Determinants of Adoption of Pond Fish Farming Innovations in Salamaua of Morobe Province in Papua New Guinea

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Abstract

Pond fish farming, introduced in the 1960s, remained an underdeveloped industry due to no policy support. About two decades ago, the industry was revived with emphases placed on smallholder production. Four fish production innovations were introduced, as a part of this program, to improve production and income of farmers and in the process, engage youth. This study, conducted at Salamaua, was aimed at determining the extent of and the factors that influence the adoption of four innovations disseminated. Thus, primary and secondary data collected were on the socioeconomic characteristics of the farmers, extent of innovation adoption and problem confrontation of farmers in adopting innovations. The pond liming and fertilizing innovation, which ranked number 1, was adopted by all the farmers followed by 56, 52 and 30 percent adoption for stock density, sampling and sexing and feed formulation in that order of ranking respectively. About 96 percent of the farmers categorized problems they faced as medium to high problems and ranked poor infrastructure as problem number 1 followed by lack of knowledge and skills, lack of marketing facilities, lack of extension contact, poor performance of fingerlings, and lack of local quality feed. Annual income and family size were the most important attributes influencing adoption and problem confrontation in adopting introduced innovations respectively. Although the innovations were disseminated to improve production and income of farmers, their dissemination was not adequately supported through farmer training and extension, market access and credit acquisition.
Key words: adoption, innovations, pond fish farming, problem confrontation, smallholder fish farmers

Introduction

At its most basic level, food security is concerned with securing a balanced meal for individual families of a given society. It is often supported by governments through state intervention programmes aimed at securing adequate food supply through crop and livestock production for the most important basic units of society, the families of

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rural communities.

Papua New Guinea (PNG) is a signatory to the FAO agreement on food security. An aspect of that agreement is the recognition given to freshwater fish farming to provide for the protein needs of the rural population (ACIAR 2007). Fish farming constitutes farming fish in fresh, brackish and sea water under controlled conditions with production interventions (FAO 1994). An example of such a farming situation recognized is the rearing of fish in man constructed ponds with water flow controls, regular stocking, feeding and protection of fish from predators.

Fish farming is gaining popularity and increasingly supported due to a number of reasons. At the global level, there is an apparent decline[1] in global catches particularly marine captured fisheries (FAO 2006, 2010, 2012, MILLER 2009). This would affect the seafood supply which accounts for one-third of the world's total food supply (FAO 2006). In this regard, fish farming offers a potential solution to meeting the growing demand for seafood that marine captured fisheries cannot provide (FAO 2006, MILLER 2009). At the national level, fish farming can help not only support securing national food security but also improve farmer family nutrition and income (ACIAR 2007). Moreover, fish farming offers the best solution for the utilization of organic wastes, unproductive[2] land, and aquatic resources and at the industrial level, fish meal as animal feed (FAO 2006).

Pond fish farming, as a technology, was introduced in PNG in the 1960s. Its introduction was to help reduce the presence of high malnutrition level of the inland population of the country (ACIAR 2007). Fish farming, however, has since been given no attention to its development as an industry. Even PNG being a signatory to FAO for food security did little to improve the fish farming situation in the country. The stagnant nature of its development was largely due to, among others, lack of policy direction to develop fish farming as an industry[3]. Consequently, it lacked the provision of a good extension service to transfer fish farming innovations thereby preventing the spread of the nutritional and financial benefits to farmers as well as the technical skills of farming to rural communities (ACIAR 2007).

In the past two decades, the National Fisheries Authority (NFA), with support from the government, has revived pond fish farming throughout the country. Given this push by the NFA and ably supported by the Australian Center for International Agricultural Research (ACIAR) and Japanese International Cooperation Agency (JICA), fish farming activities got started everywhere by involving real time farmers. For example, in 2001 (ACIAR 2007), some 5,418 famers were doing farming of which 4, 880 were located in the highlands of PNG. Assuming an average PNG family size of 5, fish farming could influence the nutrition and income of some 27,090 people.

1 This can happen largely due to over fishing where catches can be anything and everything using fishing nets on a regular basis.

2 Land that cannot be productively used for agricultural production and for homestead needs such as land on hill sides.

3 During the same period, export tree crops such as coffee, cocoa, rubber and tea were introduced and much of the focus was on the development of this sector.

Thus, for the first time since the 60s, the government, ACIAR, JICA, NFA and extension providers are working together to identify impediments, develop fish farming innovations and implement strategies to providing fish farming innovations, farmer training and the provision of extension services in the dissemination of the innovations (WANI 2004). There is thus an emerging real partnership forged between government agencies, donor agencies and extension service providers aimed at improving income generating opportunities for farmers.

