African Journal of Agricultural Research Vol. 4 (5), pp. 491-497, May, 2009
Available online at http://www.academicjournals.org/AJAR
ISSN 1991-637X © 2009 Academic Journals

Full Length Research Paper

Factors influencing the adoption of integrated pest management (IPM) by wheat growers in Varamin County, Iran

Atry Samiee*, Ahmad Rezvanfar and Elham Faham

Faculty of Agricultural Economics and Development, University of Tehran, Karaj, Iran.

Accepted 20 May, 2009

This paper presents recent results regarding driving factors and extent of adoption of integrated pest management (IPM) techniques by wheat growers in Varamin county. By proportional random sampling, a total number of 72 wheat growers were selected. Data collection was done through a questionnaire which was developed in 2008. Variables of annual on-farm income, using level of information sources and communication channels, viewpoint on extension agents and level of knowledge were significantly and positively correlated with adoption of IPM measures. The results of regression analysis showed that level of knowledge explained 58.9% of the variation in the adoption level of sustainable IPM practices. It is recommended that to reach farmer audiences with extension IPM education programs, greater consideration should be given to farmer and farm background, current use of IPM practices and preferences for educational formats.

Key words: Adoption, wheat, disease, insect, weed, knowledge.

INTRODUCTION

The potential negative environmental impacts of modern agricultural practices have long been recognized as major public health concerns. By official estimates average of 23,000 ton of pesticides used in Iran each year (not including granules) and by unofficial calculations, $120 million spent on pesticides each year. Dependency on chemical pest control and improper pesticide use has resulted in on crop and environmental contamination and detrimental effects on humans. Hence, many of the techniques or practices collectively referred to as integrated pest management (IPM) have been designed to address some of the health and environmental concerns of pesticide use and the problem of pest resistance to pesticides. In general terms, IPM is defined as a sustainable approach to managing pests by combining biological, cultural, physical and chemical tools in a way that minimizes economic, health and environmental risks (National coalition on integrated pest management, 1994). In other words, IPM is a management approach that encourages natural control of pest populations by anticipating pest problems and preventing pests from reaching economically damaging levels. All appropriate techniques are used such as enhancing natural enemies, planting pest-resistant crops and using pesticides judiciously. While IPM practices emphasize minimal use of pesticides in controlling pests, their adoption by farmers can reduce the use of pesticides and their adverse impacts. It is important to recognize the fact that IPM involves "a complex set of behavior, decision-making procedures and methods, technology and values organized to provide efficient alternative methods to pest management" (Apple and Smith, 1976). Therefore, in order to promote the extent of adoption, it will be essential to work out the social aspect and also the context of farming operations, which could prove useful for designing and dissemination techniques relevant to IPM.

Generally, researchers and extension agents are often frustrated by slower than expected adoption levels for agricultural innovations. Slow rates of adoption cause a loss of potential benefit of sustainable practices to growers and the public. This is a main reason why so much attention has been given to try and understand what drives adoption of new technology among farmers (e.g. Pannell et al., 2006; Rogers, 2005 and Vanclay, 1992). Some studies have concentrated on the theory of adoption processes. Another avenue of study has focused on identifying significant characteristics associated with adopters

*Corresponding author. E-mail: a3_samiee@yahoo.com. Tel.: 989125465700, Fax: 982612818709.

and non adopters. On the other hand, recent studies took a novel approach to investigate factors influencing technology adoption. Although studies on adoption of agricultural innovations are many, there is still an overriding need to investigate factors driving adoption of IPM practices by farmers.

The crop surveyed in this study was selected based on its regional importance and additional information was collected about production practices and IPM techniques in terms of insects, diseases and weeds for wheat. Although there is a merit in using a general definition of IPM without specifying the types of pests (insects, diseases, weeds) managed or controlled, additional understanding may be obtained by further classifying IPM into 3 groups: insect IPM, disease IPM and weed IPM.

Bearing this purpose in mind the objectives of the study are:

i.) To study socio-economic profile of wheat growers.
ii.) To determine adoption level of IPM practices among wheat growers.
iii.) To investigate factors associated with adoption of IPM practices among wheat growers.

An expanded model to explain adoption of IPM practices permits a balanced presentation of research findings that represents what are major explanatory variables. Many studies have concentrated on identifying relationships between IPM practices and the characteristics of growers and their enterprises including age, education, experience, knowledge, income, farm size, etc.

