National Dissemination of Integrated Pest Management Technology through Farmers' Field Schools in Indonesia: Was It Successful?

J. Mariyono*

AVRDC-The World Vegetable Centre, ACIAR Funded IDM Chilli Project Jl. Slamet 51, PO BOX 999 Tegal, Central Java, Indonesia

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There is a strong debate on the success of Indonesian integrated pest management project in terms of reduction in pesticide use, increase in production, and diffusion of IPM knowledge. This study aims to analyse the accomplishment of farmers' field school at national level, and the results indicated that the IPM training project failed to meet the minimum recommended requirements of training, even though IPM practices technically showed the superiority to conventional practices in the field trials. The most likely culprit was a great deal of absenteeism. Farmers leaved before completing the training as the supply of training materials was irregular. To some extent, the project was considered unsuccessful.

Key words: integrated pest management, farmers' field school, indicators of performance

Introduction

Indonesian IPM Program in rice is one of the components of sustainable agriculture development. The Indonesian Government was implementing the program with support of the UN's Food and Agriculture Organization (FAO) since May, 1989 for dissemination IPM technology among rice-based farmers trough a pilot project. The program provides an ideal case to contrast extension for sustainable agriculture with that supporting high external input agriculture. IPM is being introduced into a farming system, irrigated rice, in which the Green Revolution has been successful during the past twenty years (Rolling and van de Fliert, 1994).

This program was a realization of Presidential Decree (INPRES 3/86), three years before, which banned 57 brands of pesticides from rice cultivation, and declared IPM the national pest control policy. A policy measure

* Corresponding author: Joko Mariyono; e-mail: mrjoko28@yahoo.com

progressively reduced the subsidy on pesticides, which was previously 85 per cent, to zero in 1990 (Untung, 1996). These policy measures created a good climate for the implementation of Indonesia's National IPM Program. It is the first phase (1989-1992) of large-scale attempt to systematically introduce sustainable agricultural practices as a public sector effort at national level. Locations were purposively selected with criteria of easy accessibility and the presence of active farmer groups. Farmers participating in the school were also purposively selected for the program. Farmers with more prosperous and better informed in the selected villages were encouraged to be participants of the school. The second phase (1993-1999) was sponsored by the World Bank loan. In this phase the program was multiplied in scales. Since 1994, the pilot activities had been taken over by the National IPM Training Project funded by the World Bank loan (World Bank, 1993). The project promoted IPM and improved crop cultivation of rice and other food and horticultural crops. More regions had been covered and more actors had been involved. However, the target was not to reach all Indonesian farmers. The strategy of the program was to train a fraction of farmer community, instead of to train all farmers in the community. Thus, the spread of IPM knowledge relied on farmer-to-farmer diffusion. During implementation of second phase of the project, villages were subjectively selected with the same criteria by the project management in collaboration with Agricultural Services official both in provincial and district levels. With the assistance from agricultural office at sub-district level and farmer group leaders and farmers were also purposively selected with certain criteria, for instance: rice farmer, literacy, and ability to actively discus.

Farmers' Field School: Process

The central point of IPM program in Indonesia was IPM training called farmer's field school (FFS), a process of learning by doing. The World Bank, along with a number of development agencies promoted FFS since it had more effective method to extend science-based knowledge and practices (Feder *et al*., 2004a). Farmers' field school used a participatory approach to provide assistances for farmers to develop their capability on analytical skill, critical thinking and creativity such that farmers could make better decision (Fakih *et al*., 2003). In short, the objective of FFS was to enhance human resource development, in which farmers became experts of IPM in their paddy fields. Farmers were expected to be able to conduct field observations, to analyse agro-ecosystems, to make decisions, and to implement pest control strategies based on the results of their field observations (Dilts and Hate, 1996). Farmers would obtain those capabilities from FFS. In reality, IPM did not only involve pest control but also other aspects of farming such as balanced and efficient fertilizing, efficient use of water, crop rotation and soil conservation. The following IPM principles were central to the FFS: grow healthy crops; conserve and utilise natural enemies; carry out regular field observations; develop farmers as IPM experts in their own field (Untung, 1996). There were 25 participants in a unit of IPM training. The training consisted of 12 meetings which were executed every week. In one day, a series of activities carried out in a rice-based FFS meeting were as follows (Braun *et al*., 2000). Field Observation were done during 7:30-8:30 a.m. Farmers formed small groups of five, made observations of the whole field and then examined 10 plants per plot, recorded the number of tillers per plant, the type and number of insects, and any other relevant details. Agro-ecosystem analysis was done during 8:30-9:15 a.m. Each group prepared drawings of their field observation including information on the condition of the plants; pests and diseases; natural. Presentation and discussion were performed during 9:15-10:00 a.m. Each group presented its drawing and discussed its observations and conclusion. The whole group reached consensus about the crop management practices that they would carry out during the coming week. Then, group dynamics exercise was done during 10:15-10:30 a.m. This activity aimed to stimulate attention and participation, as well as strengthened group communication and increased solidarity. Lastly, the trainer guided the group in experiments, lessons, exercises and discussions on special topics related to what was actually occurring in the field between 10:30-12:00 a.m. With this, the processes of training above required timely and sufficient material and financial supports in order to run as expected. As cited by Agro-Chemical Report (2002), a unit cost of FFS in 1996-97 fiscal years was averaged of US$599.

