Universal Journal of Agricultural Research 2(6): 191-197, 2014 http://www.hrpub.org
DOI: 10.13189/ ujar.2014.020602

Factors Influencing Adoption of Pond Fish Farming Innovations in Potsy of Morobe Province, Papua New Guinea

Susan Singas, Peter Manus*

Department of Agriculture, PNG University of Technology, Private Mail Bag, LAE 411, Morobe Province, Papua New Guinea
*Corresponding Author: pmanus@ag.unitech.ac.pg

Abstract **P**ond fish farming, although introduced in the 1960s, remained undeveloped due to no policy support. In the past decade, it has been revived, due to government support through NFA with collaboration from ACIAR. As part of this program, four innovations were disseminated to farmers to improve their production and income. This study, conducted in Potsy, was aimed at assessing the extent of and the factors that influence the adoption of the innovations disseminated. Pond liming and fertilizing innovation was adopted quickly as it was introduced while feed formulation, stock density , and sampling and sexing innovations were, for majority of farmers (<50%) practiced when needed. Moreover, majority of the farmers (89%) rated problems they faced as high problems. Lack of knowledge and skills was ranked number 1, followed by cost of commercial feed, lack of marketing facilities, lack of local quality feed, misuse of funds and lack of credit facilities. Age was found to be significant but negatively influenced extent of adoption and problem confrontation while farm size was significant and impacted positively on farmer problem confrontation. 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.

Keywords Village Fish Farmers, Pond Fish Farming, Innovations, Adoption, Problem Confrontation

1. Introduction

Total world fish supply is made up of production contributions from captured fisheries and aquaculture of which captured fisheries contribute 60 percent of it (FAO, 2010). Of the captured fisheries, about 90 percent of it is harvested from the sea. Although marine captures, on average, remained stable (FAO 2012), there were slight declines in captures noted, for example, from 2000 to 2005 and again from 2007 to 2010 (FAO, 2006: Miller, 2009: FAO 2010: FAO, 2012) suggesting a decrease in the contribution of captured fisheries to human consumption (FAO, 2006).

Seafood accounts for about one-third of the world's total food supply. Given the increasing world population and a somewhat a steady marine captured fisheries suggest that marine captured fisheries to human consumption would fall with growing population. Aquaculture thus offers a potential solution to meeting the growing demand for seafood that catching fish cannot provide (FAO, 2006: Miller, 2009).

Aquaculture is the farming of aquatic organisms including fish in fresh, brackish and sea water under controlled conditions with some intervention in the rearing process to improve production (FAO, 1994). One such intervention is the farming of fish in ponds with production activities such as regular stocking, feeding, and protection of fish from predators. Pond fish farming is not only useful as a source of protein for man and livestock and income for farmers who grow them but a way for utilizing organic wastes, unused land[1] and aquatic resources (FAO, 1994, Miller, 2009).

In Papua New Guinea (PNG), the freshwater of pond fish farming technology was introduced in the 1960s as a solution for alleviating the malnutrition prevalence of the inland population (ACIAR, 2007). Fish farming, as an industry, has not developed since, although PNG has been a signatory to the FAO agreement on food security under which freshwater fish farming was recognized as a source for providing the protein and income needs of the population. It remained an undeveloped industry due to, among others, the government giving no attention to its development at policy[2] level and consequently lacked provision of a good extension service to transfer fish farming technologies. These bottlenecks have impeded its progress, spread of its nutritional and financial benefits and the technical knowhow to rural communities (ACIAR, 2007).

In the past decade, pond fish farming activities have intensified largely due to the active involvement of the

[1] Including land that is unproductive for agricultural production and housing such as the hill sides.
[2] Although PNG has a Ministry which very much focused on dealing with marine resources, especially tuna and other seafood as major economic activities of the agriculture and fisheries sectors.