Some of them have found no significant relationship between age and adoption of IPM (Grieshop et al., 1988; Waller et al., 1998). The same result has been achieved about the relationship between education and IPM adoption in Grieshop, Zalom et al's study (1988). However, Ridgley and Brush (1992), Fernandez-Cornejo (1998) and Waller, et al. (1998), have shown a positive correlation between education and adoption of IPM techniques. Thus, the impact of education on IPM adoption is inconclusive.

Similar inconsistencies are present in studies into the relationship between choice of pest and disease management techniques and farm size. Chaves and Riley (2001) in their analysis of pest management practices among Colombian coffee berry growers found a relationship between farm size and adoption for some combinations of practices. In contrast, Grieshop et al. (1988), Ridgley and Brush (1992), Waller et al. (1998) and Bonabana-Wabbi (2002) in their studies concluded that size of farmers' land holdings did not affect IPM adoption suggesting that IPM technologies are mostly scale neutral, implying that IPM dissemination may take place regardless of farmer's scale of operation. On the other hand, Blake et al. (2007) concluded that highly experienced growers in charge of large operations tended frequently to use more IPM practices than less experienced growers who managed smaller farms.

While it is hypothesized that income is likely to have an impact upon the adoption of IPM practice, the results of a study carried out by Alston and Reding (1998) shows that major source of income (on-farm or off-farm), probably exerts influence on adoption of IPM. Llewellyn (2006) has cited that one of the factors significantly associated with adoption of integrated weed management practices in Western Australian cropping regions is higher use of information/extension to which the grower is exposed. Information with quality characteristics can reduce the potentially costly waiting time and/or the risk of making a costly wrong decision. Information that requires less investment to seek out, analyze and integrate into existing farm-specific knowledge reduces the overall information-seeking and learning costs associated with the adoption decision (Fischer et al., 1996; Marra et al., 2003; Abadi Ghadim et al., 2005). Furthermore, as pointed out by Grieshop et al. (1988) using the tomato IPM program as a model, growers sources of information and previous experience with IPM, are important socio-economic considerations that affect the decision making process and the eventual adoption rate of the IPM program. Escalada and Heong (1993) attributed the slow spread of IPM techniques among rice farmers in the Philippines to a lack of knowledge among growers and concluded that farmer field schools would accelerate adoption by providing growers with the opportunity for experiential learning of IPM skills. Moreover, characteristics of change agents or advocates for the innovation, such as competency, credibility, communication ability and confidence are identified as factors which influence adoption (Rogers, 2005; Okunade, 2006). The results of a selection of studies are reported in Table 1.

METHODS

All things considered, a questionnaire was developed on the basis of literature review, hypotheses and interviews. Its validity was confirmed by a panel of experts after necessary corrections, while calculated Cronbach's alpha was 0.70 which indicated that the designed instrument was reliable.

The independent variables including the using level of information sources and communication channels, awareness about the effects of sustainable environmental practices, farmers' viewpoint on extension agents and knowledge level of sustainable IPM practices were measured by 6 point scales which were developed with a score range of 0 to 5, while the score was reversed for unfavorable statements.

Review of a number of studies from the literature investigating the relationships between adoption level of IPM practices and the characteristics of growers and their enterprises helped us with the collection of aforementioned independent variables.

Proportional random sampling method was employed to select a total number of 72 wheat growers in 3 districts of Varamin County located in Tehran province, Iran. Table 2 provides details of participating districts.

In order to calculate the 'adoption score', the respondents' reported answers of implementation (that is, not implementing a practice = 0 or implementing a practice = 1) was multiplied by the importance value which was assigned to each practice due to its relative importance to all other IPM practices of each category (that is, insects, diseases, weeds). This weighing system was developed in consultation

Table 1. Factors reported in selected studies as influencing adoption.

Author \ Factor	Age	Education	Experience	Income (on/off farm)	Farm size	Participation in extension - education courses	Information sources and communication channels	Awareness	Viewpoint on extension agents	Knowledge
Llewellyn, 2006						+	+			
Okunade, 2006									+	
Abadi Ghadim et al., 2005							+			
Marra et al., 2003							+			
Chaves and Riley, 2001	-	+			+					
Elsey nd Sirichoti, 2001							+			
Alston and Reding, 1998				+						
De Souza,1997					-			+		
Brough, Frank et al. 1996	0	+			0					-
Fernandez-Cornejo and Jans, 1996		+	+		+		+			
Fischer et al. 1996							+			
Boughton and de Faran, 1994						+				
Ridgley and Brush, 1992		+			0					-
Grieshop, Zalom et al. 1988	0	0								+

+ denotes a positive relationship between the factor and adoption, - denotes a negative relationship between the factor and adoption and 0 denotes no significant relationship between the factor and adoption.

