Journal of Economics and Sustainable Development
ISSN 2222-1700 (Paper) ISSN 2222-2855 (Online)
Vol.3, No.9, 2012

Economic Evaluation of Rice IPM Practices in MADA, Malaysia

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Abstract
Environmental protection is a basic element of sustainable agricultural development. Agricultural protection practices however can cause negative externalities. One of main concerns of the externality is the negative effects of pesticide. Concerns on the negative effects of pesticide use have motivated the development of Integrated Pest Management (IPM) programmes. In MADA, Malaysia the IPM collaborative research support programme (CRSP-IPM) was established to specifically address the widespread misuse of pesticides in paddy cultivation, one of the major rice producing regions in the country. An IPM practice in paddy production initiatives includes research on the optimal use of pesticides, complementary weed control strategies, and alternative cultural and biological controls. Results of this study showed that the programme would generate economic benefits which include improvements in water quality, food safety, pesticide application safety, and long term sustainability of pest management systems. A part of savings in environmental costs and the reduction in pesticide use also reduced operating expenses. The calculated economic benefits in terms of aggregate cost savings per season for 454 farmers were MYR756,393 for insecticides, MYR40,537 for herbicides, and MYR94,753 for fungicides.
Keywords: IPM, Adoption, Economic evaluation

1. Introduction

Pesticides are often applied in inappropriate amounts to paddy, as there is a premium attached to unblemished looking produce. The most widely used pesticides among paddy growers in Malaysia are Category II and III. The pesticides are known to have high toxicities. A study on pesticide residues in Malaysia reported that on drawn-out exposure to pesticides has been associated with several chronic and acute health effects like non-Hodgkin's lymphoma, leukemia, as well as cardiopulmonary disorders, neurological and hematological symptoms, and skin diseases (Syarif, et al. 2011; Andreotti, et al. 2009; Jusof et, al., 1992; Blair and White 1985; and Hoag et al. 1986).

According to the Malaysian Crop Care and Public Health Association (MCPA), MYR289 million and MYR364 million worth of agricultural chemicals were used in Malaysia during the financial year 1995 and 2010, respectively (Table 1). This represents an annually average growth rate of 1.6% increase over the past 15 years in the nominal value of agricultural chemicals used in the country. Among the agricultural chemicals, a large percentage of expenditure in recent years (70%) has been for herbicides. This was followed by 19% was for insecticides, 7% for fungicides, and 5% for rodenticide. The use of agrochemicals to improve crop yield and manage pests and diseases continue to be an important input (Nasir et al., 2010 and Tay et al. 2004). Pests and diseases represent a major constraint hindering the production of rice crops in Malaysia. At least 85% of the rice farmers reported that pests and diseases were their major problems. About 65% of these farmers needed extensive use of pesticides to control the problems (Normiyah et al. 1998 and Ghazali et al. 1994).

The empirical level of adoption of IPM programme by growers ranges between 30% and 100%, and without significant presence of the extension component the IPM adoption levels stands at around 30% (Sivapragasam, 2001). Adoption of IPM in rice production initiatives includes research on the optimal use of pesticides, complementary weed control strategies, and alternative cultural and biological controls. If successful, the programme should generate benefits that can be measured in economic terms. These benefits include improvements in water quality, food safety, pesticide application safety, and long run sustainability of pest management systems.

The aim of this study was to carry out economic assessment on the benefits, impacts and factors associated with the adoption of IPM practices in rice production within Malaysia.

2. Methodology

Primary data collection from 454 paddy farmers in four regions, via, Region 1 (Perlis), Region 2 (Jitra), Region 3 (Pendang) and Region 4 (Kota Sarang Semut) were undertaken to identify farm and farmer characteristics, pesticide usage, pest management practices, perceptions about pesticides' hazards, awareness of IPM strategies and willingness to adopt specific IPM technologies. McFadden's Random Utility Model was used as the theoretical framework for analysis of the type of discrete, binary choice problem embodied in selection of pest management technology in this study (Antle and Capalbo 1995).