National Fisheries Authority (NFA) in collaboration with donor funding agencies, such as the Australian Centre for International Agricultural Research (ACIAR). Government regulatory bodies are keen in identifying impediments and implement strategies such as developing new technologies and training to improve fish farming opportunities for farmers and extension providers are stepping up efforts to transfer fish farming technologies (Wani, 2004). There is thus an emerging partnership forged between government agencies, donor agencies and extension service providers aimed at improving income generating opportunities for farmers.

Farmers could exploit the opportunities provided to their advantage by practicing fish farming innovations provided to them not only to improve income for their families but meet the growing demand for fish in PNG. Wani (2004), however, noted that farmed fish production was not sufficiently meeting the growing demand for fish and was keen to know whether the innovations provided to farmers were adopted.

The crucial link to improve fish production by the resource poor farmers is effective transfer of fish farming innovations to them. Rogers (1995) and Ekong (2002) describe adoption of new technology as the "innovation decision process where an innovation passes through the time of first knowledge of the innovation to the decision stage of adoption or rejection and to confirmation of that decision". The adoption-rejection decision of the farmer is, to a larger extent, dependent on the degree of risk involved relative to the existing practices. A number of factors could influence that decision; the most important ones are the (i) characteristics of the innovation, and (ii) the socioeconomic characteristics of farmers including their social, physical and cultural environments and a picture of exactly where the farmer fits (Jones, 1987) in fish farming. In addition to these are the extent of availability of the technologies being disseminated, extension methods provided (Nweke, 1981) and extent of resources available[3] to farmers (Nweke, 1981 & Wetengere, 2008: Wetengere, 2010).

Farmers adopt fish farming technologies if they believe that fish farming is profitable and would benefit the livelihood of society (Stanley *et al*, 2010 & Chi and Yamada, 2002). Essentially then, the superiority of the recommended technology relative to existing practices must be clearly demonstrated to farmers (Wetengere, 2008). Neverthless, it must be noted that, adoption of recommended fish farming technology is not only influenced by economic motivation but also by resources endowment of farmers and their access to information (Wetengere, 2010). Furthermore, in some situations, education, among others, can be a constraint and where this is present, further trainings must be conducted (Njankouawandji *et al*, 2012). On the other hand, it is difficult for farmers to adopt aquaculture technology if farmers do not have access to funds to maintain their ponds and to buy feed (Nwachukwu and Roseline, 2007). Essentially then, establishing, for example, clear linkages to acquire credit funds (Ike and Roseline, 2007), markets, training (Njankouawandji *et al,* 2012) and extension services is important as they are the elements that enhance adoption. Even though the benefits of new innovations could far exceed the benefits of existing practices, providing such an enabling environment reduces potential rejection of these innovations.

The NFA has disseminated four fish farming innovations, as a package, to promote fish farming as a viable cash income generating activity for the farmers with involvement of youth and in the process increase production to help meet the growing local demand for fish. Since their dissemination, no study was conducted to determine the extent of the adoption of these innovations and the factors that influence the farmer's adoption decisions. This study is thus aimed at providing some information that may be useful to promoting fish farming in Morobe Province[4].

2. Methodology and Data

2.1. Selection of Farmers

The research was conducted in Potsy, located in the Huon Gulf District of Morobe Province of PNG. The study site was purposively selected due to its active promotion of pond fish farming activities. Potsy is accessible by road and is situated closer to Lae city, the administrative capital of Morobe Province.

Prior to sampling, an attempt was made to establish the total pond fish farming farmers of the study site from Provincial Department of Agriculture and Livestock (PDAL), Bris Kanda[5], and even from District DAL Office. There was no such registry of fish farmers existed anywhere in these places; hence 37 farmers were purposively selected for interview. The approach used was to interview the next farmer that the researcher comes into contact while walking through the village areas. The households were scattered so the researcher walked throughout the study area.