Table 2. Statistical population and sample size of the study.

Sample size	No. of wheat gowers per district	District	County
37	1280	Javadabad	
13	430	Pishva	Varamin
22	760	Markazi	
72	2470	Total	

with research specialists. Finally, wheat growers were categorized as "low", "fairly low", "fairly high" and "high" adopters based on the collective 'adoption score'. Score ranges for low, fairly low, fairly high and high adoption categories were determined by mean and standard deviation.

Data were analyzed using descriptive and inferential statistics such as extent of mean, standard deviation, coefficient of varia-ion, correlation analysis and stepwise regression analysis. Despite the fact that the dependent variable was parametric, mean compa-ison was done through nonparametric tests (Man-Whitney Test, Kruskal- Wallis H) because the distribution of groups wasn't normal.

RESULTS AND DISCUSSION

Socio-economic profile of wheat growers

On average, respondents were 47 years of age in this survey. Each household had an average of 5 members and farm size of 10.7 ha grown to wheat. It was found out that a high proportion of wheat growers (83.3%) were literate. Among respondents, 66.6% cropped on owned farmlands. Average yield was 4.076 t/ha annually. The overall average of 29 years of farming indicates that wheat growers were highly experienced in farming practices therefore they may apply IPM practices effectively. The average of total on-farm and off-farm incomes were R40125000 Rials = 4098.28 $ Rials)/yr and 20634330 Rials= 2107.54 $(Rials)/yr respectively. Approximately 64% of farmers were members of rural cooperatives. Farmer participation was measured by the number of IPM sessions attended by each farmer. Of the survey respondents, 65.2% have never participated in farmer training course on sustainable IPM practices. About 15.3% of the survey respondents declared low opinion of characteristics of change agent whereas only 5.8% of wheat growers expressed high opinion.

Prioritized indicators of IPM practices

Based on the results of Table 3 wheat growers commonly used insect IPM practices rather than other types of IPM measures.

Table 3. Prioritized indicators of IPM practices.

Statement	Mean	Std. dev.	CV	Priority
Insect IPM Practices	2.576	0.777	0.302	1
Weed IPM practices	2.483	0.868	0.349	2
Disease IPM practices	1.142	0.504	0.441	3

Adoption level of IPM practices among wheat growers

Table 4 shows the percentage of wheat growers scoring in the low, fairly low, fairly high and high levels of adoption with regard to assumed types of measures and adoption of IPM practices in general.

Correlation analysis among adoption level of IPM practices and selective variables

Table 5 points out that annual on-farm income was positively and significantly ($r = 0.282$, $P < 0.05$) correlated with adoption level of IPM practices among wheat growers which is accordant to the results of Alston and Reding (1998). There was a positive and significant correlation ($r = 0.357$, $P < 0.01$) between using level of information sources and communication channels and adoption level of IPM practices among wheat growers while some studies by Grieshop et al. 1988; Fischer et al. 1996; Marra et al. 2003; Abadi Ghadim et al. 2005 and Llewellyn, 2006 confirm this correlation. Moreover, viewpoint on extension agents was positive and significant cor-relation ($r = 0.237$, $P < 0.05$) between and adoption level of IPM practices among wheat growers that is in line with the studies of Rogers (2005) and Okunade (2006). In a similar vein, level of knowledge about IPM practices was positively and significantly ($r = 0.768$, $P < 0.01$) correlated with adoption level of IPM practices among wheat growers. This result is accordant to the results of Escalada and Heong (1993). There is no significant correlation between age and adoption level of IPM practices, which is in line with findings of Grieshop et al. (1988) and Waller et al. (1998). Moreover, there is no significant relationship between level of literacy and adoption which is accordant to Grieshop et al. (1988). It could be inferred from the table that there is no significant correlation between years of farming and adoption level of IPM measures which is in contrast with the results of Blake et al. (2007) study. Similar result is found in case of the relationship between farm size and adoption which is consistent with Grieshop et al. (1988), Ridgley and Brush (1992), Waller et al. (1998) and Bonabana-Wabbi (2002), in their studies concluded that size of farmers' land holdings did not affect IPM adoption suggesting that IPM technologies are mostly scale neutral. In our analysis of adoption of IPM practices among wheat growers we didn't find any relationship between use of extension - education courses and adoption of practices, on the contrary, Llewellyn (2006) has cited that one of the factors significantly associated with adoption of integrated weed management practices is higher use of extension to which the grower is exposed. Furthermore, level of awareness about the effects of IPM practices didn't influence IPM adoption on account of our findings.