The decision maker's unobserved net gain in utility of adopting practice j, denoted by U*j is the difference between an individual's utility from deciding to adopt the technology and utility from not adopting the technology.

This net gain can be interpreted as being explained by the variables Xj that would have explained utility levels with adoption or without adoption, plus the disturbance term ε, such that:

$$U^*j = U\ \text{adoption} - U\ \text{non-adoption} = Xj\beta j + \varepsilon j$$

Since only the decision on whether or not to adopt is observed, it can be inferred that

$$Yj = \begin{cases} 1 \text{ if } U^*j - \varepsilon j \geqslant Xj\beta j \\ 0 \text{ if } U^*j - \varepsilon j < Xj\beta j \end{cases}$$

Where Yj is a binary endogenous variable representing adoption of practice j and Xj is a vector of exogenous variables regressors relevant in explaining adoption.

The likelihood function is formed as: L = πi [eXiβ / (1 + eXiβ)] = πj [1/(1+ eXjβ)]; the subscript i denotes adopters and j denotes non-adopters. This likelihood function is maximized with respect to β (using an iterative procedure, usually Raphson-Newton) to get the maximum likelihood estimates of β (βMLE).

The explanatory exogenous variables (regressor) used in the logit analysis are classified according to the following general categories: 1) farmer characteristics; 2) managerial factors; 3) farm structure; 4) physical/location factor; 5) information/institutional factors; and 6) awareness /perceptions regarding pesticide impacts. The variables names used and definitions are provided in Table 2.

3. Results and discussion

A synthesis of results from the estimation and evaluation procedures described in the methodology section is presented here. It begins with a discussion of the results from descriptive statistics analysis of the survey data, and is followed with a discussion of the results from the step-by-step evaluation of the IPM programme in Malaysia, Malaysia.

3.1 Socio-economic profile

The respondents, via farmers were asked about their farm area, which was classified into Northern, Central and Southern zones. The numbers of respondents from Region 1 (Perlis), Region 2 (Jitra), Region 3 (Pendang) and Region 4 (Kota Sarang Semut) areas were 106 (23.35%), 140 (30.84%), 107 (25.57%) and 101 (22.25%) respectively. Among the respondents, 98.2 % were Malays, 0.4 % Chinese, 0.2 % Indians and 1.1 %t other races. Majority (71.15%) of the respondents interviewed were above 51 years old. Only 12.33% of the respondents were females.

Most of the respondents (35.90%) had gone through secondary school education and 60.79% had only primary school education, 0.2% received higher education at Bachelor's or Diploma level and among the remaining respondents 3.08% has no schooling at all. Normiyah et al. (1998) reported that 3.50% of rice growers had no formal education.

The majority of the respondents (88.2%) treated agricultural as their full-time job. This was equivalent to 5-8 hours per day working on the farms in Table 3.

3.2 Farm characteristics and operations

Farmers selected across the three zones showed no significant differences in terms of farm characteristics. In terms of land tenure status, 454 farmers or 71.4 percent of farmers had self-owned lands. Paddy was usually transplanted two seasons a year, the first round in December/January and harvested before the rains started in April/May and the second season was from around July/August to October/November. Land preparation started 45 days before planting, with harvesting occurring between 70 and 120 days after planting. The average farm net income per month for each hectare of the paddy planted in the Region 4 was MYR3,324 which was substantially higher as compared to those planted in the Region 1, Region2, and Region 3 which were MYR1,139, MYR2,468 and MYR1,896 respectively.

3.3 Indicators of pesticide exposures

Several questions about respondents' immediate farm environment and the precautionary measures they took against pesticide exposures were incorporated in the survey to assess the degree of environmental risks in the areas. Surface water in the regions was at risk from pesticide runoff. The distance of the paddy farms to surface water ranged from as close as 1 metres to about 5 metres and the average distance was 4.15 metres (Table 4).