2.2. Data

Primary data collected were of two types. The first are on selected socio-economic characteristics of the fish farmers. The second set of information collected related to 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 who helped interviewing farmers. The questionnaire was read to the respondents and the responses obtained were recorded by the interviewer. The data were collected over a two[6] week period in June/July, 2011.

[3] Farmer resources are such as land, labor, water and fingerlings in addition to other on farm inputs.

[4] Of the 21 provinces in PNG, Morobe province is one of them embracing pond fish farming for village farmers.

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

[6] The research was conducted as a part of the first author's Postgraduate Diploma Dissertation. Data was collected during 2 weeks of inter-semester break in June.

2.3. Measurement of Dependent Variables

2.3.1. Dissemination of Four Innovations

Four fish innovations disseminated to farmers were chosen for this study. They are (i) pond liming and fertilizing, (ii) stock density, (iii) fish sampling and sexing, and (iv) fish feed formulation. These innovations, disseminated as a bundle, were aimed at improving both fish quality and production as a sources of income.

2.3.2. Extent of Adoption of Innovations

To determine how quickly the innovations disseminated were adopted, the sampled farmers were categorized into adopter categories by computing an adoption score. Thus, for each of the innovations disseminated, the farmers were asked to rate themselves as "innovators", "early adopters", "late adopters" and "laggards" based on their assessment of their current stage of adoption situation. 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 (by laggards) and 12 indicating quick adoption (by innovators). The extent of adoption of the fish pond innovations disseminated was measured by computing the farmers' Total Adoption Index (TAI).The TAI for each adopter category can vary between zero and 111, zero indicating no adoption and 111 indicating adoption of innovation.

2.3.3. Extent of Problem Confrontation

The anticipated problem confronted 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 listed problems which, in their opinion, affect non or partial 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). The TPCI for each adopter category can vary between zero and 111, zero indicating problem as no problem and 111 indicating problem as high problem for the adoption of an innovation.

2.4. 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, education level was measured as the number of years of schooling completed, 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 measured in unit scores, and cosmopoliteness is measured as number of trips made outside of his village.

2.5. 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.

3. Results and Discussions

3.1. Adoption of Innovations

The results on the rates of adoption of the pond fish farming innovations are presented in Table 1. These innovations, introduced as a package, when adopted together can help sustain production and sale of fish. As shown in Table 1, the adoption patterns for the pond fish farming innovations disseminated were similar except the pond liming and fertilizing innovation which was adopted early when introduced.

Pond liming and fertilizing innovation was quickly adopted by 54 percent of the farmers (innovators) followed by 35 percent of the farmers as earlier adopters and 11 percent as late adopters. For stock density, it was quickly adopted by 8 percent of farmers (innovators) when introduced followed by 16 percent of farmers as early adopters and 14 percent of farmers as late adopters. On sampling and sexing, the innovation was quickly adopted by 3 percent of the farmers (innovators) followed by 11 percent as early adopters and 14 percent as late adopters. For feed formulation, it was quickly adopted by 15 percent of the farmers (innovators) followed by 24 percent of the farmers as early adopters and 11 percent of the farmers as later adopters.

An important observation made from the forging results is that, regardless of at which stage the farmers adopted the innovations, the pond liming and fertilizing innovation was adopted by all the farmers (100%) while feed formulation, stock density and sampling and sexing innovations were adopted by 49, 38 and 29 percent of the sampled farmers for the named innovations respectively. These outcomes are clearly obvious from the results on the TAI scores in Table 2 which indicates that the adoption of pond liming and fertilizing innovation ranked number 1 followed by feed formulation, stock density and fish sampling and sexing innovations.