Comparison of adoption level of IPM practices among different groups of wheat growers in terms of membership in cooperatives, participation in extension-education courses and farming system

Results of Mann-Whitney test reveals that there is no significant difference in adoption level of IPM practices between the compared groups in terms of membership in cooperatives, participation in extension-education courses and farming system (Table 6). Therefore, membership in cooperatives, participation in extension-education courses and farming system didn’t exert influence on adoption level of IPM practices among wheat growers.

Comparison of adoption level of IPM practices among different groups of wheat growers with regard to land tenure status

Results of Kruskal-Wallis test reveals that there is no significant difference in adoption level of IPM practices between the compared groups regarding land tenure status (Table 7). In other words, there is no difference among the groups who owned lands, rented lands and partly rented and owned lands regarding adoption of IPM practices.

Regression analysis to explain variations in adoption level of IPM practices

Stepwise multiple regression analysis was used to determine the links between a range of independent variables and adoption level of IPM practices explaining variations in adoption level by independent variables. Based on Table 8, level of knowledge about IPM practices entered to regression equation solely could explain 58.9% of variation in level of wheat growers' adoption in IPM practices. According to results of Table 8, following model is estimated for explaining level of wheat growers' adoption in IPM practices

Y = 0.947+0.932KIPMP

Where Y: dependent variable that representing level of wheat growers' adoption in IPM practices.

There is little reliability in the findings of studies into the

Table 4. Frequency distribution of wheat growers regarding IPM practices adoption.

Variable	Group	Frequency	% of Frequency	% of Cumulative Frequency
Adoption level of insect IPM practices	Low (0.7 - 1.799)	10	13.9	13.9
	Fairly Low (1.800-2.576)	30	41.7	55.6
	Fairly High (2.577 - 3.353)	27	37.5	93.1
	High (3.354 - 4.100)	5	6.9	100
	Max:4.000 Min: 0.500	Std. Dev.: 0.868		Mean: 2.483
Adoption level of disease IPM practices	Low (0-0.637)	18	25.0	25.0
	Fairly Low (0.638-1.141)	24	33.3	58.3
	Fairly High (1.142-1.645)	26	36.1	94.4
	High (1.646-2.40)	4	5.6	100
	Max: 2.400 Min: 0	Std. Dev.: 0.504		Mean: 1.141
Adoption level of weed IPM practices	Low (0.500 - 1.615)	11	15.3	15.3
	Fairly Low (1.616 - 2.483)	29	40.3	55.6
	Fairly High (2.484 - 3.351)	18	25.0	80.6
	High (3.352 - 4.000)	14	19.4	100
	Max: 4.100 Min: 0.700	Std. Dev.: 0.777		Mean: 2.576
Adoption level of IPM practices	Low (1.900 - 4.342)	14	19.4	19.4
	Fairly Low (4.343 - 6.201)	18	25.0	44.4
	Fairly High (6.202 - 8.060)	29	40.3	84.7
	High (8.06 1- 10.500)	11	15.3	100
	Max: 10.50 Min: 1.90	Std. Dev.: 1.859		Mean: 6.201

Table 5. Correlation analysis among adoption level of IPM practices and selective variables.

Variable	Insect IPM	Disease IPM	Weed IPM	IPM (Total)
Age	- 0.073	-0.035	-0.208	-0.137
Level of literacy	0.059	-0.040	0.091	0.056
Years of farming	- 0.012	-0.001	-0.052	-0.030
Annual on-farm income	0.256*	0.243*	0.233*	0.282*
Annual off-farm income	- 0.115	-0.018	-0.051	-0.091
Farm size	0.126	0.056	0.176	0.150
Level of participation in extension - education courses	0.023	-0.179	-0.144	-0.106
Using level of information sources and communication channels	0.181	0.326**	0.414**	0.357**
Level of awareness about the effects of IPM practices	0.115	0.160	0.178	0.175
Viewpoint on extension agents	0.146	-0.090	-0.110	0.237*
Level of knowledge about IPM practices	0.601**	0.561**	0.780**	0.768**

* ($P<0.05$) and ** ($P<0.01$).

adoption of integrated pest management (IPM) practices. Our study focusing on grower and enterprise characteristics has failed to identify any relationships between variables such as age, education, farm size, experience, use of extension- education courses and level of awareness. On the other hand, based on the results of our study on-farm income, using level of information sources and communication channels, viewpoint on extension agents and level of knowledge were found to have significant and positive correlation with adoption, while level of knowledge about IPM practices is strongly associated with adoption in the regression analysis. Therefore, it can be induced that knowledge plays a crucial role in adoption of IPM practices.