In general, the respondents knew about protection against pesticide exposures. More than 88% of the respondents wore face masks (or any substitute), and more then 90% wore long pants or long sleeved-shirts and shoes when applying pesticides.

About 89% of the farmers used government water supply as their main source of drinking water, and only 12% from other sources (river, mountain water and pond). As an indication of how important it was to farmers to avoid being sick from contaminated water, they were asked whether they boiled their water before drinking. About 95% said they did boil their water before use.

3.4 Goodness of fit measures of IPM technology adoption

The likelihood ratio tests indicate that the amount of variations explained in each of the model (AGROPRAC, TRIWEEKLY, ONEHERB, BIOPRAC, and ETL) was significantly different from zero. Two criteria for goodness of fit are reported in the table, the –2LogL statistics. Two values for both measures were highly significant (99.0% confidence level), providing evidence that the regression coefficients were significantly different from zero (Table 5). Count R2 which is a ratio of correct predictions to the total number of observations was 0.89 for the AGROPRAC model, 0.84 for the TRIWEEKLY model, 0.92 for the ONEHERB model, 0.73 for the BIOPRAC model, and 0.76 for the ETL model. This suggested that the selected regressors were good predictors of adoption and non-adoption of IPM technologies.

The diagnostics collinearity resulted that a condition index (Ci) below than the usual threshold value 30.00, tolerance (T) above than 0.10, and variance inflation factor (VIF) below than 10.0. RETURN variable was used to capture income effects. All the other pairs of explanatory variables had significant Pearson correlation coefficients. Therefore, it concluded that there is no strong collinearity between the attribute variables and all are subsequently included in the regression.

The proportion of correct prediction compares the correct predictions of both adoption and non-adoption with the observed outcomes based on explanatory variable information. Results showed that the AGROPRAC model correctly predicts 89% of adoption cases and 55% of non-adoption cases. For the other four models, 92% (TRIWEEKLY), 98% (ONEHERB), 93% (BIOPRAC) and 82% (ETLS) adoption cases were correctly predicted, while non-adoption was correctly predicted for 84% (TRIWEEKLY), 96% (ONEHERB), 91% (BIOPRAC) and 93% (ETLS) of the observations. The strong predictive ability of each of the models in estimating the probabilities of adoption provides justification for using these probabilities to project adoption rates in the area.

3.5 Estimated adoption rates based on logistic regression

The estimated adoption rates for each technology in each of the sites were based on the logistic regressions. The logit models estimated the predicted probabilities of adoption which were shown in Table 6. A farmer is classified as an adopter if the predicted probability of adopting a particular technology for an individual farmer given his or her specific set of attributes, is greater than his or her probability of non-adoption i.e. greater than 50% of the predicted probability of adoption practices AGROPRAC, TRIWEEKLY, ONEHERB, and BIOPRAC. The ETL had only 25% of the respondents from the survey.

3.6 Factors affecting the adoption of IPM technologies

Influence of the explanatory variables on the adoption of IPM technologies is shown in Table 7. Logit regression results for the AGROPRAC model revealed that the coefficients for Awareness about IPM (HEARD), the Knowledge (EDUC), advice (ADVICE) and REGION 4 as well as the amounts of care taken to avoid exposure turned out to be positive. The marginal effects of the significant variables as well as their odds ratios are also reported. The odd-ratio, computed by exponentiation of the parameter estimate for each explanatory variable, indicates the factor by which the odds of the event is increased or decreased.

All information variables (EDUC, EXPR, OWNERS, PSHARE, REGION4, ADVICE, PREVENT, and HEARD) significantly explained adoption of the BIOPRAC technology. Getting pest management information (ADVICE and HEARD) through farmers' cooperatives increased the probability of adopting the technology. The organized structure of farmers' cooperatives is a valuable attribute that aids in information dissemination. In the same manner, the extensiveness of the marketing channels placed by pesticide companies makes them a formidable influence in farmers' pest management decisions.