Table 1. Distribution of Adoption of Pond Fish Farming Innovations

Innovations Disseminated	Categories	Number (N=37)	Percent (%)	Mean	Standard Deviation
Pond liming and fertilizing	Laggards	0	0		
	Late Adopters	4	10.8	2.43	0.69
	Early Adopters	13	35.1		
	Innovators	20	54.1		
Stock density	Laggards (0)	23	62.2		
	Late Adopters (5)	5	13.5	0.70	1.02
	Early Adopters (12)	6	16.2		
	Innovators (9)	3	8.1		
Fish sampling and sexing	Laggards (0)	27	73.0		
	Late Adopters (5)	5	13.5	0.43	0.80
	Early Adopters (8)	4	10.8		
	Innovators (3)	1	2.7		
Fish feed formulation	Laggards (0)	19	51.4		
	Late Adopters (4)	4	10.8	1.00	1.15
	Early Adopters (18)	9	24.3		
	Innovators (15)	5	13.5		

Table 2. Extent of Adoption of Pond Fish Innovations (N=37)

No	Types of Innovation	Innovators	Earlier Adopters	Late Adopters	Laggards	TAI	Rank
		(3)	(2)	(1)	(0)		
1	Pond liming and fertilizing	20	13	4	0	79	1
2	Feed fish formulation	5	9	4	19	37	2
3	Stock Density	3	6	5	23	26	3
4	Fish sampling and sexing	1	4	5	27	16	4

Pond liming and fertilizing[7], for most farmers, was quickly adopted as it was an important activity needed to provide feed for the fingerlings to establish themselves as they are introduced to the pond. Furthermore, chicken manure, which can easily be secured from large broiler farmers who grow them for Niugini Table Birds on contractual basis, is less expensive.

The last category of adopters is the laggards, who tend to wait unit the innovations have already passed them one after the other after they were introduced (Mawusi, 2004). They are either lazy or poorly resourced farmers. Except for the liming and fertilizing innovation, about 51, 62, and 71 percent of the farmers are categorized as laggards in the adoption of feed formulation, stocking density and sampling and sexing innovations respectively.

The stock density innovation constitutes cleaning the pond to create space for fish multiplication, growth and development. A part of the growth and development process is to separate the fingerlings to different ponds according to their sizes. These are time consuming labor intensive activities. The fish feed formulation is one innovation that is practiced only when feed ingredients are available. To develop feed requires buying some ingredients and the development of the feed is time consuming and labor intensive. The alternative is to buy and feed fish with commercially prepared feed but the farmers were not able to afford that as well.

Against the forgoing situations, it must be mentioned here that a number of farmers who adopted the innovations early (innovators and early adopters) were contracted broiler chicken growers. They are farmers who have a regular income and thus have finance to secure the resources required to adopt and practice the innovations. On the other hand, more than 50 percent of the farmers for the adoption of feed formulation, stocking density and sampling and sexing were laggards. Although they farm fish, their extent of adopting these innovations was restricted largely due to not having access to a regular income to finance the feeding resources they need. In addition to this limitation is

[7] Chicken manure was commonly used for pond fertilizing. This was important for fingerlings early growth and development.

that, the execution of the innovations is time consuming and labor intensive. Essentially then, the fish farming activities are conducted at the subsistence level.

The accept-reject decision of an innovation depends on an individual farmer who engaged in farming activities (Mawusi, 2004). The innovations can be adopted at a very slow pace 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 and constraints faced (Wetengere, 2008). The adoption of innovations in this study was, among other factors, constrained by farmers not having access to resources needed.

3.2. Problem Confrontation of Farmers

The distribution of farmers according to their problem confrontation of selected problem items in adopting fish farming innovations are given in Table 3. The results indicate that 68 percent of the farmers were in the high problem category followed by 22 percent and 11 percent of the farmers in the medium and low problem categories respectively. These outcomes provided 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 in addition to the ones already identified. Some of these factors which influenced such outcome are presented in Table 4.

The results of anticipated Problem Confrontation Index (PCI) of Table 4 on the adoption of pond fish farming innovations disseminated varied between 37 and 100 against a possible score of zero and 111. Of all the problems anticipated, lack of knowledge and skills was ranked as the number one problem followed by cost of commercial feed, lack of marketing facilities, lack of local quality fish feed, misuse of farmers funds by the middleman, lack of credit facilities, and other problem such as water, disaster, stealing, and such in the like. Essentially, the seventh anticipated problem – other, is a composite of all other problems not listed above. These problems could explain the reasons for non-adoption or slow adoption of innovations disseminated.