Debate on the Accomplishment of the Program

It is reported in Agro-Chemical Report (2002) that Indonesia has been one of the leaders in the application of IPM in Asia. Since 1989, the national IPM program has helped Indonesian farmers to reduce their reliance on pesticides and to increase their harvests. It has also dramatically reduced the incidence of pesticide-related illnesses and environmental pollution. Winarto (1995) showed an impressive process of transfer IPM knowledge at farmer level. During the first few years of the IPM program, pesticide use dropped by approximately 50 per cent and yields increased by around 10 per cent (Pincus, 1991), and the IPM-promoters claimed that Indonesian IPM Program has been successful done because farmers can reduced pesticide use and escalated rice production (van den Berg, 2004).

However, Feder *et al*. (2004a; 2004b) expressed strongly disagree with the successful IPM program. There is no evidence that the expected environmental and health benefits of the program are significant since there is no effect of the program on pesticide use. By using panel data analysis and a quite complex econometric approach to cope with selection biases, the empirical studies show that the claim of the success are implausible (Feder *et al*., 2004a) and the diffusion of knowledge was very slow (Feder *et al*., 2004b). The findings highlight the complexity of training in disseminating IPM technology where farmers could not convey the core of messages to the other farmers through informal communication. But, it does not immediately mean that IPM technology fails to control pests using a lower level of pesticide use. The technology itself is expected to be superior to the conventional one in controlling pest infestations with a lower level of pesticide use, because it combines various compatible techniques of crop protection (Matteson, 2000; Untung, 1996). The most likely cause of the failure is that there were administrative problems in implementing the IPM training project funded by the World Bank (Pretty and Waibel, 2005). This led to untimely deliveries of training materials such that the IPM training could not run properly. Thus, there are two conflicting parties. It is still disputable which one represents the real impact of IPM program. It would be worthwhile to provide information on the implementation IPM training for which both parties are expected to re-evaluate their claims whether or not the findings are adequate. One proposition that should hold is that the high-quality of IPM training may results in good economic impacts on agricultural production. The objective of this study was to evaluate the implementation of IPM training. Using the data from a management information system (MIS) of the project, this study analyses the quality of IPM training.

Materials and methods

This study was conducted by using descriptive, simple statistical test (Diekhoff, 1992) and regression methods (Wooldridge, 2003) to analyse the implementation of IPM training. Since the IPM training has been considered failed, the analysis starts with the economic superiority of IPM technology. The key measure of the superiority was an ability of IPM technology to reduce of pesticide use and to increase or maintain the same level of rice yield. The analysis proceeded with the characteristics of IPM training, which consisted of farms, participants and pattern of attendance in the training. These characteristics are selected for analysis because they are strongly correlated with the qualities of training. A multiple-regression method is used to analyse the attendance of participants during 12 weeks. Following Chiang (1984), the attendance is modelled as:

$$A = \beta_0 + \beta_1 M + \beta_2 M^2 \qquad (1)$$

where A is the number of participants in each week of meeting; β_0 is a constant number representing the number of participants in the first week of meeting; M is jth meeting, for j=1, 2,…12; β_i is coefficients representing the pattern of attendance during implementation of training. It is expected that β_0 is significantly equal to 25, β_1 and β_2 are insignificant, meaning that the number of participants is constantly 25 during the training. The most likely case is that β_1 is negative and β_2 is positive, meaning that the number of participants falls in some early weeks, but the number increases in the late weeks of training. The greater β_1 (in absolute value) represents a dramatic fall, and the greater β_2 represents a rapid increase in the number of participants. Estimation and test for significance of β_i follow a procedure explained by Wooldridge (2003).

Data are compiled from a database of management information system (MIS) conducted by FAO-technical assistance for the project. The MIS started operating in 1994, when the IPM program was conducted in a large scale and funded by the World Bank loan. Information on training was collected by IPM facilitators in the field using a set of forms. The forms were then compiled by the district project offices and reported to the sub-province project offices. At this level, the data were entered into a computer. However, because of technical difficulties, the data processing was taken over by the national project office under supervision of the FAO-technical assistance.

Results and Discussion

Up to April 1998, there were 12,806 units of IPM training that had been reported by 11 of 12 implementing provinces. One province project office, Lampung, did not report to the national project office. The distribution of implementation of training is given in Fig. 1. IPM training was concentrated in the Indonesian rice bowls: West Sumatra, Java, and South Sulawesi. If the number of trainings reported here is considered the real implementation of training, the number was much lower than that formally reported by the national project which claimed that around one million farmers that would be trained during the project. As a unit of IPM training covered 25 farmers (Braun *et al*., 2000), this means that the target of 40,000 units of IPM-training should had been executed by the end of the project. Given that the project would conclude by the end of 1999, Pincus (2002) described that the number of IPM trainings was reported by local authorities to be fictitious in the years when the IPM training was funded by the World Bank loan.