For adoption of BT and bacteria control agents, factors that represent scale of operations and flexibility of farmers to experiment and try new practices increase the odds of adoption (HEARD) by a factor. Like in the BIOPRAC model, knowledge (EDUC) and information variables (ADVICE and HEARD) had a significant impact in increasing the odds of adoption.

The probability of adoption of the TRIWEEKLY technology is increased when farmers are more aware of IPM concepts. Six variables were positively significant (at least at the 10% level of significance) were EDUC, FHOUR, FULWORK, REGION 4, ADVICE, and HEARD. Farmers in Regions 4 they had personally witnessed any one of the environmental impacts of pesticide use, and had taken more precautionary measures against pesticide exposure.

The ONEHERB model indicated six variables to be significant to affect the willingness to adopt 50% reduction in herbicide treatments. This was proven by the coefficients EDUC, FHOUR, PSHARE, REGION4, ADVICE, and HEARD which were positively correlated with the increase of ONEHERB adoption. A positive correlation was also true for PSHARE sharing there higher profit farmers tend to increase the use of ONEHERB adoption. Increased adoption of more ONEHERB model meant that controlling weeds is more efficient and at the same time would reduce the amount of weedicide used.

Awareness of the IPM system (HEARD), the knowledge (EDUC) and the water management (WTERCON), REGION 4, and information variables (ADVICE) together with the amount of care taken to avoid exposure, all had a positive influence on the dependent variable ETL. As expected, farmers who owned larger farms were more likely to reject the technologies. These result could be seem where the ETL model showed that the odds for adoption is significantly increased by a unit increase in the HEARD, EDUC, WTERCON ADVICE, and REGION4 variables. This implies that increasing farmers' awareness of the health and environmental impacts of pesticide use and their knowledge of IPM were very important in promoting adoption of alternative pest management practices. Additionally, cooperatives and pesticide sales agents were important sources for these changes to happen. Collaboration among the different change agents (extensions and pesticide agents, as well as farmer cooperatives) for technology promotion should be advocated.

On top of savings in environmental costs, the reduction in pesticide use also reduced operating expenses (Table 8). Calculated reduction in economic costs showed the aggregate cost saving per season (of 454 paddy farmers) were MYR756,392 for insecticides, MYR40,536 for herbicides, and MYR 94,753 for fungicides.

4. Conclusion

In this study, 454 respondents were interviewed to identify farm and farmer characteristics, pesticide usage, pest management practices, perception about pesticides' hazards, awareness of IPM strategies and willingness to adopt specific IPM technologies. The probabilities of adoption of the IPM technologies were predicted using a maximum likelihood logit model. Calculated reduction in economic costs showed the aggregate cost saving per seasons (of 454 paddy farmers) of insecticides, herbicides and fungicides was MYR 891,681.

The estimated adoption model provided insights into the factors that influence adoption of different technologies. For example, informational factors such as the source of pest control advice were highly significant in the different models. Results indicated that if pest control advice was obtained through farmer cooperatives, the probability of adoption also increased.

The educational efforts designed to increase awareness may be worthwhile. The adoption model estimated allows for adoption rates to be further projected to a larger community and bigger population given information on average values of general socio-economic attributes of paddy producers.

This study provides justification for public investment of resources in training and educational programs to increase awareness about IPM and promote IPM adoption particularly in areas like North zone. The Region 4 group even has an advantage over the others group in that they have been exposed to IPM concepts in paddy and some of the practices and beliefs learned from paddy IPM are carried over in their paddy farming.

The economic success of a highly organized group of farmers makes a good case for espousing establishment of farmers' cooperatives to help hasten IPM technology transfer. The IPM – Collaborative research support programme (CRSP) technologies can reduce pesticide use in rice without loss of efficacy. For example, results of the IPM - CRSP field trials showed that herbicide use could be reduced by as much as 50% with adoption of the alternative weed control strategies, and a no-insecticide option is viable to control paddy pest if biological controls are used.