Successful adoption of innovations is dependent on one key socioeconomic factor, the level of knowledge and skills possessed by the fish farmers. Although 97 percent of the farmers received formal schooling ranging from primary to university education, yet they lacked knowledge and skills of adopting fish innovations. If this is a correct reflection, then the outcome that arises is indicative of first, a lack of provision of fish farming information in the form as suitable reading materials on the innovations disseminated and in the absence of this, the second is that the intensity of extension services provided on the innovations was probably low.

Pond fish farmers with medium to low income levels could have found difficulty in using commercial feeds due to the high price of purchasing them. The alternative to using commercial feed is to formulate and used locally available feed stuff yet this is a problem faced by farmers because they had to buy feed concentrates, for example, fish meal and feed mix- a mixture of salt, minerals and vitamins. The farmers having faced with this problem, and given the lack of credit facilities being offered by credit institutions, have formed a legally registered fish farmer association in the study area to seek outside funding. While it initially worked, the set up collapsed due to misuse of funds by people who were entrusted to look after the association funds. Given the lack of proper feeding, the commercial viability of fish farming is diminished and this is largely constrained by a lack of access to the necessary funds to either buy commercial feed or prepare feed based on locally available feed stuff.

Table 3. Distribution of Farmers According to their Anticipated Problem Confrontation in the Adoption of Pond Fish Farming Innovations

Categories	Number	Percent	Mean	Standard Deviation
Low (up to 4)	4	10.81		
Medium (5-9)	8	21.62	2.25	0.65
High (above 9)	25	67.57		

Table 4. Anticipated Problem Confrontation of Farmers in Adopting Fish Farming Innovations (N =37)

No	Problems	Extent of Problems					
		High (3)	Medium (2)	Low (1)	No problem (0)	PCI	Rank Order
1	Lack knowledge and skills	31	1	5	0	100	1
2	Cost of commercial fish feed	24	13	0	0	98	2
3	Lack of marketing facilities	26	8	3	0	97	3
4	Lack of local quality fish feed	25	6	6	0	93	4
5	Misuse of farmers funds by the middleman	9	20	5	3	72	5
6	Lack of credit facilities	4	14	15	4	55	6
7	Others (water problem, disaster, stealing, etc)	1	13	8	14	37	7

Lack of marketing facilities was the third ranked anticipated problem faced by the farmers. Farmers sell their fish at the Village and Urban local markets but require alternative marketing outlets. The latter is required as fish production is increased. A key factor to marketing is the post harvest handling and storage of fresh fish which require particular attention. This would be a necessary facility to handle larger quantities of fish as production increases.

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 (Kashem, 2005), the sentiments which are also shared by ACIAR (2007) and Bris Kanda (2007).

At a general level, innovations are rejected if the profitability relative to the existing practice is less (Wetengere, 2008, Stanley *et al,* 2010), inadequate availability of resources (Wetengere, 2008; Wetengere, 2010; Adeokun *et al*, 2008; Oladele, 2005), inadequate provision of market, inadequate provision of extension service, training and support (Nweke, 1981, Njankouawandji *et al,* 2012) after they are introduced and lack of access to credit (Ike and Roseline, 2007) On the other hand, if the farmers believe that the relative profitability of the innovations relative to the existing one is high but face problems in adopting it in its entirety, the innovations are modified (Wetengere, 2008) to suit their conditions an outcome that limit them from realizing potential benefits. In the case of Potsy, the second scenario seems to fit where farmers practice some of the innovations when deemed necessary. The impact of such practices is that potential benefits are not fully realized and this seems to be the situation in Potsy where farmers only make what they can to meet the family needs as a first priority and market the surplus as a second goal. Given the subsistence outlook of fish farming, the goal of involving the young in the cash economy as a way to reduce urban drift and undesirable social behavior in the rural societies are not critical supported.