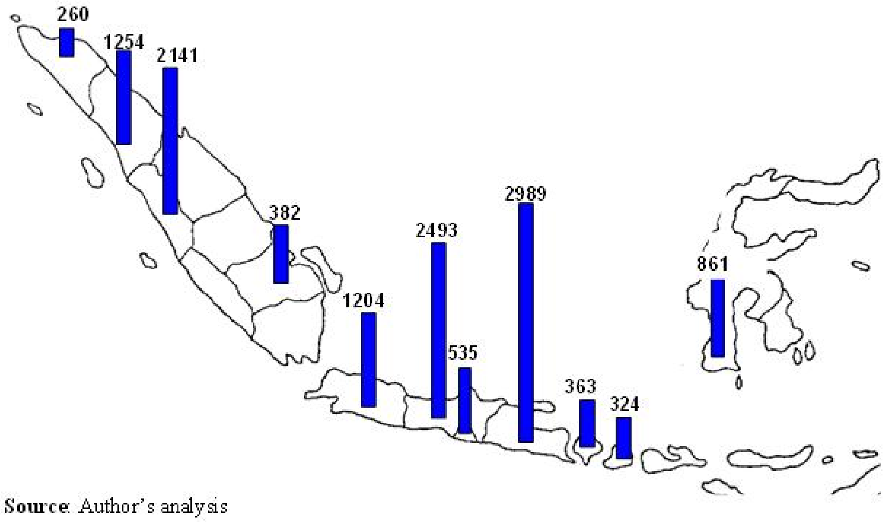

Fig. 1. Distribution of IPM training in Indonesia.

Feder *et al*. (2004a and 2004b) stated that the economic indicators of successful IPM training increased in rice yield and decreased in pesticide use. Thus, comparing such indicators in the field trials between IPM practices and conventional ones showed that the level of yield in IPM practices should be demonstrated technically higher than that of conventional ones, and the level of pesticide use in IPM practices should be shown less than that in conventional ones. As depicted in Fig. 2, IPM practices in the field trials of IPM training in all provinces showed higher level of rice yield than conventional practices. There were 3 provinces – South Sulawesi, Central Java and North Sumatra — that showed tiny difference in rice yield. This indicated that rice in the three provinces had been intensively cultivated as the provinces which were rice bowls. Overall, there was not much difference in rice yield between both practices because IPM technology that was not mainly intended to increase yield, but to reduce pesticide use without sacrificing yield (Useem *et al*., 1992; Pretty and Waibel, 2005).

If there was no impact on the dissemination of IPM technology on rice yield and pesticide use, it means that there was something wrong with the process of dissemination where farmers could not absorb the essential ideas delivered by the process of training. In this case, IPM training was the main process of the dissemination of IPM technology in Indonesia (Fig. 2 and Fig. 3).

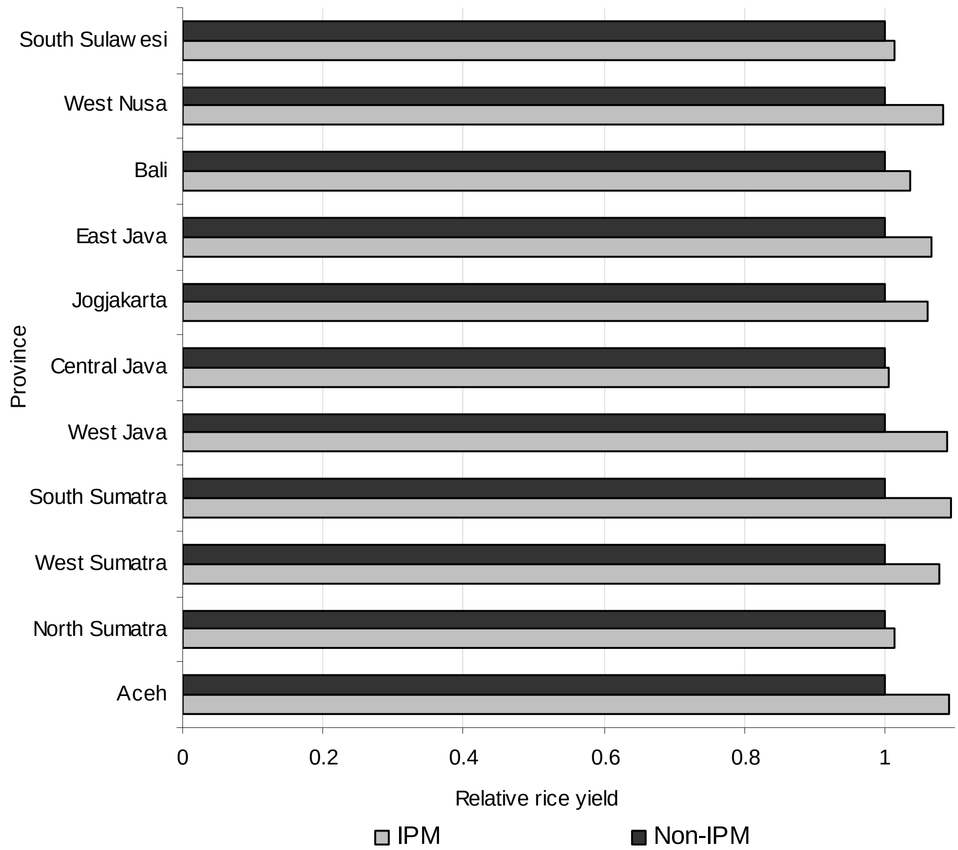

Fig. 2. Comparison of rice yield, simple t-test procedure shows significant difference in rice yield at 0.01 level.