Farmed fish production is reported to be insufficient to meet the growing demand for fish in the country (WANI 2004) implying that farmed fish production must be increased. The increase in the production of farmed fish or lack of it is influenced by how successfully fish farmers are adopting the fish farming innovations disseminated. Essentially, the key to improving production is the effective transfer of the fish farming innovations.

Adoption of a new technology has been described as an "innovation decision process" where the innovation passes through from the time of first knowledge of it to the decision stage of either to reject or adopt it to the confirmation stage of the reject or adopt decision made at the decision stage (ROGERS 1995, EKONG 2002). Essentially, it takes time for the farmers to first become aware of the existence of the innovation. They then take a decision on either to adopt or reject the innovation (decision stage) after evaluating it. The decision made at the decision stage is at a later date confirmed based on the evidence available at that stage.

The adoption-rejection decision of the farmer is thus dependent on the degree of risk involved relative to the existing practices. In that regard, the adoption or rejection decision is based on the characteristics of the innovation, the socioeconomic conditions of farmers as well as their social, physical and cultural environments which drive them (JONES 1987). Ideally then, the profitability of the innovation relative to the existing practice must be adequately demonstrated to farmers (WETENGERE 2008). The fish farming technologies are adopted only when farmers are convinced that fish farming is profitable and would benefit society (CHI and YAMADA 2002, STANLEY *et al*. 2010). In addition, adoption of innovations is also influenced by the farmers' economic motivation (WETENGERE 2010), resources endowment (NWEKE 1981, WETENGERE 2008, 2010) and access to information (WETENGERE 2010), education and trainings (NJANKOUAWANDJI *et al*. 2012), and access to funds to maintain ponds and buy feeds (Ike and ROSELINE 2007), degree of accessibility to of innovations by farmers and extension methods used (NWEKE 1981).

Essentially, to give the farmers a fair chance of evaluating the potential benefits of the innovations, they must be properly linked to service providers for extension services and training (NJANKOUAWANDJI *et al*. 2012), and credit institutions for their credit needs (IKE and ROSELINE 2007), in addition to establishing clear marketing linkages where possible and easy access to innovations disseminated. Thus, fish farmers justify adoption or rejection of the introduced innovations based on the foregoing range of attributes.

The NFA has disseminated four fish farming innovations namely (i) liming and fertilizing, (ii) stock density, (iii) fish feed formulation, and (iv) sampling and sexing. These innovations, which are being disseminated as a package, must be adopted together for farmers to realize maximum benefit and in the process increase production to help meet local demand for fish. Given the dissemination of these innovations in the Morobe Province, no information is available on how successfully they are adopted and the factors that affect their adoption. This study was, therefore, conducted aimed at determining the extent of the adoption of the innovations disseminated and moreover, to identify the factors influencing the adoption decisions of the farmers. This information, when become available, are useful for policy, research and extension.

Data Collection and Analysis

Selection of Farmers

The research was conducted in Salamaua, an area located in the Huon Gulf District of Morobe Province of Papua New Guinea. The study site was purposively selected due to its active promotion of pond fish farming activities. Salamua, although situated closer to Lae city, the administrative capital of Morobe Province but is inaccessible by road. The only way out is by sea[4].

A prior check with Provincial Department of Agriculture and Livestock (PDAL), Bris Kanda[5], and even from District DAL Office, revealed that there was no registry of fish farmers existed anywhere in these places to be used as a sampling frame. Essentially, 23 farmers[6] were selected for interview using the snowball sampling method. The approach used was to interview the next farmer that the researcher comes into contact while walking through the village areas. The interview process includes observation of the fish pond sites. The households were scattered so the researcher walked throughout the study area. Given that fish farming is a new technology, not many farmers are expected to be involved in fish farming. Essentially, although the study sample is less than 30, it is believed that the sample is representative of the population.

Data

The data was collected over a two week period in June/July, 2011 with the help of two research assistants[7]. The data collected were on the selected socio-economic

4 All service provisions either by private or government and all businesses are conducted by sea transport including transporting fish and garden produce for marketing in Lae city. Infrastructural development is poor and access to services is also poor

5 Bris Kanda is a Non Government Organization which provided extension services to fish farmers in the area.

6 The 23 farmers selected are males and the heads of families who did fish farming.

7 The two research assistants are two postgraduate students that did their postgraduate diploma in Agriculture.

characteristics of the fish farmers and the level and extent of adoption of innovations and anticipated problem confrontation in the adoption of fish farming innovations. The data collection instruments used constituted a structured questionnaire, observations and two research assistants. The questionnaire was read to the respondents and the responses received were recorded.

