# Integrated Pest Management Training in Indonesia: Does the Performance Level of Farmer Training Matter?

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## Abstract

Indonesia introduced integrated pest management (IPM) technology to farmers through a package of training called the Farmer Field School (FFS). This study aims to analyze the performance of FFS. A descriptive analysis and a simple regression method are used to estimate trends of FFS performance and its impact on rice production and pesticide use. This study uses data of IPM performance drawn from a monitoring and evaluation database and farm-level data drawn from surveys conducted in 1999, 2001, and 2004. The results indicate poor performance of FFS. But there was a slight improvement in the performance resulting from project management efforts. The main factors leading to poor performance of FFS were a low rate of attendance of participants in the training and untimely supplies of training materials. Further results show that the performance of FFS is one of the significant factors that increases the level of rice production and diminishes the level of pesticide use. The low FFS performance is the cause of low rice production and high pesticide use.

Key words: integrated pest management; Farmer Field School; indicators of performance, rice production, and pesticide use

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## 1.0 Introduction

Agricultural policy in Indonesia promoted sustainable rice production through an integrated pest management (IPM) program from 1989 to 1999. A national program was initiated under the technical guidance of the Food and Agriculture Organization to train farmers in season-long Farmer Field Schools (FFS), a package of field training on IPM, in order to make independent decisions on crop health management through their own observations of the crop ecosystem (Dilts & Hate, 1996). The IPM technology was institutionalized through a long process of farmers' participation (Fakih, Rahardjo, & Pimbert, 2003). 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 & van de Fliert, 1994, p. 98),

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when the use of agricultural chemicals has increased dramatically, partly because of massive subsidies (Untung, 1996). The program did not reach all Indonesian farmers, and the spread of IPM knowledge relies on farmer-to-farmer diffusion.

The promoters of IPM in Indonesia stated that the Indonesian IPM program had been successful. Indonesia has been one of the leaders in the use of IPM in Asia because it helped farmers to reduce their reliance on pesticides and increase their harvests. It has also dramatically reduced the incidence of pesticide-related illnesses and environmental pollution (Agro-Chemical Report, 2002). However, the success is debatable. Feder, Murgai, and Quizon (2004) strongly disagree with the success of the IPM program, and there is no evidence that the expected environmental and health benefits of the program are significant, since the program failed to reduce pesticide use. This has been strongly argued by van den Berg (2004) by pointing to various IPM case studies; Feder et al. (2004) mostly object to the methodology of the studies. Recently, an analysis that uses the same data as Feder et al. (2004) shows different results (Yamazaki & Resosudarmo, 2008). None of the studies considers the performance level of the FFS.

It will be worthwhile to get clarity about the FFS performance, which is the core of the Indonesian IPM program, to answer the question of whether the Indonesian IPM program effected a reduction in pesticide use and an increase in rice production. One proposition that needs to be demonstrated is that the FFS performance will result in normative impacts. The objective of this study is to recognize the implementation of FFS and to examine the impact of FFS performance on production and pesticide use.

### *1.1 Farmer Field School*

The heart of the Indonesian IPM program is FFS, a process of learning by doing. The World Bank, along with a number of development agencies, promoted FFS since it is a more effective method to extend science-based knowledge and practices (Feder et al., 2004). FFS used a participatory approach to assist farmers in developing their analytical skills, critical thinking, and creativity such that farmers could make better decisions. Farmers are expected to be able to conduct observations, to analyze agroecosystems, to make decisions, and to implement pest-control strategies based on the results of their field observations. In reality, the IPM FFS involves not only 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 principles are central to the FFS: grow healthy crops; conserve and utilize natural enemies; carry out regular field observations; and develop farmers as IPM experts in their own field (Untung, 1996).

An IPM FFS consists of a training group of 25 farmers, selected either from one farmer group or across such groups within one village. Farmers and locations were purposively selected with criteria of easy accessibility and the presence of active farmers' groups. Kingsley and Siwi (1997) show that women have a significant role in rice farming, which accounts for more than 50% of agricultural activities carried out by women. This finding implies that women should be involved in FFS. In prepreparation meetings for FFS, the fact that women have a significant role in rice farming is shown by FFS facilitators to encourage women's participation in FFS. The prepreparation meeting is attended by both male and female farmers, who will be selected as FFS participants. FFS facilitators use visual aids to show women's activities in agricultural practices. It is expected that 30% of participants are woman farmers.