There were some factors e.g. farm characteristics, the composition of participants and the attendance of participants that might influence the process of dissemination. Farm characteristics in this study consisted of land-ownership and types of irrigation. The IPM training in Indonesia was directed to build farmers as ‘experts’ in their own field, meaning that farmers would make better decisions based on the field observations (Untung, 1996). The process of decision-making was likely to work properly if all IPM-trained farmers operated farms on their own paddy field. There were more than 25 per cent of participants did not operate farms on their privately owned land (Fig. 4). It would be difficult for those who were not the owners to make a proper decision related to IPM practices. For example, in a shared farming, a farmer would not able to make a correct decision because he/she should discuss with the owner. If the owner knew about IPM well, the correct decision related to IPM practices was likely to be made.

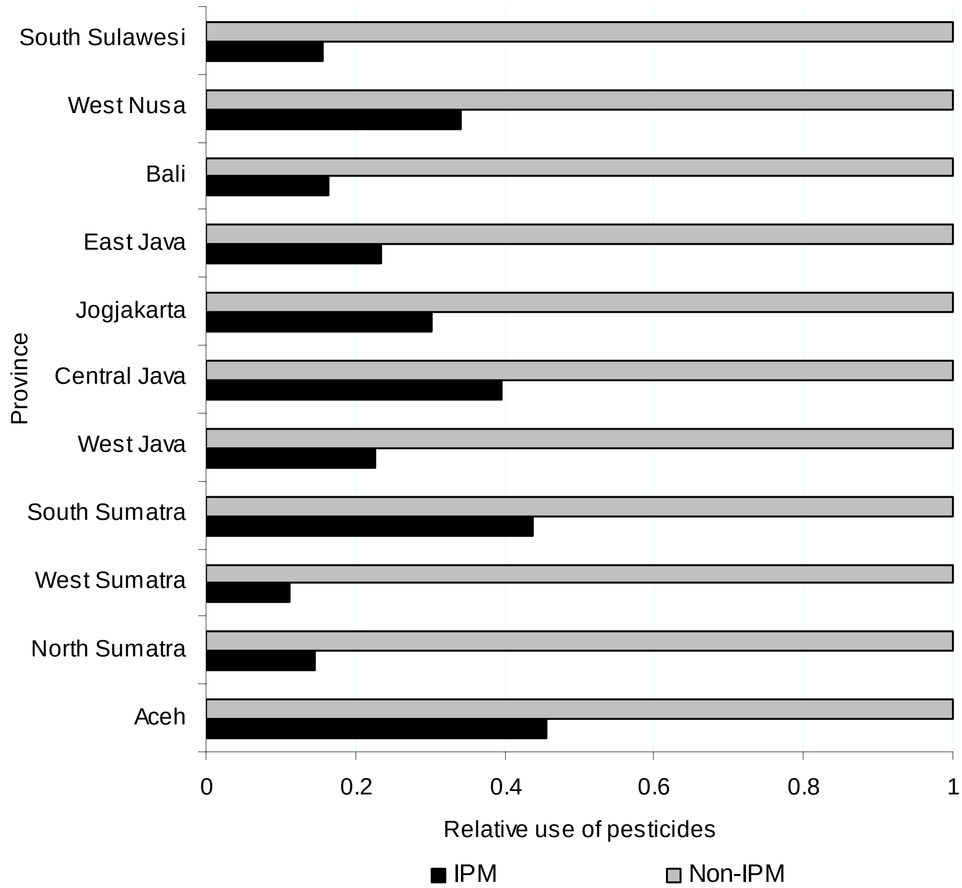

Fig. 3. Comparison of pesticide use, simple t-test procedure shows significant difference in pesticide use at 0.01 level.

An irrigated farm indicated an intensiveness of rice cultivation, because a modern rice technology that needs better water management. About 30 per cent of farms were rain-fed (Fig. 5). For those operating farms in the rain-fed lands made it was difficult to apply full IPM practices. Some techniques of pest controls could only be applied by controlling the level of water in the paddy field (Gallagher *et al*., 2005; Kalshoven, 1981), which was unlikely to be carried out in rain-fed lands. A manageable level of water irrigation was considered to be one of the essential components in IPM practices (Braun *et al*., 2000).