Measurement of Dependent Variables

Dissemination of four Innovations

Four fish innovations disseminated to farmers were chosen for this study. They are (i) pond liming and fertilizing - which is the fertilization and liming of the fish ponds to increase fish weight gaining and production[8], (ii) stock density - is to introduce and maintain the correct fish population in a given pond to promote maximum growth, (iii) fish sampling and sexing - is the process involved in determining the sexes (male or female) from a sample of fish in the pond, a process that helps maintain correct stock density, and (iv) fish feed formulation - involves preparing a balance fish feeds from locally available food stuff and byproducts. These innovations, disseminated as a bundle, were aimed at improving both fish quality and production as a sources of income.

Extent of Adoption of Innovations

There were four categories of adopters, viz., innovators, earlier adopters, late adopters and laggards. The farmers were categorized into these groups after discussing with them the time it took them to adopt an innovation. Most farmers were not able to distinguish between early adopters and earlier majority categories. Therefore, these categories were grouped together as early adopters. The innovators were the fish farmers who adopted an innovation within 6 months after its introduction while for the early adopters; it took them about one to one and a half years to adopt it after it was introduced. For the late adopters, it took them two years while for the laggards two and a half to three years to adopt the innovation after it was introduced. It must be noted that, the adopter categories were done arbitrarily based on farmer memory recall. Furthermore, the farmers are resources poor. Thus, all things being equal, the farmers ability to adopt an innovation was entirely based on the resources they have and for most, they get things done with what they have. Essentially, the adoption rates vary considerably from the standard adoption rates of Rogers often found in adoption-diffusion of innovation literature.

The adoption for each of the innovations disseminated was measured by computing an adoption score. Each of the respondent was, thus, read to each of adoption category to which the respondent responded by identifying his/her adopter category as "innovator, earlier adopter, late adopter and late adopter" since the

8 Fertilizing the ponds promotes the growth of phytoplankton (microscopic green plants) while liming helps improve water quality and stabilize pH of bottom mud and increases production of aquatic insects. Liming and fertilizing therefore help the production of food for pond fish.

innovation was introduced in the area. Each of these responses received a score of 3, 2, 1 and 0 for innovators, earlier adopters, late adopters and laggards respectively. The scores received for each of the innovations was then added up to determine the adopter score of an individual respondent. The adopter scores of a respondent could vary between zero and 12, zero indicating no adoption (laggards) and 12 indicating adoption (innovators).

The extent of adoption of the fish pond innovations disseminated was measured by computing the farmers total adoption index (TAI) as:

$TAI=(A_1x3)+(A_2x2)+(A_3x1)+(A_4x0)$

Where; A1 = No. of farmers as innovators; A2 = No. of farmers as early adopters; A3 = No. of farmers as late adopters; A4 = No. of farmers as laggards. The TAI for each adopter category can vary between zero and 69, zero indicating no adoption and 69 indicating full adoption of the innovation.

Extent of Problem Confrontation

The anticipated problem confrontation[9] in the adoption of the innovations disseminated for each farmer was measured by using a four-point Likert scale. The farmers were asked to indicate 7 problems (poor infrastructure, lack of knowledge and skills, lack of marketing facilities, lack of extension contact, poor performance of fingerlings, lack of local quality fish feed and a composite of others - stealing, etc) which, in their opinion, affect non-adoption of innovations disseminated and the responses received were categorized as "no problem, low problem, medium problem and high problem" with each receiving a score of 0, 1, 2, and 3 respectively. The scores received for each of the problems was then added up to determine the problem confrontation score of an individual respondent. The problem confrontation scores of an individual could thus vary between zero and 21, zero indicating problem as no problem for adoption and 21 indicating problem as high problem for adoption.

The extent of anticipated problem confrontation for adoption of the fish pond innovations disseminated was measured by computing the farmers' total Problem Confrontation Index (TPCI) as:

$TPCI=(A_1x3)+(A_2x2)+(A_3x1)+(A_4x0)$

Where, A1 = No. of farmers rating problem faced as high problem; A2 = No. of farmers rating problem faced as medium problem; A3 = No. of farmers rating problem faced as low problem; A4 = No. of farmers rating problem listed as no problem

The TPCI for each adopter category can vary between zero and 69, zero indicating problem as no problem and 69 indicating problem as high problem for the adoption of an innovation.