FFS starts with a ballot-box pretest of knowledge and ends with a posttest. A ballot-box test is a simple tool to measure the level of a farmer's knowledge on an agroecosystem. Several weeks before planting, prepreparation meetings identify communities that fulfill the criteria for establishing FFS and identify suitable participants. Observation, analysis, and action FFS for rice hold weekly meetings 12 times in one planting season (about 3 months). The first meeting begins 2 to 3 weeks after transplanting to cover observations of all critical stages of the growth and development of the crop. FFS uses a framework of an agroecosystem analysis. The agroecosystem analysis is based on about 1000 $m^2$ of rice field divided into two plots: an IPM plot and another plot based on locally conventional management of which the application of pesticides eliminates natural enemies of insect pests.

The key processes and elements above have to be fulfilled to ensure that FFS functions adequately, and that FFS receives timely and sufficient material and financial support. As it is cited by the Agro-Chemical Report (2002), a unit cost of FFS in the 1996–97 fiscal year is, on average, US$599. It constitutes honorarium of the facilitator, preparation and coordination expenses, facilitator's transport, materials, refreshments, compensation of land used for field trial, stipends for participants, and field day or ceremony for closing the FFS.

## 2.0 Methodology

### *2.1 Performance of FFS*

A monitoring and evaluation (M&E) system of the IPM program used indicators to assess implementation of FFS from 1994 to 1999.[1] There are seven key indicators of standard implementation of FFS (Program Nasional PHT, 1999). These indicators are adequately related to the key processes and elements of FFS (see Braun, Thiele, & Fernandes, 2000). A summary of the key performance indicators, description, standard performance, and scoring method are described in Table 1.

The overall evaluation of FFS performances is classified as follows. The FFS is said to be highly satisfactory if there are six scores of A either with or without score of C; or if there are four scores of A without score of C. The FFS is said to be unsatisfactory if there are four or more scores of C. Neither highly satisfactory nor unsatisfactory FFS is classified as satisfactory.

This study mostly analyzes the performance of FFS descriptively using cross-table and graphic approaches. A simple linear regression method is used to support the significance of trend. The regression is formulated as:

$$Y = \beta_0 + \beta_1 T + \varepsilon \qquad (1)$$

where $Y$ is the dependent variable, $T$ is the time trend, $\beta_0$ is the intercept indicating a constant value, $\beta_1$ is the marginal effect measuring a change in the dependent variable as a result of one unit increase in the time trend, and $\varepsilon$ is the error term.

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[1] The Indonesian IPM program began in 1989, but the M&E system was established in 1994 when the scale of the program was expanded. The IPM program was terminated at the end of 1999, and there was no more FFS funded by the central government. Some local governments still continue to undertake FFS with local funding, but the performance of FFS is not monitored and reported. This study is only based on the M&E of FFS reported by the central government.

Table 1. *Key Indicators and Measurements*

| No. | Indicators | Score | | |
|---|---|---|---|---|
| | | A | B | C |
| 1 | Prepreparation of FFS | ≥ 2 times | 1 time | none |
| 2 | FFS starting 3 weeks after planting | on time | 1 week late | > 1 week late |
| 3 | Meeting attended by at least 20 participants | > 8 times | 6–8 times | < 6 times |
| 4 | Meeting with complete supporting material | > 8 times | 6–8 times | < 6 times |
| 5 | Women in attendance | > 8 women | 6–8 women | < 6 women |
| 6 | Frequency of each topic presented | > 10 times | 8–10 times | < 8 times |
| 7 | Farmers with more than 20-point increase in ballot-box test | > 19 farmers | 14–19 farmers | < 14 farmers |

*Source.* Summarized from M&E Report of Indonesian IPM Training Project.

