.5</td>
<td>%62.9</td>
<td>%14.5</td>
</tr>
<tr>
<td>RM</td>
<td>%12.9</td>
<td>%48.3</td>
<td>%38.7</td>
</tr>
</tbody>
</table>

Education
Farmers’ levels of education divided in 7. (Table.4) In IRFC system, most of farmers have at least diploma (51.61%). In contrast, in RM system the most frequency is for the group of farmers who have primary/secondary educations (39.87%). The percentage of illiterates in RM system is strictly higher than IRFC system.

Table 4: Farmers’ educational levels

<table>
<thead>
<tr>
<th>The percentage of frequency</th>
<th>IRFC system</th>
<th>RM system</th>
</tr>
</thead>
<tbody>
<tr>
<td>Illiterate</td>
<td>1.6</td>
<td>19.35</td>
</tr>
<tr>
<td>Primary/secondary school</td>
<td>24.19</td>
<td>39.87</td>
</tr>
<tr>
<td>High-school diploma</td>
<td>51.61</td>
<td>34.4</td>
</tr>
<tr>
<td>Associated degree</td>
<td>8.06</td>
<td>4.3</td>
</tr>
<tr>
<td>Bachelor degree</td>
<td>8.06</td>
<td>2.17</td>
</tr>
<tr>
<td>Master degree</td>
<td>6.48</td>
<td>0</td>
</tr>
<tr>
<td>Doctorate</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Gender
As farming is one of the most difficult activities, it needs physical/body strength. Relaying on this fact most of the farmers in both IRFC and RM systems are men. (Table.5).

Table 5: Farmers’ genders.

<table>
<thead>
<tr>
<th>The percentage of frequency</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>IRFC system</td>
<td>91.93</td>
<td>8.06</td>
</tr>
<tr>
<td>RM system</td>
<td>81.72</td>
<td>18.27</td>
</tr>
</tbody>
</table>

Professional Features Analyses
Farm management
The most popular farm management method in the case study was family farm management. Less than half of farms in both groups were managing in manager and worker method. (Table 6).

Table 6: Farm management and ownership.

<table>
<thead>
<tr>
<th>The percentage of frequency</th>
<th>IRFC system</th>
<th>RM system</th>
</tr>
</thead>
<tbody>
<tr>
<td>Family farm management</td>
<td>58.06</td>
<td>65.59</td>
</tr>
<tr>
<td>Manager and worker</td>
<td>41.93</td>
<td>34.41</td>
</tr>
<tr>
<td>Personal/family ownership</td>
<td>69.35</td>
<td>54.83</td>
</tr>
<tr>
<td>Renting</td>
<td>17.74</td>
<td>23.65</td>
</tr>
<tr>
<td>Shareholding</td>
<td>12.9</td>
<td>21.5</td>
</tr>
</tbody>
</table>
Farm ownership
Only 3 types of farm ownership were popular among farmers; Personal/Family ownership, renting, shareholding. In terms of importance, farm is a part of farmer's identity. Thus, over 50% of farmers were personal/family farms owners in both systems. (Table 6).

Farm-scale
In RM system, more than 75% of farms were smaller than 10,000 m². In contrast, 100% of farms in IRFC were larger than 10,000 m² because of the work type necessities.

Workshop and experiences
Collected data about agricultural knowledge and experiences shows that, farming in both systems was only relied on farmers' experiences. Table 7 explains this matter clearly. (Table 7).

<table>
<thead>
<tr>
<th>Table 7: Farmers' experiences and workshop attendancy.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>The percentage of frequency</strong></td>
</tr>
<tr>
<td>Farmers with related experiences</td>
</tr>
<tr>
<td>Farmers attended in related workshops</td>
</tr>
<tr>
<td>Farmers attended in related workshops and with related experiences</td>
</tr>
</tbody>
</table>

Production Function Estimation
In consideration of quantitative collected data, six production functions were estimated totally. The indexes are as same as what mentioned before (part 2.3) and cross-indexes show the inputs correlations. Moreover, parameter L shows the logarithm form of the equation.