Gender composition of participants in the training was reported to be a significant factor in the success of training because the presence of women made the training to be more dynamic. For that reason, the project management encouraged woman farmers to participate in the IPM training. Another reason was that almost 50 per cent of farm activities were conducted by women (Kingsley and Siwi, 1997). It was strongly recommended that the number of participants in a unit of IPM training was at least 30 per cent (World Bank, 1993).

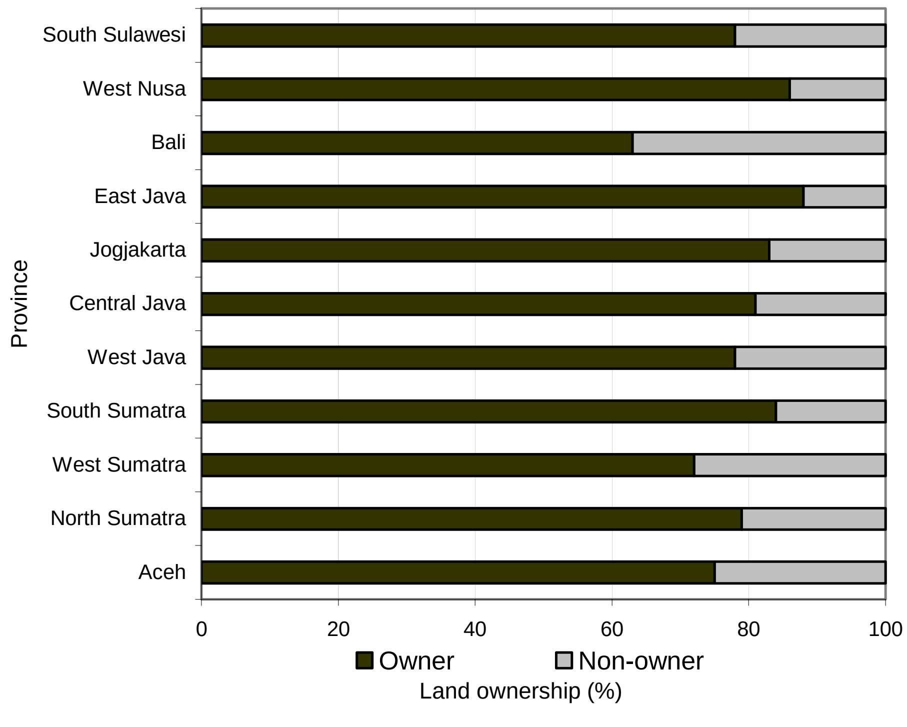

Fig. 4. IPM training participants, by land ownership, simple t-test procedure shows significant difference in land ownership at 0.01 level.

The target of 30 per cent woman participants could not be fully met, despite the fact that in some regions there were more than 30 per cent of woman participants. Local culture seemed to be a significant determinant of the variation in gender composition of participants. For example, in West Sumatra where 'mother' played an important role in the social life of household, the number of woman participants was the largest. On the contrary, in Bali where the social culture benefited men, the number of woman participants was the smallest (Fig. 6).