As mentioned above lack of knowledge, is the key obstacle to the widespread use of IPM and therefore extension programs are needed to increase the knowledge level of farmers about IPM techniques. Besides the strengthening of the extension arm of the implementation model, non-formal education methods such as farmer field schools (FFSs) need to be promoted to make farmers literate in pest management practice. The focus of

Table 6. Comparison of adoption level of IPM practices among wheat growers by using Mann-Whitney Test.

t	Mann-Whitney U	Mean rank	Groups	Grouping variable	Test variable
0.183	444.500	37.84	Member	Membership in cooperatives	Adoption level of IPM practices
		31.02	Non-member		
0.25	446.500	40.20	Participants	Participation in extension-education courses	
		34.11	Non-participants		
0.085	455.500	30.77	Smallholder	Farming system	
			Large holder		

Table 7. Comparison of adoption level of IPM practices among wheat growers by using Kruskal - Wallis Test.

t	Chi-Square (x^2)	Mean rank	Groups	Grouping variable	Test variable
0.147	3.829	33.19	Owning	Land Tenure	Adoption level IPM practices
		46.95	Renting		
		37.96	Owning- Renting		

Table 8. Regression analysis explaining variations in adoption level of IPM practices.

Rangers' participation			Label	Description
t	Beta	B		
1.744		0.947		Constant
10.019**	0.768	0.932	KIPMP	Level of knowledge about IPM practices
	F = 100.271**		R^2 = 0.589	R^2 (adjusted) = 0.582

*P < 0.05, **P < 0.01.

FFSs is on learning through discovery, experimentation and group or community actions. FFSs thus have social goals beyond mere changes in pest management techniques that seek to promote the empowerment of farmers by building human and social capital (Gallagher, 2000). Farmers are no longer positioned as receivers of already developed technological packages, but as field experts, who collaborate with the extension staff to find solutions relevant to the local realities. Evaluations of the accomplishments of various FFS programs agree in their main conclusion that attending an FFS strengthens farmers' ecological knowledge on pests and predators (Thiele et al., 2001; Rola et al., 2002; Feder et al., 2004; Reddy and Suryamani, 2005 and Tripp et al., 2005). Consequently, the more factors involved in the grower's IPM adoption are harmonized during the formulation of the IPM program, the more probable adoption of IPM practices will be. Additionally, in our efforts to reach farmer audiences with extension IPM education programs, greater consideration should be given to farmer and farm background, current use of IPM practices and preferences for educational formats. Hence, farmers' needs should be identified clearly through a systematic needs assessment process.

REFERENCES

Abadi Ghadim AK, Pannell DJ, Burton MP (2005). Risk, uncertainty and learning in adoption of a crop innovation. Agric. Econ. 33: 1-9.

Alston DG, Reding ME (1998). Factors Influencing Adoption and Educational Outreach of Integrated Pest Management. J. Ext. 36(3). Available at: http://www.joe.org/joe/1998june/a3.html.

Apple JL, Smith RF (1976). Integrated pest management. Plenum Press. N. Y. pp. 200.

Blake G, Sandler HA, Coli W, Pober DM, Coggins C (2007). An assessment of grower perceptions and factors influencing adoption of IPM in commercial cranberry production Renewable Agriculture and Food Systems 22: 134 - 144.

Bonabana-Wabbi J (2002). Assessing factors affecting adoption of agricultural technologies: the Case of Integrated Pest Management (IPM) in Kumi District. M.Sc Thesis. Eastern Uganda.

Boughton D, de Faran BH (1994). Agricultural research impact assessment: the case of maize technology adoption in Southern Mali. MSU International Development Working Paper No. 41. Department of Economics, Michigan State University, MI.

Chaves B, Riley J (2001). Determination of factors influencing integrated pest management adoption in coffee berry borer in Columbian farms. Agriculture, Ecosystems and Environment 87: 159-177.