## *2.2 Impact of the Performance of FFS*

To examine the impact of FFS performance on rice production and pesticide use, this study uses a production function modelled as:

$$Q = A \cdot Z_i^{\alpha_i} \cdot X^{\phi_1 + \phi_2 K} \cdot e^{\delta K + \psi} \qquad (2)$$

where $Q$ is output, $A$ is total factor productivity, $Z$ is vector of productive inputs, $X$ is pesticides, $K$ is performance of FFS ($K$ = 1 for unsatisfactory, 2 for satisfactory, and 3 for highly satisfactory), $e$ is an exponential operation, $\psi$ is error terms, $\alpha, \phi_1, \phi_2$, and $\delta$ are coefficients of technology to be estimated.[2]

In this model, the performance of FFS does not only affect the total factor productivity, $A$, but also affects the elasticity of production with respect to $X$. In this sense, $\delta$ is expected to be positive, meaning that the performance of FFS brings about an increase in total factor productivity; and $\phi_2$ is negative such that the output elasticity with respect to pesticides falls as the quality of FFS rises.[3] This results in a decrease in input use as a consequence of the increase in FFS performance. The estimation of equations 1 and 2 was conducted using a simple regression method. The significance of all coefficients in equations 1 and 2 was tested using a *t*-test (Wooldridge, 2003).

[2] To estimate coefficients of the technology, the production function is transformed in a logarithmic form, such that the production function becomes: $\ln Q = \ln A + \alpha_i \ln Z_i + \phi_1 X + \phi_2 K \ln X + \delta K + \psi$. The error term is assumed to be independently and identically distributed with zero mean and constant variance, $iid \sim (\mu, \sigma_\psi^2)$ (Wooldridge, 2003), which represents uncontrolled factors excluded from the production, such as temperature, rain, and light intensity.

[3] In other words, marginal product of pesticides evaluated at the same level of use is lower than that when there is an increase in $K$.

### *2.3 Data and Sources*

Data on performance of FFS was collected from an M&E system of the project. The M&E system was established with the objective of assessing FFS performance, particularly the quality and effectiveness of FFS implementation. The M&E system was conducted using simple, total population, and self-assessment approaches. Data collection of M&E was conducted by pest and disease observers (PHP) assisted by IPM-trained farmers. District Field Leaders (FL-2) were responsible for compiling the collected data at district levels. The compiled data at district levels were then sent to the subprovincial project offices (SPPO). The coordinator of the SPPO (FL-1) assisted by FL-2 at the subprovincial level was responsible for compiling and reporting M&E to the provincial project office. At the national level, M&E was based on the reports of the provincial levels.

Farm-level data on rice farming was collected from farm surveys conducted in 1999, 2001, and 2004, in Lampung, Jogjakarta, East Java, Nusa Tenggara, and South Sulawesi. Of the total number of 1,407 surveyed farmers, 304 farmers are identified as members of farmers' groups that participated in FFSs during the dissemination of IPM. These consist of 192 farmers from unsatisfactory FFSs, 79 farmers from satisfactory, and 33 farmers from highly satisfactory FFSs. A selection bias is expected to be absent in this sample because all farmers' groups were formerly participants of FFSs. It is expected that the farmers' groups still implement and develop IPM practices (Feder et al., 2004).

## 3.0 Results and Discussion

### *3.1 Performance of FFS*

The implementation of FFS has been documented by provincial project offices, and the performance levels of FFS are presented in Table 2. On average, 32% of FFSs in Indonesia were highly satisfactory, approximately 62% were satisfactory, and about 6% were unsatisfactory. This achievement indicates that the quality of FFS in Indonesia was high if the satisfactory FFS was considered the targeted standard performance.

Table 2. *FFS Performance in Indonesia*

| Year | % FFS performance | | | |
|---|---|---|---|---|
| | HS | S | US | Total |
| 1994 | 22 | 68 | 10 | 100 |
| 1995 | 23 | 67 | 10 | 100 |
| 1996 | 36 | 58 | 6 | 100 |
| 1997 | 28 | 63 | 9 | 100 |
| 1998 | 41 | 57 | 2 | 100 |
| 1999 | 42 | 57 | 1 | 100 |

*Note.* HS = highly satisfactory, S = satisfactory, US = unsatisfactory. Analyzed from M&E Report of Indonesian IPM Training Project.