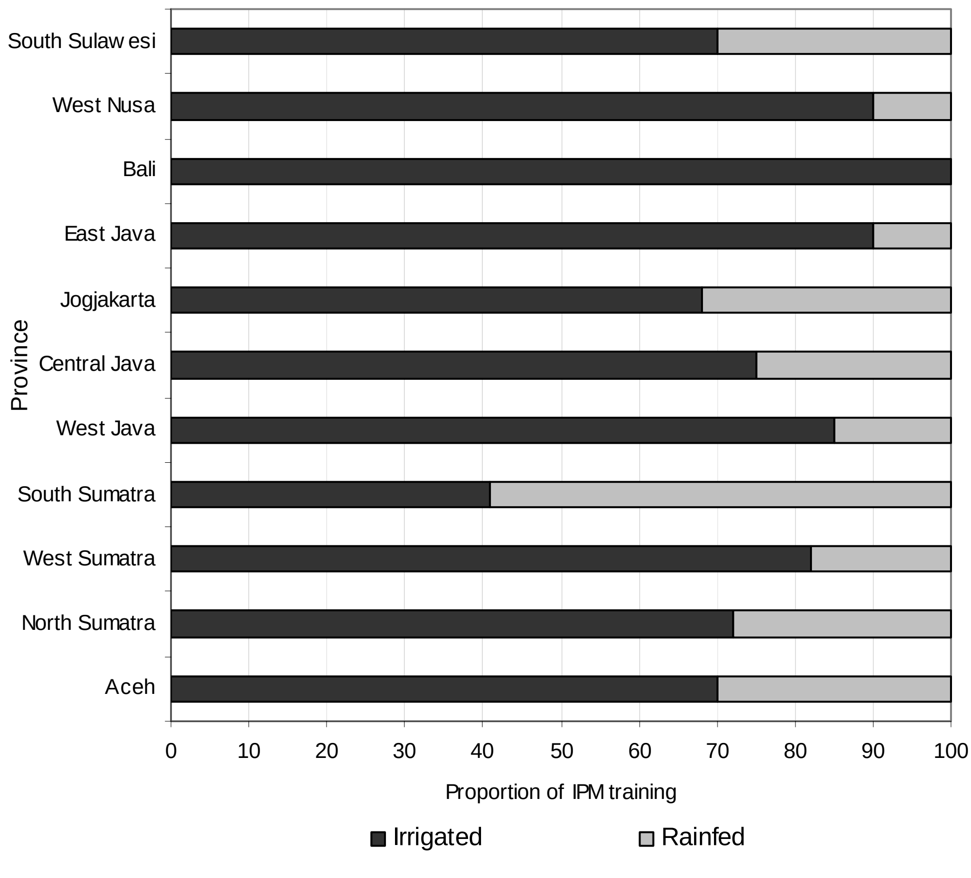

Fig. 5. Proportion FFS, by type of irrigation, simple t-test procedure shows significant difference in types of irrigation at 0.05 level.

Based on the both characteristics and the composition of participants, it seems that there was no serious problem in the process of dissemination of

IPM technology as the fraction of unanticipated characteristics that was only around 20-30 per cent. About 70-80 per cent of farmers operating their privately owned irrigated farms that would be expected to adopt IPM technology if they fully participated in the training. The attendance of participants needed to analyse during a 12-week process of IPM dissemination. This was an essential factor because a full attendance ensured that farmers could learn IPM technology in a complete cycle of training. Table 1 shows the estimated model of pattern of farmers' attendance in IPM training.

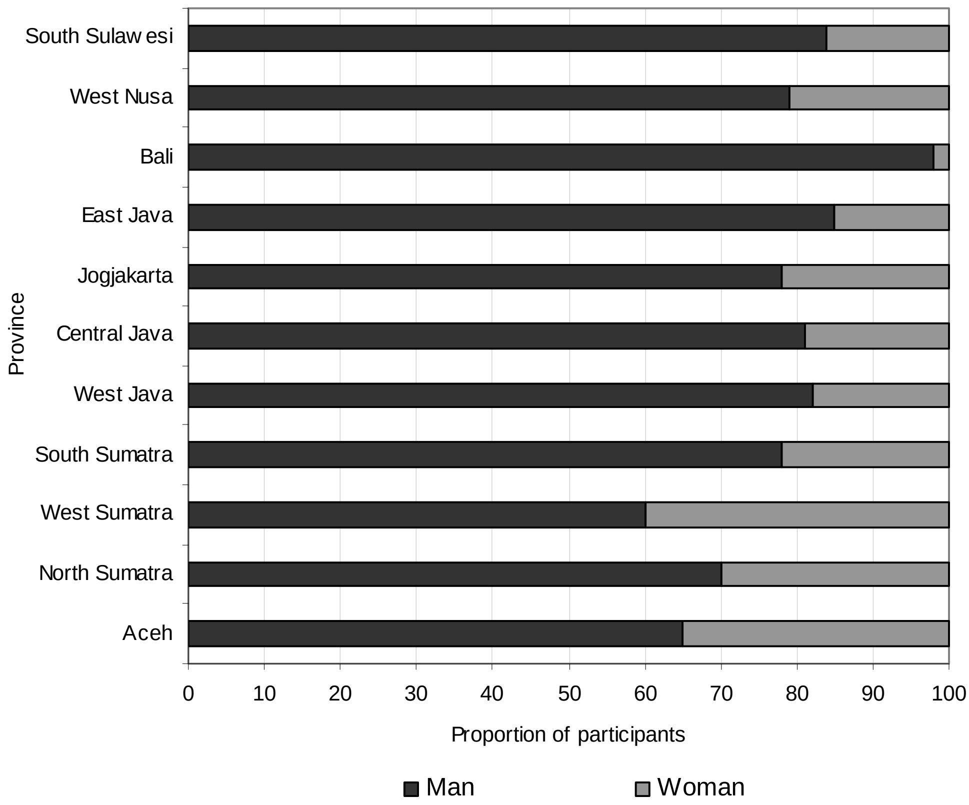

Fig. 6. Proportion of farmer's field school (FFS) participants, by gender, simple t-test procedure shows significant difference in composition by gender at 0.05 level.

Table 1. Attendance pattern of farmer's field school (FFS).