9 Problem confrontation is aimed at isolating the problems which the farmer deemed important to be addressed for the development of the fish farming industry.

Measurement of Independent Variables

The socioeconomic characteristics of the respondents such as age, education level, farming experience, family size, pond (farm) size, annual income and cosmopoliteness were taken as the independent variables. Age was measured in years from birth, education was measured as the number of years of schooling, farming experience as number of years in farming fish, family size was measured as the number of persons in the family, pond size is measured in squared meters, annual income is income earned by fish farming family and is valued in PNG Kina[10], and cosmopoliteness is measured as number of trips made outside of his village.

Data Analysis

The data were analyzed using descriptive statistics, such as the mean, frequency distribution, percentages, and standard deviation. These descriptive statistics were used to describe the variables used in the study. Pearson Product Moment Correlation Coefficient was used to determine the relationships between the dependent and independent variables of the study. The descriptive and the correlation coefficients were computed using the SPSS computer program.

Results and Discussions

Socioeconomic Characteristics of the Farmers

The results of the socio-economic characteristics of the fish farmers are presented in Table 1.

Age: The majority of the farmers (96%) were found to be relatively young (young and middle aged groups) and were observed to be the most active farmers. Given that fish farming requires adequate attention and responsibilities, the middle aged group was to be the most important group in the rural communities (OFUOKU *et al*. 2008), also a finding of this study. The participation of the younger aged groups is important in two respects; first is for the development of the pond fish farming industry in the country and secondly, their involvement in the cash economy through fish farming was expected to prevent them from moving to urban areas and causing social activities in the rural villages.

Education: Majority of the farmers (69.6%) received formal schooling, although most of them up to grade 8 (52.2%) while the remaining 30.4 percent were found to be illiterate. It would appear that children in Salamaua have better access to primary and secondary education, largely due to better access to government services including primary and secondary schools. Education, according to DROST (1998) helps guide individuals to process information with respect to their needs and problems and makes better decision to overcome them in their own locality. Essentially, the high level of

10 PNG Kina is the legal currency of Papua New Guinea and a PNG Kina : US $ 0.40

Table 1. Socio-economic characteristics of the pond fish farmers.

Characteristics	Measurement	Categories	Number (N=23)	Percent (%)	Mean	Standard Deviation
Age	Numbers of Years	Young age (20-30)	10	43.5	30.09	7.23
		Middle age (31-40)	12	52.2		
		Old age (Above 40)	1	4.3		
Education Level	Number of Years completed	Illiterate	7	30.4	3.70	3.43
		Primary (1-8)	12	52.2		
		Secondary (9-12)	4	17.4		
		Tertiary (above 12)	0	0		
Farming Experience	Number of Years	Less experience (1-3)	7	30.4	4.39	1.23
		Medium experience (4-6)	16	69.6		
		High experience(above 6)	0	0		
Family size	Number of family members	Small (up to 4)	4	17.4	6.04	2.38
		Medium (5-7)	15	65.2		
		Large (above 7)	4	17.4		
Farm (pond) size	Hectares (ha)	Small (up to 0.5)	1	4.4	1.59	1,24
		Medium (0.6-1.0)	13	56.5		
		Large (above 1.0)	9	39.1		
Gross Annual Income	In Unit scores	Low (< K5,000* = 1 unit)	17	73.9	2.12	1.35
		Medium(K5,000-K10,000 = 2 units)	6	26.1		
		High(> K10,000 = 3 units)	0	0		
Cosmopoliteness	Scoring	Low (up to 3)	5	21.7	2.09	0.79
		Medium (4-6)	7	30.4		
		High (above 6)	11	47.8		

* The current exchange rate of PNG Kina to USD is PNG Kina 1: US$ 0.40.

education attainment found in the study site helps farmers to pick up fish farming skills by reading and communicating effectively with development officers.

Experience: A higher proportion (70%) of the farmers had a medium level of exposure to fish farming. While this is true, all the farmers have years of experience ranging from 1 to 6 years suggesting that they are still on the learning curve. The innovations introduced are relatively new and as the farmers continue to learn and do farming their level of experience will grow and skills for farming will sufficiently be developed.