Finally, as soon as farmers begin to adopt these technologies, impacts on pesticide use can be more accurately estimated. Because different farmers face different constraints or production functions, the reduction in pesticide use from adoption of the technologies may differ from one farmer to another.

Table 1. Agricultural chemicals in Malaysia (MYR million), 1995 – 2010

Agricultural Chemical	1995	2000	2005	2010	AVG 1995-2000	%	AGR 1995-2000
Herbicide	220.0	273.0	218.0	235.0	236.5	69.9	0.4
Insecticide	43.0	68.0	64.0	79.3	63.6	18.8	4.2
Fungicide	15.0	23.0	24.0	29.7	22.9	6.8	4.7
Rodenticide	11.0	14.0	17.0	20.0	15.5	4.6	4.1
Total	**289.0**	**378.0**	**323.0**	**364.0**	**338.5**	**100.0**	**1.6**

Source: Malaysian Crop Life and Public Health Association (MCPA), Malaysian Agriculture and Agro-base Industries (MOA) value at end-user level, and Food and Agriculture Organization (FAO).

Note: AVG= Average, %=Percentage, AGR (%) = Annual Growth Rate in Percentages and MYR=Malaysia Ringgit

Table 2. The explanatory variables (endogenous) used in the logit analysis

Definition variable	Unit
Farmer characteristics	
Age (AGE)	No. of years
Educational attainment (EDUC)	No. of years
Experience of farming (EXPER)	No of years in Paddy farming
Tenure status (OWNER)	1 = owner-operator or 0 = otherwise
Managerial factors	
Farm hours (FHOURS)	Time spent on farm per week; number of hours
Off-farm work (OFFWORK)	1 = farmer has off-farm employment or 0 = otherwise
Pesticide costs (PESCOST)	Ratio of pesticide expenses to total operating costs; percent
Farm structure	
Farm size (FARMSIZE)	No. of hectares
Paddy profit share (PSHARE)	Ratio of profits from paddy to total farm income; percent
Physical/location factor	
Region 4	1 = farm is located in that site or 0 = otherwise
Institutional/informational factors	
IPM awareness (ADVICE)	e 1= farmer obtained pest control from the specified source; 0=
IPM training (ATTEND)	1= farmer attended an IPM training; 0= otherwise
Experiences and awareness about impacts of pesticide use	
Preventive against pesticide exposure (PREVENT)	Use of preventive measures against pesticide exposure
Health impact (SICK)	1= farmer got sick after spraying pesticide; 0= otherwise

[a] Variable dropped from the model to avoid a singular matrix

Table 3. Socio-economic Profile and Farm Characteristic by Regions

Socio-economic Profile		Location – Region				Overall	
		Region 1 n = 106	Region 2 n = 140	Region 3 n = 107	Region 4 n = 101	n=454	%
Age (Year)	Below 30	1	1	3	3	8	1.76
	31 – 40	6	6	3	10	25	5.51
	41 – 50	22	28	24	24	98	21.59
	51 – 60	30	43	33	35	141	31.06
	Above 60	47	62	44	29	182	40.09
Academic level	No school	6	7	1	NA	14	3.08
	Primary school	68	91	69	48	276	60.79
	Secondary school	32	42	37	52	163	35.9
	Higher degree	NA	NA	NA	1	1	0.22
Experience (Year)	Below 20	28	33	25	34	120	24.44
	21 - 30	24	42	38	26	130	28.63
	31 - 40	40	45	27	26	138	30.4
	41 - 50	14	20	12	9	55	12.11
	Above 51	NA	NA	5	6	11	2.42
Type of farming	Full-time	106	138	105	101	450	99.12
	Part-time	NA	2	2	NA	4	0.88
Tenure Land Status	Self-owned	74	87	78	85	324	71.37
	Rental	27	53	29	21	130	28.63
Paddy Farm Size (Ha/season)	Below 2.0	58	97	72	59	286	65.30
	2.1 – 4.0	35	30	26	20	111	25.30
	4.1 – 6.0	5	4	6	11	26	5.90
	6.1 – 8.0	2	2	1	3	7	1.60
	Above 8.1	4	1	0	3	8	1.80
Paddy Yield Per Hectare (Kg/Season)	Below 2,000	15	13	19	3	50	11.01
	2,001 - 4,000	54	36	34	27	151	33.26
	4,001 - 6,000	22	28	22	25	97	21.37
	6,001 - 8,000	8	29	15	10	62	13.66
	8,001 - 10,000	7	19	12	17	55	12.11
	Above 10,0001	0	15	5	19	39	8.59
Gross Income Per Hectare (MYR/Season)	Below 5,000	94	88	83	57	322	70.93
	5,001 - 10,000	12	50	24	38	124	27.31
	10,001 - 14,000	NA	2	NA	5	7	1.54
	Above 14,001	NA	NA	NA	1	1	0.22
Net Income Per Hectare (MYR/Season)	Below 2,000	84	67	64	43	258	56.83
	2,001 - 4,000	14	36	24	19	93	20.48
	4,001 - 6,000	7	26	12	22	67	14.76
	6,001 - 8,000	1	10	6	8	25	5.51
	8,001 - 10,000	0	1	1	7	9	1.98
	Above 10,001	0	0	0	2	2	0.44