These estimations are available here:

**RM system,**

*(Equation.1) Cobb-douglas:

\[
LY = 3.108 + 0.064Lf + 0.064LL + 0.063Llbr + 0.056Lm + 0.062Lp + 0.064Lsd + 0.460LW
\]

*(Equation.2) Translog:

\[
LY = -17.903 + 2.983LW - 4.411LP + 7.020LSD - 1.037LM + 1.948LLND + 4.785LLBR - 4.372LF - 0.184LW - 0.157LSD + 0.161LM - 0.727LMLLND + 1.479LMLLBR
\]

*(Equation.3) Generalized quadratic:

\[
Y = -747.201 + 1.017X_ad + 0.993X_{ld} + 0.019X_{sd} - 0.076X_f^2 + 0.5(0.034X_uX_p - 0.0002X_uX_{ad} + 0.173X_{ld}X_f - 0.675X_{ad}X_f - 0.0614X_{sd}X_p + 0.030X_{sd}X_u)
\]
**IRFC system**

*(Equation 4) Cobb-douglas:*

\[
LY = 13.498 - 0.023LBR + 0.283LFF + 0.451LFSH + 0.448LL - 0.024LM - 0.064LP - 0.088LSD + 0.0005LW
\]

*(Equation 2) Translog:*

\[
LY = -9.329 - 3.966LBR + 5.221LFF - 3.042LFSH - 3.117LL - 0.044LM - 4.241LP + 10.944LSD - 1.023LW - 0.630LBR + 0.2009LP - 0.598LSD + 0.5(-0.745LBRLFF - 2.752LBRLP + 2.214LBRLSD + 2.448LBRLW + 0.969LFFLFSH - 0.329LFFLP - 0.963LFFLW - 3.095LLLP + 4.511LLLSD - 1.248LLLW)
\]

*(Equation 6) Generalized quadratic:*

\[
Y = 4432677.919 + 48230.662FF - 108346.803FSH + 1025394.698LBR - 17805946.318LND + 2646378.2M - 598705.128P - 27320.515SD - 9.418W + 67.025FSH + 4140.848LBR + 46848426.982LND - 100651.377M + 8344.145P + 37.657SD - 1.707W + 0.5(-2097.159FP - 0.074FW - 12038.963FSLBR + 308898.977FSHLND + 8549.962FSHP - 3352740.572LBRLND + 379492.808LBRM - 4079.131LBRSD + 10.003LBRW - 652733.223LNDM - 286.359LNDW - 5.674PW + 0.184SDW)
\]

**Table 8: Production function superaority index.**

<table>
<thead>
<tr>
<th>Equation number</th>
<th>Sys.</th>
<th>$R^2$</th>
<th>Log-likelihood</th>
<th>Durbin-Watson</th>
<th>HQC</th>
<th>SBC</th>
<th>AIC</th>
<th>Significant ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equation. 1</td>
<td>RM</td>
<td>0.91</td>
<td>-7.68</td>
<td>1.3</td>
<td>0.28</td>
<td>0.33</td>
<td>0.25</td>
<td>%100</td>
</tr>
<tr>
<td>Equation. 2</td>
<td></td>
<td>0.93</td>
<td>19.97</td>
<td>1.5</td>
<td>0.37</td>
<td>0.75</td>
<td>0.11</td>
<td>%8</td>
</tr>
<tr>
<td>Equation. 3</td>
<td></td>
<td>0.95</td>
<td>-652.99</td>
<td>1.7</td>
<td>15.73</td>
<td>15.92</td>
<td>14.61</td>
<td>%81</td>
</tr>
<tr>
<td>Equation. 4</td>
<td>IRFC</td>
<td>0.99</td>
<td>117.84</td>
<td>1.4</td>
<td>-3.3</td>
<td>-3.2</td>
<td>-3.5</td>
<td>%55</td>
</tr>
<tr>
<td>Equation. 5</td>
<td></td>
<td>0.99</td>
<td>146.07</td>
<td>1.8</td>
<td>-3.7</td>
<td>-2.4</td>
<td>-4</td>
<td>%68</td>
</tr>
<tr>
<td>Equation. 6</td>
<td></td>
<td>0.99</td>
<td>-972.9</td>
<td>1.8</td>
<td>32.7</td>
<td>33.3</td>
<td>32.3</td>
<td>%58</td>
</tr>
</tbody>
</table>

**Production Function Selection**

The best econometric tools to choose the most efficient production function are listed in table 8. In RM system equation 3 (Generalized quadratic) is the most efficient. Mostly because of $R^2$-adjusted, log-likelihood and Durbin-Watson criteria. On the other hand, the best selection switch in IRFC system is equation 5 (translog) because of the results in its criteria, totally. Achieved values from these two production functions are study’s reliable results and the foundation for next assessments. (Table.8).