Province		Constant	M	M^2	Statistics
Overall	β_i	25.29	-0.9431	0.0137	R^2=0.25
	t_{stat}	48.73[a]	-5.14[a]	4.06[a]	F-stat=132[a]
Aceh	β_i	23.71	0.3467	-0.0638	R^2=0.62
	t_{stat}	14.16[a]	0.59[n]	-1.49[b]	F-stat=7.39[a]
North Sumatra	β_i	25.73	-1.8449	0.1202	R^2=0.95
	t_{stat}	57.30[a]	-11.62[a]	10.10[a]	F-stat=81.37[a]
West Sumatra	β_i	25.06	-1.2230	0.0728	R^2=0.97
	t_{stat}	102.81[a]	-14.19[a]	11.28[a]	F-stat=161.79[a]
South Sumatra	β_i	27.05	-1.3162	0.0950	R^2=0.92
	t_{stat}	72.29[a]	-9.95[a]	9.58[a]	F-stat=49.55[a]
West Java	β_i	25.92	-1.4702	0.0879	R^2=0.97
	t_{stat}	87.21[a]	-13.99[a]	11.17[a]	F-stat=155.14[a]
Central Java	β_i	24.07	-1.2890	0.0788	R^2=0.93
	t_{stat}	57.73[a]	-8.74[a]	7.14[a]	F-stat=56.03[a]
Jogjakarta	β_i	25.91	-1.0579	0.0624	R^2=0.97
	t_{stat}	118.92[a]	-13.73[a]	10.81[a]	F-stat=156.74[a]
East Java	β_i	25.09	-1.0272	0.0677	R^2= 0.82
	t_{stat}	51.28[a]	-5.94[a]	5.22[a]	F-stat= 20.57[a]
Bali	β_i	25.03	-0.0914	0.0061	R^2=0.77
	t_{stat}	495.65[a]	-5.12[a]	4.58[a]	F-stat=14.70[a]
West Nusa	β_i	25.39	-0.9138	0.0571	R^2=0.96
	t_{stat}	127.19[a]	-12.95[a]	10.81[a]	F-stat=114.48[a]
South Sulawesi	β_i	25.20	-0.4875	0.0293	R^2=0.88
	t_{stat}	116.21[a]	-6.36[a]	5.10[a]	F-stat=31.58[a]

Dependent variable average number FFS attendances; [a]significant at 0.01; [b]significant at 0.1; [n]not significant.

It can be seen that, overall, the first meeting of training were fully attended by 25 participants. However, the number of 25 participants could not be sustained during the process of training. The regression result was analysed in each province. In Aceh, β_1 was insignificant and β_2 was significantly negative. This means an increasing rate of drop-outs during the IPM training. In other provinces, β_1 was significantly negative, β_2 was significantly positive, and the absolute value of β_1 was much greater than β_2 This means that the number of participants dropped in the middle of training, but increased at the ends of meetings. Since β_2 was much less than β_1, the number of participants at the end of training was not as full as at the first meeting. The largest number of drop-outs was in North Sumatra and the smallest was in Bali.

Despite the fact that there was a tendency of increasing number of participants at the end of meeting, there was no guarantee of qualified graduation since the participants coming back in the end of meetings were not exactly the same farmers as before. This was likely the case as there were strong bureaucratic incentives to exaggerates the extent of training accomplished in terms of farmers actually attending the training (Pincus, 2002). Thus, the fluctuating number of participants was considered a failure because farmers could not gain the knowledge through a full module of training. A plausible explanation of that failure was reported by Feder *et al*. (2004a) that during the implementation of the World Bank-financed expansion of the FFS program in Indonesia there were periods when training activities were afflicted by untimely transfers of funds to the field training organizers. As a result, training was not being fully synchronized with the rice-growing season calendar and supplies of meals and training material for participants were irregular. Farmers became reluctant to attend the training as the materials were incomplete in the middle of training. However, some farmers loyally continued as the participants of training, although the training was supplied with incomplete training materials and meals. Such farmers indeed wanted to learn IPM practices and would deliberately apply IPM knowledge after completing the training to cope with the endemic pest infestation. It was likely the case that such farmers operated rice farms on their privately owned lands and the farms were technically irrigated (Mariyono, 2007). Some groups of such farmers have been documented and reported by the IPM promoters as the cases of successful implementation of IPM in Indonesia (Susianto *et al*., 1998; Kusmayadi, 1999; van den Berg, 2004).

Conclusion and Suggestion

The IPM training project in Indonesia disseminated IPM technology which is considered to be environmentally friendly. This kind of technology was expected to support a sustainable agricultural development by replacing the intensive use of chemicals. The technology was claimed to be institutionalised, but the success on reduction in pesticide use and increase in rice yield were questionable. To answer such question, information on the achievement of dissemination process is required. Using the data from MIS conducted by the technical assistance for IPM project, this study shows that the accomplishment of IPM training in Indonesia was not satisfactory. This is because the minimum recommended requirements of training could not be fulfilled by the project management. Some units of training were conducted in unfavourable conditions such as participants were farmers who operated farms in non-privately owned lands and non-technically irrigated farms, and low woman participation in the training. The conditions were exacerbated by the absenteeism of farmers in the middle of training because of the untimely delivery of the training materials synchronised with planting season calendar. The absenteeism was considered a major failure because farmers could not completely gain knowledge through a learning cycle, which was essential in the process of training. Despite the fact that IPM practices in the field trials, where farmers were participating in the training, were economically superior to the conventional practices in terms of rice yield and pesticide use, farmers were not able to fully adopt the knowledge. It seems that the overall realization of IPM training supports the statement of Feder *et al*. (2004a), despite the fact that some case studies raising the successful program in some regions were not totally wrong. Some farmers fully participated in the training, although the training materials and meals were irregularly supplied. Some groups of such farmers had been documented and reported by the IPM promoters as successful cases.