Source: 2010/2011 Producer Survey

Note: NA = Not applicable, MYR = Malaysia Ringgit

Table 4. Indicators of pesticide exposure

PESTICIDE EXPOSURE	Percentage of "yes" responses								Overall	
	Region 1		Region 2		Region 3		Region 4		n=454	%
	n = 106	%	n = 140	%	n = 107	%	n = 101	%		
1. Is there an area of water containing fish that is near your farm?										
	86	81.13	118	84.29	36	33.64	83	82.18	80.75	70.31
2. Do you consume fish from this source?										
	88	83.02	120	85.71	92	85.98	95	94.06	98.75	87.19
3. Treatment of water as source of drinking water?										
	89	83.96	119	85.00	96	89.72	100	99.01	101	89.42
4. Protection against pesticide exposure										
Face Mask	90	84.91	121	86.43	94	87.85	96	95.05	100.25	88.56
Long Sleeved-Shirts	93	87.74	122	87.14	96	89.72	100	99.01	102.75	90.90
Long Pants	92	86.79	122	87.14	96	89.72	100	99.01	102.5	90.67
Rubber Shoes	92	86.79	122	87.14	96	89.72	100	99.01	102.5	90.67
5. Distance between Surface Waters and Paddy Field (average) meters?										
	4.20		4.23		4.00		4.16		4.15	

Table 5. Goodness-of-Fit measures/Predictive ability of the logit models

Measure of Goodness of Fit		LOGIT MODELS				
		AGROPRAC	TRIWEEKLY	ONEHERB	BIOPRAC	ETLS
% Correct predictions:						
Adoption		88.7	92.3	98.0	96.9	81.9
Non-Adoption		54.7	84.0	96.4	91.0	93.3
Count R^2		88.6	84.3	92.1	73.2	75.5
-2 Log L	λ^2 value	176.3	143.2	94.1	75.9	44.8
	p-value	0.0002	0.0001	0.0001	0.0054	0.0075

Table 6. Predicted adoption rates by site (region)

IPM Model	Region 1		Region 2		Region 3		Region 4		Average	
Adoption Rates	n = 106	%	n = 140	%	n = 107	%	n = 101	%	n=454	%
AGROPRAC	90	84.5	122	86.8	93	87.0	90	88.7	395	87.00
BIOPRAC	53	50.3	71	50.5	60	56.1	79	78.7	263	57.93
ONEHERB	46	51.9	73	52.1	62	57.9	82	81.2	263	57.93
TRIWEEKLY	51	47.9	67	48.1	57	53.4	76	74.9	251	55.29
ETLS	7	6.1	7	4.7	34	31.4	66	65.7	114	25.11