**Inputs Elasticities**

Inputs elasticities in each group calculated based on preferable production functions. (Table.9)

First, the results show both systems are same in using water. It means, fish live in rice extra irrigation

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8Hannan–Quinn information criterion (HQC).
9Bayesian information criterion (BIC) or Schwarz criterion (also SBC, SBIC).
10Akaike information criterion (AIC).
water and no more water is needed to add to the rice cultivation. Both rice and fish farming rely on water. So that, it can explain the equal amount of elasticity in two systems. Second, land elasticity in IRFC system is higher than RM. It is maybe because a IRFC farm needs larger field due to the matter of its work activity (fish need more space to live), the results follow the fact easily. Third, the negative elasticity of seed input in both systems shows that farmers try to maximize their rice yields by using more seeds but this high density reduce the total yield. Forth, In IRFC system, no fertilizer is needed and fish can fertilize soil completely. Fifth, to reduce destructive effects of pests, farmers in RM system use pesticides. Since pests have got more resistant to pesticides during decades, farmers use this factor more and more. This exceeding may not reduce the number of pests, but also it can reduce rice yield. Sixth, traditional farming in RM system into IRFC system relies more on labor, and less on machinery and this explain the difference between the amounts of machinery elasticities. Finally, no baby fish and fish food are needed in RM system. Feeding fish from paddy fields food sources such as pests and herbs is the reason of low elasticity in fish food.

**Table 9**: Inputs elasticities

<table>
<thead>
<tr>
<th>Input</th>
<th>Inputs’ elasticity in RM system</th>
<th>Inputs’ elasticity in IRFC system</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>0.054</td>
<td>0.05</td>
</tr>
<tr>
<td>Land</td>
<td>0.0000</td>
<td>0.423</td>
</tr>
<tr>
<td>Seed</td>
<td>-0.596</td>
<td>-0.191</td>
</tr>
<tr>
<td>Fertilizer</td>
<td>0.310</td>
<td>-</td>
</tr>
<tr>
<td>Pesticide</td>
<td>-6.046</td>
<td>0.777</td>
</tr>
<tr>
<td>Labor</td>
<td>1.028</td>
<td>0.415</td>
</tr>
<tr>
<td>Machinery</td>
<td>2.374</td>
<td>-0.044</td>
</tr>
<tr>
<td>Baby fish</td>
<td>-</td>
<td>0.619</td>
</tr>
<tr>
<td>Fish food</td>
<td>-</td>
<td>0.003</td>
</tr>
</tbody>
</table>

**Discussion**

Based on the findings of the description and analysis of the data, the following are needed to improve the overall performance of the farmers.

Regarding the operation and selection of a better and more efficient cropping method, it is recommended:

Due to the small size of farms in RM method, and lack of infrastructure, it is recommended for farmers to create farmers’ cooperatives to facilitate the operation of these lands. Land, with an area of more than one hectare not only simplifies the use of machinery on the farm, but also allows farmers to do in IRFC method if enough water is accessible. In order to avoid excessive use of rice seed in both methods, farmers are advised to replace traditional and local items with high quality and improved items. Due to the high amount of pesticide application and its lack of efficiency, it is suggested to find ways for face a biological struggle to deal with pests in RM system. By supportive principled trainings, farmers can be encouraged to make progress in their profession. So that, agriculture will be preserved as their ancestors and the migration of farmers to cities will be reduced. This leads a boom in rural agriculture by employing rural labor and increasing food security and their social welfare. The education and promotion of IFO can also be achieved through the expansion of their educational and promotional programs for farmers. It contributes to the optimal use of fish inputs, and maintains and nurtures them to use this quality input, which is very important to optimize, and ultimately produce a better product.

**Conclusion**

With regard to the results obtained from the surveys, both in the descriptive section and inferiority, it was concluded that farmers in IRFC, in terms of economic (inferential results) and general living conditions (descriptive results) are living in a better condition. In addition, IRFC system has more
benefits such as increasing environmental sustainability; reducing environmental pollution; pest control and weed control creating a sustainable agriculture platform; increasing in water-soluble oxygen content; faster oxidation, rehabilitation, and soil productivity enhancement; creating a mineral cycle and bring it back to the soil; reducing production costs; rising production level and increasing farmers' income; reducing production risk.

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References


De Datta SK, Tauro AC. 1968. "Effect of plant type and nitrogen level on growth characteristics and grain yield of indica rice in the tropics". Balaoning.


Fisheries and Aquaculture Department (FI) under the ownership of "FAO". Retrieved 20 March 2011 Ecosystems. "Rice paddies".