Based on the reality of which IPM training has not been totally implemented with the recommended requirements. It is expected that both opposing parties to re-evaluate the results of corresponding studies using the results of this study as a ‘mirror’. It may be useless to criticise each other because it will not deal with the core of the problem.

References

Agro-Chemical Report. (2002). Pesticide and policy: the impact of integrated pest management (IPM) on the Indonesian economy. Agro-Chemical Report 2(2): 18-20.

Braun, A.R., Thiele, G. and Fernandes, M. (2000). Farmer field schools and local agricultural research committees: complementary platforms for integrated decision-making in sustainable agriculture. Agricultural Research & Extension Network, Network Paper, 105.

Chiang, A.C. (1984). Fundamental Methods of Mathematical Economics. Tokyo: McGraw-Hill.

Diekhoff, G. (1992). Statistics for the Social and Behavioral Sciences: univariate, bivariate, multivariate. Wm. C. Brown Publishers, Dubuque.

Dilts, D. and Hate, S. (1996). IPM farmer field schools: changing paradigms and scaling up. Agricultural Research and Extension Network Paper 59b, pp. 1-4.

Fakih, M., Rahardjo, T. and Pimbert, M. with Sutoko, A., Wulandari, D. and Prasetyo, T. (2003). Community Integrated Pest Management in Indonesia: Institutionalising Participation and People Centred Approaches. International Institute for Environment and Development (IIED) and Institute for Development Studies (IDS), Printed by Russell Press: Nottingham.

Feder, G., Murgai, R. and Quizon, J.B. (2004a). Sending farmers back to schools: the impact of farmer field school in Indonesia. Review of Agricultural Economics 26(1): 45-62.

Feder, G., Murgai, R. and Quizon, J.B. (2004b). The acquisition and diffusion of knowledge: the case of pest management training in farmer field school, Indonesia. Journal of Agricultural Economics 55 (2): 221-243.

Gallagher, K., Ooi, P., Mew, T., Borromeo, E., Kenmore, P. and Katelaar, J-W. (2005). Ecological basis for low-toxicity integrated pest management (IPM) in rice and vegetables. In The Pesticide Detox: Towards a More Sustainable Agriculture, ed. J N Pretty pp. 116-134. London: Earthscan.

Kalshoven, L.G.E. (1981). Pests of Crops in Indonesia. Jakarta: PT Ichtiar Baru-Van Hoeve.

Kingsley, A.M., and Siwi, S.S. (1997). Gender study II: gender analysis, agricultural analysis, and strengthening woman's leadership development in the national IPM program. Jakarta: Indonesian National IPM Program.

Kusmayadi, A. (1999). Integrated pest management in rural poverty alleviation: case study of Indonesia. Paper presented in the SEARCA Workshop June 1999, The Philippines.

Mariyono, J. (2007). Adoption and diffusion of integrated pest management technology: a case of irrigated rice farm in Jogjakarta Province, Indonesia. Journal of Agricultural Technology 3(1): 39-50.

Matteson, P.C. (2000). Insect pest management in tropical Asian irrigated rice. Annual Review of Entomology 45: 549–574.

Pincus, J. (1991). Farmer Field School Survey: Impact of IPM Training on Farmer's Pest Control Behavior. Jakarta: IPM National Program.

Pincus, J. (2002). State simplification and institution building in bank-financed development project. In Reinventing the World Bank, eds. J Pincus and J Winters, pp. 76-100. Ithaca New York: Cornel Univ. Press.

Pretty, J. and Waibel, H. (2005). Paying the price: the full cost of pesticides. In The Pesticide Detox: Towards a More Sustainable Agriculture, ed. J N Pretty, pp. 39-54. London: Earthscan.

Rolling, N. and van de Fliert, E. (1994). Transforming extension for sustainable agriculture: the case of integrated pest management in rice in Indonesia. Agriculture and Human Value 11(2/3): 96-108.

Susianto, A., Purwadi, D. and Pontius, J. (1998). Kaligondang Sub-district: a case history of IPM Sub-district. In Community IPM: Six Cases from Indonesia, pp. 15-99. Jakarta Indonesia: Semi-annual FAO IPM Technical Assistance Progress Report.

Untung, K. (1996). Institutional constraints on IPM implementation in Indonesia. Publication of the Pesticide Policy Project 3A: 37-47.

Useem, M., Setti, L. and Pincus, J. (1992). The science of Javanese management: organizational alignment in an Indonesian development programme. Public Administration and Development 12: 447-471.

van den Berg, H. (2004). IPM farmer field schools: a synthesis of 25 impact evaluations. Prepared for the Global IPM Facility, Wageningen University.

Winarto, Y.T. (1995). State intervention and farmer creativity integrated pest management among rice farmers in Subang, West Java. Agriculture and Human Value 12(4): 47-57.

Wooldridge, J.M. (2003). Introductory Econometrics: A Modern Approach. Australia: South-Western College Publishing.

World Bank. (1993). Staff Appraisal Report: Indonesia Integrated Pest Management Training Project. Washington: The World Bank.

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