Table 7. IPM adoption models: Logistic regression result

Variable a	AGROPRAC		BIOPRAC		TRIWEEKLY		ONEHERB		ETL	
	Coeff	**Odd-Ratio**	**Coeff**	**Odd-Ratio**	**Coeff**	**Odd-Ratio**	**Coeff**	**Odd-Ratio**	**Coeff**	**Odd-Ratio**
INTERCEPT	-2.63	0.072	-17.93	0.001	-4.12	0.016	-8.655	0.001	-6.32	0.002
AGE	0.051**	1.053	-0.158	0.854	0.039	1.04	0.022	1.022	-0.018	0.982
EDUC	0.148*	1.16	0.027*	1.027	0.294*	1.341	0.267**	1.306	0.072*	1.075
EXPR	-0.024	0.976	0.311*	1.365	0.015	1.015	0.067	1.069	0.043	1.044
OWNERS	0.006	1.006	2.139**	8.492	0.536	0.585	0.412	0.662	-1.31*	0.27
FHOUR	0.178	0.837	0.322	0.725	0.527*	0.59	0.431**	0.65	0.161	0.851
FULWORK	0.37	1.447	0.892	2.44	1.374*	3.953	1.161	3.192	0.932	2.54
RPESCOST	-0.005	1.005	-0.065	1.067	-0.021	1.021	-0.006	0.994	-0.008	0.992
FSIZE	0.009	1.009	0.557	0.573	0.257	0.773	0.009	0.991	0.088	1.093
PSHARE	0.006	1.006	0.044*	1.045	0.001	1	0.019***	1.020	0.007	1.007
REGION	-0.162	0.85	-1.418	0.242	-0.431	0.65	-0.849	0.428	-1.45	0.234
REGION4	0.262*	0.77	1.497*	0.224	2.835*	17.028	1.400**	4.057	3.628*	37.64
ADVICE	1.191*	32.9	2.263*	9.61	2.357*	10.562	3.190*	24.295	0.203*	1.225
PREVENT	-0.134	0.874	1.834*	6.258	0.228	0.796	0.103	1.109	0.104	1.109
HEARD	3.072*	21.593	10.13*	25.07	5.450*	23.274	5.808*	33.296	4.557*	95.258
WTERCON	0.334	1.397	2.293	9.906	1.083	2.955	0.678	1.969	1.548*	4.702

Note: [a] Variables that significantly affect the dependent variable are noted with asterisks; * indicates the variable is significant at α = 1%, ** for 5 %, and *** represents 10% level of significance.

Coeff = Coefficient, T-Stat = T statistic value and Odd-Ratio = A one unit change in the independent variable increases the odds of Adoption IPM by a factor of Odd-Ratio.

Table 8. Cost savings from adoption of IPM technologies

IPM Technology	Cost Saving (MYR) Expenses on Pesticides Per Season		
	Insecticides	**Herbicides**	**Fungicides**
AGROPRAC	162,577.22	19,658.60	94,753.32
BIOPRAC	158,053.49		
TRIWEEKLY	145,370.34		
ONEHERB		20,878.21	
ETL	290,391.64		
TOTAL	756,392.69	40,536.81	94,753.32

Note: The value in Malaysia Ringgit, and NA = Not available

Acknowledgements

This study was made possible by the generous financial and administrative support of the Malaysian Agriculture Research and Development Institute (MARDI), Universiti Putra Malaysia (UPM) and Ministry of Agriculture and Agro-Based Industries (MOA). The dedication and efforts provided by the IPM Adoption administrators, researchers, and collaborators through their leadership who have established an IPM initiative has touched and improved many lives throughout the world.

I wish to express my thanks to all the farmers and members of the Association of Rice Farmer Malaysia for their very cooperative, helpful, and friendly attitudes during the interviews. Special thanks to lately "mother" Hajah Fatimah, who passed away during my critical time to complete this reserach. I always remember your encouragement, love, advice and moral support. Last but not least, thank to my parents who have assisted me throughout the duration of this research.

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