Family Size: About 82.5 percent of the pond fish farmers had small to medium family sizes, implying that most of the fish farmers were young and active, an outcome already noted. Given this result, the older age group tend to have a larger family size implying that through the young members comes the necessary labor force needed to undertake fish farming activities. Pond fish farming is a labor intensive activity and family sizes are considered as an important parameter (Niyaki and Allahyari 2010), a finding that prevails at Salamaua.

Farm Sizes: About 95.6 percent of the pond fish farmers owned medium to larger farm sizes while the remaining 4 percent have small farms. A farmer, on average, operates up 3 to 4 ponds. Farmers tend to increase farm size and thereby production when they have accessed improved production information (Ofuoku *et al*. 2008). With improved information, this can easily be done as the farmers at Salamaua have plenty of land.

Annual Income: All the fish farmers earned incomes less than K10,000, however, 74 percent of them with incomes less than K 5,000. Although marketing of fish was conducted at the local markets, most of the fish were produced by the lower income categories as well as some from the medium to large categories appeared to be consumed at home. Selling price for fresh fish at the local markets are normally low when compared to fish prices at Lae Urban local markets. Economic factors (MALPANI 2011) such as the price of fish promotes adoption of sustainable agricultural practices. There is thus, a greater need for marketing outlets for the farmers to sell their produce to earn a higher level of income.

Cosmopoliteness: About 48 percent of the farmers' cosmopolite more frequently while there is less frequent travel for 52 percent of the fish farmers. Nevertheless, almost all farmers left home to visit other places more than once and such movements could help them acquire new ideas, skills and knowledge regarding fish farming which could become the driving tools to improve fish farming practices in their farms. Moreover, farmers with high contact outside of their social system could help adopt innovations faster by observing other farmers (TALUKDAR and SONTAKI 2005).

Adoption of Innovations

The adoption of the pond fish farming innovations results are presented in Table 2. The innovations introduced were such that when adopted together could help sustained production and sale of fish. As shown in Table 2, the adoption patterns for the pond fish farming innovations disseminated were similar except pond liming and fertilizing

Table 2. Distribution of Adoption of Pond Fish Farming Innovations.

Innovations Disseminated	Categories	Number (N=23)	Percent (%)	Mean	Standard Deviation
Pond liming and fertilizing	Laggards (0)	0	0	2.30	0.56
	Late Adopters (1)	1	4.3		
	Early Adopters (28)	14	60.9		
	Innovators (18)	8	34.8		
Stock density	Laggards (0)	10	43.5	1.00	1.09
	Late Adopters (5)	6	26.1		
	Early Adopters (12)	4	17.4		
	Innovators (9)	3	13.0		
Fish sampling and sexing	Laggards (0)	11	47.8	1.04	1.15
	Late Adopters (5)	3	13.0		
	Early Adopters (8)	6	26.1		
	Innovators (3)	3	13.0		
Fish feed formulation	Laggards (0)	16	69.6	0.61	1.08
	Late Adopters (4)	3	13.0		
	Early Adopters (18)	1	4.3		
	Innovators (15)	3	13.0		

innovation which was adopted early when introduced.

Pond liming and fertilizing innovation was quickly adopted[11] by 35 percent of the farmers as innovators followed by 61 percent of the farmers as early adopters. Pond liming and fertilizing[12] was quickly adopted as it was an important sources of feed for the fingerlings to establish themselves as they are introduced to the pond.

For stock density, it was quickly adopted by 13 percent of the farmers (innovators) when it was introduced followed by 17.4 percent of the farmers as early adopters and 26 percent as later adopters. On sampling and sexing innovation, 13 percent of the farmers (innovators) adopted the innovation as soon as it was introduced, followed by 26 percent as early adopters and 13 percent as late adopters. For feed formulation, the innovation was quickly adopted by 13 percent of the farmers (innovators) when introduced followed by 4 percent of farmers as early adopters and 13 percent as late adopters.

An important feature that surfaces is that, although the time of adoption varied among farmers, the pond liming and fertilizing innovation was adopted by all the sampled farmers (100%) while stock density, fish sampling and sexing and feed formulation innovations were adopted by 56, 52 and 30 percent of the farmers for those innovations respectively. These results are invariance with the results on the extent of the adoption of these innovations presented in Table 3 with the adoption of pond liming and fertilizing ranked number 1 followed by stock density, sampling and sexing and feed formulation.

The last group of farmers is the laggards, who have waited until late when the innovations have already gone past one after another after they were introduced (Mawusi 2004). About 44, 48 and 70 percent of the farmers were found to be laggards in the adoption of stock density, sampling and sexing and feed formulation innovations respectively. These are a group of farmers who are poorly resourced. Thus, given the poor provision of marketing and extension services, they decide to adopt what they with what they have.