3.3. 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 innovation and extent of problems confrontation of the farmers are given in Table 5. The results indicate that these relationships were statistically not significant except the relationship between adoption and age and the relationships between problem confrontation and age and family size.

The relationships between extent of adoption and the socioeconomic attributes fitted were all negative except farming experience and pond size which were positive. The positive relationships suggest that adoption of innovations increased with farming experience and pond sizes. On the other hand, adoption of innovations decreases with age and education. Since older people cannot endure physically demanding farming activities, the negative relationship between adoption and age was expected. Although the level extension provision was low, the inverse relationships between adoption of innovations and education, annual income and cosmopoliteness were not expected. This could suggest that as income earned from fish decreases farmers exploit the level of education they have and their exposure to places outside of their own setting to turn to alternative income earning activities thus less attention placed on fish farming. The negative relationship between adoption and family size suggests that adoption increases with decreases in family size. This outcome was expected since 81 percent of the farmers were observed to be young who are able to conduct all activities associated with the innovations adopted.

Table 5. Correlation between Independent and Dependent Variables at Potsy (N=37)

No	Independent Variables	Extent of Adoption	Problem Confrontation
1	Age	-0.287*	-0.295*
2	Education Level	-0.077	-0.104
3	Farming Experience	0.012	0.041
4	Family size	-0.143	0.282*
5	Farm (pond) size	0.161	0.018
6	Annual Income	-0.073	0.155
7	Cosmopoliteness	-0.028	0.040

* Significant at 10 percent level of probability.

The relationships between the anticipated problem confrontation and selected socioeconomic characteristics were all positive except age and education levels of farmers. The negative relation between problem confrontation and age is expected since older people are less inclined to deal with problems associated with physically demanding farming activities. Education helps farmers to evaluate circumstances facing them and with insights gained from such assessments to chart a desired direction given the limited resources they have. Essentially, the negative relationship that anticipated problem confrontation decreases with increases in education level was expected. Furthermore, like education, the relationships between anticipated problem confrontation and farming experience and cosmopoliteness were expected to be positive but were not the outcomes observed. The positive relationships could suggest that length of farming experience and number of exposures to other places could occur without sufficient skills and knowledge gains to deal with problems associated with the adoption of innovations. This could happen with less extension service provision and training and visits to other places for reasons focused on other things than fish farming. On the other hand, the increase in anticipated problem confrontation with increases in annual income and family size were also not expected. These outcomes suggest that farmers with their families turned to and increase production of other income generating activities as the anticipated problems confronted increases. It also suggests that as the problems encountered increase a larger family is required not only to undertake the time consuming physical activities associated with the innovations introduced but also

to sources and prepare an improvised fish feed from local feed stuff.

4. Summary and Conclusions

Four pond fish farming innovations were disseminated, as a package, to improve production and income of farmers. Except for pond liming and fertilizing, the innovations introduced were not adopted quickly and practiced only when necessary. About 90 percent of the farmers rated problems faced as medium to high problems and ranked lack of knowledge and skills as problem number 1 followed by cost of commercial feed, lack of marketing facilities, lack of local feed, misuse of funds and lack of credit facilities. Essentially then, the non adoption of innovations were affected by these problems farmers faced. Age was found to be an important attribute affecting adoption of innovations while age and family size were the important attributes influencing problems confrontations of farmers. Although the innovations were disseminated to improve production and income of farmers, their dissemination was not adequately supported through adequate farmer training and extension service provision, creating marketing facilities, and provision or linking farmers to acquisition of credit. Given that 81 percent of the farmers were young and medium age categories, adequate support in the suggested areas will help not only to improve production and income for them but also reduces urban drift and social problems in rural societies.