De Souza FH (1997). The Adoption of Sustainable Agricultural Technologies. Ashgate, UK.

Elsey B, Sirichoti K (2001). The adoption of integrated pest management (IPM) by tropical fruit growers in Thailand as an example of change management theory and practice. Integrated Pest Magt. Reviews 6: 1–14.

Escalada MM, Heong KL (1993). Communication and implementation of change in crop protection. In Crop Protection and Sustainable Agriculture. Chichester, UK: Wiley. pp. 191-202.

Feder G, Murgai R, Quizon JB (2004). The acquisition and diffusion of knowledge: the case of pest management training in Farmer Field Schools, Indonesia. J. Agric. Econ. 55: 221-243.

Fernandez-Cornejo J, Beach ED, Huang WY (1994). The adoption of IPM techniques by vegetable growers in Florida, Michigan and Texas. J. Agric. Applied Econ. 26:158-172.

Fernandez-Cornejo J, Jans S (1996). The economic impact of IPM adoption for orange producers in California and Florida. In: Brumfield,

R.G. (Ed.), Proceedings of the XIII International Symposium on Hort. Econ. Acta Hort. 429: 325–334.
Fernandez-Cornejo J (1998). Environmental and economic consequences of technology adoption: IPM in viticulture. Agric. Econ. 18: 145-155.
Fischer AJ, Arnold AJ, Gibbs M (1996). Information and the speed of innovation adoption. Ame. J. Agric. Econ. 78: 1073-1081.
Gallagher KD (2000). Community study programs for integrated production and pest management: Farmer field schools. In: Human Resources in agricultural and rural development. Food and Agriculture Organization (FAO). Rome, Italy pp. 60-67.
Grieshop JI, Zalom, FG, Miyao G (1988). Adoption and diffusion of integrated pest management innovations in agriculture. Bulletin of the Entomological Society of America pp. 72-78.
Llewellyn R (2006). Achieving rapid adoption: information value and the role of grower groups. Proceedings of the Australian Agronomy Conference, Australian Society of Agronomy. Available at: http://www.regional.org.au/au/asa/2006/.
Marra M, Pannell DJ, Abadi Ghadim A (2003). The economics of risk, uncertainty and learning in the adoption of new agricultural technologies: Where are we on the learning curve? Agric. Systems 75: 215-234.
National Coalition on Integrated Pest Management (1994). Toward a goal of 75% cropland under IPM by 2000. Austin, TX.
Okunade EO (2006). Factors Influencing Adoption of Improved Farm Practices Among Women Farmers in Osun State. J. Hum. Ecol. 19 (1): 45-49.
Pannell DJ, Marshall GR, Barr N, Curtis A, Vanclay F, Wilkinson R (2006). Understanding and promoting adoption of conservation technologies by rural landholders. Aust. J. Expt. Agric.
Reddy SV, Suryamani M (2005). Impact of Farmer Field School Approach on Acquisition of Knowledge and Skills by Farmers about Cotton Pests and Other Crop Management Practices - Evidence from India. In: Ooi, P.A.C., Praneetvatakul, S., Waibel H., Walter-Echols G. (Eds.), The impact of the FAO EU IPM Programme for cotton in Asia. Pesticide Policy Project Publication Series n. 9, Hannover University, Germany
Ridgley AM, Brush SB (1992). Social factors and selective technology adoption: the case of Integrated Pest Management. Human Org. 51: 367-378.
Rogers EM (2005). Diffusion of Innovations. New York.
Rola A, Jamias S, Quizon J (2002). Do Farmer Field School Graduates Retain and Share what they Learn? An Investigation in Iloilo, Philippines. J. Int'l. Agric. Ext. Edu. 9: 65-76.
Thiele G, Nelson R, Ortiz O, Sherwood S (2001). Participatory research and training: Ten lessons from the Farmer Field Schools (FFS) in the Andes. Currents Uppsala. 27: 4-11.
Tripp R, Wijeratne M, Piyadasa VH (2005). What should we expect from farmer field schools? A Sri Lanka case study. World Dev. 33: 1705-1720.
Vanclay F (1992). Barriers to adoption: a general overview of the issues. Rural Society 2(2): 10-12.
Waller BE, Hoy CW, Henderson JL, Stinner B, Welty C (1998). Matching innovations with potential users: a case study of potato IPM practices. Agric. Ecosyst. Environ. 70: 203-215.