The stock density innovation involves cleaning the pond to create space for fish multiplication, growth and development. A part of the growth and development

Table 3. Extent of adoption of pond fish farming innovations (N=23).

No.	Types of Innovation	Innovators (3)	Earlier Adopters (2)	Late Adopters (1)	Laggards (0)	TAI	Rank
1	Pond liming and fertilizing	8	14	1	0	53	1
2	Stock density	3	6	3	11	24	2
3	Fish sampling and sexing	3	4	6	10	23	3
4	Feed formulation	3	1	3	16	14	4

11 This is an activity that needs to be done before the fingerlings are introduced to the ponds.

12 Chicken manure was commonly used for pond fertilizing. This was important for fingerlings early growth and development. Chicken manure is cheaper to obtain from chicken grower in the area.

Table 4. Distribution of farmers according to their Anticipated Problem Confrontation in the Adoption of Pond Fish Farming Innovations.

Categories	Number (N=23)	Percent	Mean	Standard Deviation
Low (up to 4)	1	4.4		
Medium (5-9)	7	30.4	2.28	0.68
High (above 9)	15	65.2		

process is to separate the fingerlings to different ponds according to their sizes. They are the time consuming labor intensive activities. The fish feed formulation activity is practiced only when feed ingredients are available. The development of feed requires buying some ingredients which are not affordable and the development of the feed is time consuming and labor intensive as well. The other option is to buy commercially prepared feed but the farmers were not able to afford that as well.

The decision to either accept or reject an innovation depends on an individual farmer who engaged in farming activities (Mawusi 2004). The innovations in this study were adopted at a very slow pace or practiced when needed to be done because farmers had to make their choices on which innovations they wanted to practice in relation to their fish farming situations, given the limited resources they have.

Problem Confronted by Farmers

The distribution of farmers according to their anticipated problem confrontation of selected problem items in adopting fish farming innovations are given in Table 4. About 65 percent of the farmers rated problems faced as the high problem category followed by 30 percent and 4 percent of the farmers in the medium and low problem categories respectively. These outcomes provide the reasons for the slow or non-adoption of the innovations disseminated but it is thus far less clear as to which anticipated problems influenced such an adoption outcome.

As indicated in Table 5, of all the problems anticipated, poor infrastructure was ranked as problem number one followed by lack of knowledge and skills, lack of marketing facilities, lack of extension services, poor performance of fingerlings, lack of local quality fish feed, and other problem such as water, disaster, stealing, and such in the like. The seventh anticipated problem - other, is thus a composite of all other problems not listed above. These problems provide the reasons for non-adoption or slow adoption of innovations disseminated. It must be noted that farmer lack of knowledge and skill and poor performance fingerlings are problems can be addressed by the farmers themselves while the remaining problems listed in Table 5 are beyond the control of the farmers and can be solved by external sources such as the government and its agencies and extension service providers, among others.

Infrastructure constitutes roads, schools, health services, and even provision of marketing facilities. An infrastructure that opens the outside world and opens the door for conducting business is the presences of a good road network. Salamaua is, one

Table 5. Anticipated Problem Confrontation of Farmers in Adopting Fish Farming Innovations (N =23).

No.	Problems	Extent of Problems				PCI	Rank Order
		High (3)	Medium (2)	Low (1)	No problem (0)		
1	Poor infrastructure	22	0	1	0	67	1
2	Lack of knowledge and skills	21	1	1	0	66	2
3	Lack of marketing facilities	19	4	0	0	65	3
4	Lack of extension contact	18	5	0	0	64	4
5	Poor performance of fingerlings	17	6	0	0	63	5
6	Lack of local quality fish feed	10	13	0	0	56	6
7	Others (water problem, disaster, stealing, etc)	0	10	11	2	31	7

area, not linked by road and the only way out to access government services and be connected to Lae City, the administrative centre of Morobe Province is by sea transport. Given the non existence of a road net work and the irregularity of sea transport do not adequately linking extension providers to farmers and marketing facilities to farmers. Essentially, farmers find it difficult to conduct business due to poor infrastructure (ACIAR 2007, Bris Kanda 2007). Apparently, the level of extension provided is low. Lack of knowledge and skills is due to provision of low level of extension services and together with poor infrastructure; absence of market facilities and even lack of credit facilities in addition to farmers with inadequate resources would make the adoption of innovations disseminated difficult and the increased production of fish and income earning capacity objectives of the farmers are not maximized.