REFERENCES

[1] Adeokun, O. A., Ajana, A. M., Ayinla, O. A., Yarhere, M. T., Adeogun, M.O., 2008. Application of logit model in adoption decision: A study of hybrid clarias Lagos State, Nigeria. Amer-Eurasian J. Agric. Environ. Sci., 4_4_: 468-472.

[2] ACIAR, 2007. Aquaculture in PNG: Status of fresh water fish farming, Australian Centre for International Agricultural Research, Canberra

[3] Bris Kanda, 2007. Market Linkages and Business Analysis – Huon Gulf District, Morobe Province, Papua New Guinea.

[4] Drost, D., Long K. Hales., 1998. Targeting extension efforts for the adoption of sustainable farming practices. Journal of Extension (On-line) 36.5, pp 1-9. http://www.joe.org

[5] Ekong, E.E., 2002. An Introduction to Rural Sociology. Jumak Publisher, Nigeria. FAO, 1994, Handbook on small-scale freshwater fish farming, Rome

[6] FAO, 1994. Handbook on small-scale freshwater fish farming, Rome

[7] FAO, 2006. The state of Food Security, Food and Agricultural Organization, Rome

[8] FAO, 2010. Fishery and Aquaculture Statistics, FAO Year Book, Rome

[9] FAO, 2012. The State of World Fisheries and Aquaculture, FAO Fisheries and Aquaculture Department, Rome

[10] Ike, N and Roseline, O., 2007. Adoption of Aquaculture Technology by Fish Farmers in Imo State of Nigeria. Journal of Technology studies. Vol XXXIII (1), Pp 57-64

[11] Jones, D., 1987. World Agricultural Economics and Rural Sociology Abstract. Vol. 9(3):917http://www.uwpress.wisc.edu/journals/indandab.htmlCached - Similar

[12] Malpani, N., 2011. Agricultural Innovation in Rural India. The Paradox of Farmers Non-adoption in Bajwada Pradesh. Dissertation.com, Boca Raton, Florida, USA. http://www.bookpump.com/dps/pdf-b/2337678b.pdf

[13] Mawusi, B., 2004. Farmers' Knowledge and Perception towards a Sustainable Adoption of Sugar Beet in Kenya, Lund University, Swed.

[14] Miller, J., 2009. Farm Ponds for Water, Fish and Livelihoods. FAO Diversification Book 13. Rural Infrastructure and Agro-Industries Division, Rome.

[15] Njankouawandji, D.,Pouomogne, V., Nyemeck Binam, J., and Yossa Nouaga, R. 2012. Adoption of New Aqcuaculture Technologiesin the Western Highlands of Cameroon. Tropicacultura, Vol 30 (3). Pp 180-184.

[16] Nweke, F.I., 1981. "Determinants of Agriculture Progressiveness in the Small – Holder Cropping system of South Eastern Nigerial and Consequences for Research & Extension Administration. Agricultural Administration vol.8 No3. pp: 163-176. 12.

[17] Rogers, E. M., 1995. Diffusion of Innovations, (4th ed) New York, The Free Press. hppt://www.stanford.edu/class/.../Diffusion%20of%20Innovations.htmCached-Similar

[18] Stanley, J. Clouston, B., & Baker, R., 2010. Understanding Land Manager Constraints to the Adoption of Changed Practices or Technological Innovations: Advanced Journal of Food Science and Technology. Vol. 2 (1):55-62

[19] Talukdar, P. K., & Sontaki, B. S., 2005. Correlates of Adoption of Composite fish Culture Practices by Fish Farmers of Assam, India, The Journal of Agricultural Sciences, vol. 1(113). http://www.sab.ac.lk/Acade-Activity/Vol_1/paper3.pdfSimilar

[20] Wani, J.A., 2004. The Status of Aquaculture Development in Papua New Guinea: An information paper. National Fisheries Authority. Port Moresby

[21] 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.

[22] 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, Vol 2 (1). Pp 55-62