Majority fish farmers (74%) with low income could not afford commercial feeds. This requires the need for fish farmers to source local feed which must be seriously addressed by service providers. Other problems such as stealing, water problems, and natural disasters do not occur frequently but when they do occur, they affect the operations of the fish farmers, the sentiments which are also shared by ACIAR (2007) and Bris Kanda (2007). Furthermore, problems faced by farmers can also affect the utilization of information among the rural fish farmers (Ofuoku *et al*. 2008) and can make adoption of innovation difficult.

When compared to available literature, innovations would be rejected when the profitability relative to an existing practice is less (Wetengere 2008, Stanley *et al*. 2010), less resources endowment (Oladele 2006, Adeokun *et al*. 2008, Wetengere 2008), inadequate provision of markets, inadequate provision of extension service, training and support (Nweke 1981, Njankouawandji *et al*. 2012) and lack of access to credit (Ike and Roseline 2007). If, on the other hand, the relative profitability is high compared to the existing practice but farmers faced problems in adopting them as introduced, the innovations are modified (Wetengere 2008) to suit their situation. This practice limits the full realization of the potential benefits from the innovations, a case observed to be practiced at Salamaua. Given the drawbacks, production of fish is done

for the subsistence needs of the farming families as first priority with the surplus sold in the local markets. With the subsistence production outlook, the goal of involving youth meaningfully in the cash economy through fish farming is unlikely to be achieved.

Relationships of the Extent of Adoption and Problem Confrontation with Selected Socioeconomic Characteristics

The relationships between the selected socio-economic characteristics and the extent of adoption of innovations and extent of anticipated problems confrontation of the farmers are given in Table 6. The results indicate that these relationships were statistically not significant except the relationship between adoption and annual income and the relationship between problem confrontation and family size.

The relationships between extent of adoption and the socioeconomic variables fitted were all positive except age, family size, and pond size which were negative. The positive relationships suggest that the adoption of innovations increased with education level, farming experience, annual income and cosmopoliteness.

On the other hand, adoption of innovations decreases with age, family size and farm size. The negative relation between adoption and age is expected since older people will not endure physically demanding farming activities. The negative relationship between adoption and family size suggests that adoption increases with decreases in family size. This relationship was expected since 83 percent of farmers were young (young and medium categories) with young families. Moreover, the inverse relationship between adoption and pond size suggests pond sizes increased with a decrease in adoption. This relationship was although not expected; farmers do have larger farm sizes constructed to farm fish before the innovations were actually introduced.

The relationships between anticipated problem confrontation and the selected socioeconomic characteristics were all positive except annual income. The inverse relationship between annual income and problem confrontation was expected given that the majority of the famers indicated problems faced as high problems affecting fish farming. Problem confrontation increased with family size suggesting that most of the

Table 6. Correlation between independent and dependent variables (N=23).

No.	Independent Variables	Extent of Adoption	Problem Confrontation
1	Age	− 0.003	0.096
2	Education Level	0.270	0.183
3	Farming Experience	0.213	0.258
4	Family size	− 0.151	0.408*
5	Farm (pond) size	− 0.063	0.208
6	Annual Income	0.663*	− 0.001
7	Cosmopoliteness	0.297	0.010

* Significant at 10 percent level of probability.

problems identified were beyond the farmers control to find solutions to it.

Summary and Conclusions

Four pond fish farming innovations disseminated, as a package, were aimed at improving production and income of farmers. Of the four innovations, the liming and fertilizing innovation was quickly adopted. About 96 percent of the farmers indicated problems faced as medium to high problems and ranked poor infrastructure as the number 1 problem followed by lack of knowledge and skills, lack of market facilities and lack of extension service provision. Consequently, the slow or non-adoption of the innovations were caused by the problems farmers encountered. Most of the solution to these problems need to be addressed by the government, it agencies and service providers. Annual income was found to be the most important socioeconomic attribute that positively influenced adoption of innovations while family size also positively influenced anticipated problem confrontation in the dissemination of innovations. The intent of the dissemination of the innovations was to increase production and income of farmers. These objectives were not achievable due to inadequate support provided through training and extension and lack of marketing facilities and the general poor provision of infrastructure in the study area. Given this state of outlook, the long term strategy of engaging the young in fish farming to reduce urban drift and social problems in the rural societies do not seem promising unless immediate steps are taken to address the problems encountered. In the short term, a sustained approach to providing extension services, farmer trainings and marketing support for fish sales seem necessary.

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References

ADEOKUN, O. A., AJANA, A. M., AYINLA, O. A., YARHERE, M. T. and ADEOGUN, M. O. 2008. Application of Logit Model in Adoption Decision: A Study of Hybrid Clarias Lagos State, Nigeria. American-Eurasian Journal of Agricultural and Environmental Sciences, 4: 468-472.

ACIAR 2007. Aquaculture in PNG: Status of Fresh Water Fish Farming. Australian Centre for International Agricultural Research, Canberra.

BRIS KANDA 2007. Market Linkages and Business Analysis - Huon Gulf District, Morobe Province, Papua New Guinea.

CHI, T. T. N. and YAMADA, R. 2002. Factors Affecting Farmers' Adoption of Technologies in Farming System: A Case Study in Omon District, Can Tho Province, Mekong Delta. Omonrice, 10: 94-100.

DROST, D. and HALES, L. K. 1998. Targeting Extension Efforts for the Adoption of Sustainable Farming Practices. Journal of Extension, 36(5).

EKONG, E. E. 2002. An Introduction to Rural Sociology. Jumak Publisher, Nigeria.

FAO 1994. Handbook on Small-scale Freshwater Fish Farming. FAO, Rome.

FAO 2006. The State of Food Security. FAO, Rome.

FAO 2010. Fishery and Aquaculture Statistics. FAO Year Book, Rome.

FAO 2012. The State of World Fisheries and Aquaculture. FAO, Rome.

IKE, N. and ROSELINE, O. 2007. Adoption of Aquaculture Technology by Fish Farmers in Imo State of Nigeria. Journal of Technology Studies, 33:57-64.

JONES, D. 1987. World Agricultural Economics and Rural Sociology Abstract, 9:917.

MALPANI, N. 2011. Agricultural Innovation in Rural India: The Paradox of Farmers Non-adoption in Bajwada Pradesh. Universal-Publishers, Florida.

MAWUSI, B. 2004. Farmers' Knowledge and Perception towards a Sustainable Adoption of Sugar Beet in Kenya. Lund University, Sweden.

MILLER, J. 2009. Farm Ponds for Water, Fish and Livelihoods. FAO, Rome.

NIYAKI, A. and ALLAHYARI, A. 2010. Socio-Personal Characteristics on The Adoption of Rice Fish Culture System in Northern Iran. African Journal of Research, 5: 3470-3476.

NJANKOUAWANDJI, D., POUOMOGNE, V., NYEMECK BINAM, J. and YOSSA NOUAGA, R. 2012. Adoption of New Aquaculture Technologies in the Western Highlands of Cameroon. Tropicacultura, 30: 180-184.

NWEKE, F. I. 1981. Determinants of Agriculture Progressiveness in the Smallholder Cropping System of South Eastern Nigeria and Consequences for Research and Extension Administration. Agricultural Administration, 8: 163-176.

OFUOKU, A. U., EMAH, G. N. and ETEDJERE, B. T. 2008. Information Utilization Among Rural Fish Farmers in Central Agricultural Zone of Delta State, Nigeria. World Journal of Agricultural Science, 4: 558-564.

OLADELE, O. I. 2006. A Tobit Analysis of Propensity to Discontinue Adoption of Agricultural Technology among Farmers in Southwestern Nigeria. Journal of Central European Agriculture, 6: 249-254.

ROGERS, E. M. 1995. Diffusion of Innovations, 4th edition. Free Press, New York.

STANLEY, J., Clouston, B. and Baker, R. 2010. Understanding Land Manager Constraints to the Adoption of Changed Practices or Technological Innovations. Advanced Journal of Food Science and Technology, 2: 55-62.

TALUKDAR, P. K. and SONTAKI, B. S. 2005. Correlates of Adoption of Composite Fish Culture Practices by Fish Farmers of Assam, India. The Journal of Agricultural Sciences, 1: 12-18.

WANI, J.A. 2004. The Status of Aquaculture Development in Papua New Guinea: An Information Paper. National Fisheries Authority. Port Moresby.

WETENGERE, K. 2008. Determinants of Adoption of A Recommended Package of Fish Farming Technology: The Case of Selected Villages in Eastern Tanzania, Maxwell Scientific Organization, Tanzania.

WETENGERE, K. 2010. Determinants of Adoption of A Recommended Package of Fish Farming Technology: The Case of Selected Villages in Eastern Tanzania. Advanced Journal of Food Science and Technology, 2: 55-62.