The achievement was not static. There was an improvement in the performance of FFS implementation. As shown in Figure 1, the proportion of highly satisfactory FFS tended to increase over time; and on the contrary, the proportions of satisfactory and unsatisfactory FFS tended to decrease. It is important to note that trends of the three performance levels of FFS fluctuated over time. The proportion of highly satisfactory FFS increased sharply from 23% in 1995 to 36% in 1996. At the same time, in contrast, the proportion of satisfactory and unsatisfactory FFS dropped by 11% and 4%, respectively. In the consecutive year, the proportion of highly satisfactory FFS decreased from 36% in 1996 to 28% in 1997; on the contrary in the same consecutive year, the proportion of satisfactory and unsatisfactory FFS increased by 5 and 3 percentage points respectively.[4] After that the proportion of highly satisfactory FFS increased, and the proportion of satisfactory and unsatisfactory FFS dropped. It seems that the increase in proportion of highly satisfactory FFS came from a reduction in the proportions of satisfactory and unsatisfactory performance levels.

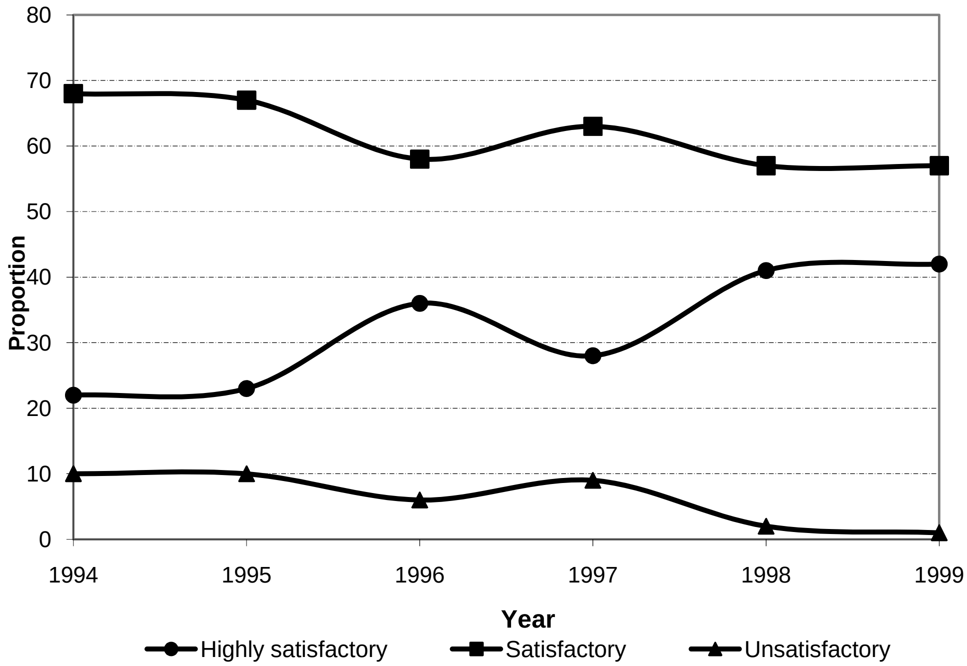


*Figure 1.* Trend in performance level of FFS.

By using a simple linear regression method, the dynamics of FFS performance are represented in Table 3. It can be seen that the increase in highly satisfactory FFS and the decrease in satisfactory and unsatisfactory FFS were statistically significant. On average, the increase in proportion of highly satisfactory FFS was 3.9 percentage points per year. By contrast, the reduction in proportion of satisfactory and unsatisfactory FFS was 2.0 and 1.9 percentage points per year, respectively. Based on the estimated coefficient on time trend, it is reasonable to say that the increase in highly satisfactory FFS came from a decrease in proportion of both satisfactory and unsatisfactory FFS. This indicates that the highly satisfactory FFS was the target of the project management. Both satisfactory and unsatisfactory FFS existed because of the presence of a score of

[4] It seems that the fall in proportion of highly satisfactory FFS was due to the economic crisis of 1997.

Table 3. *Estimated Trend in FFS Performance*

| FFS Performance | Constant | Trend | Standard error | $R^2$ |
|---|---|---|---|---|
| HS | 18.54 | 3.87* | 1.05 | 0.77 |
| S | 88.87 | - 2.03* | 0.68 | 0.68 |
| US | 12.787 | - 1.88* | 0.45 | 0.81 |

*Note.* HS = highly satisfactory, S = satisfactory, US = unsatisfactory. Analyzed from M&E Report of Indonesian IPM Training Project.

*Significant at 95% confidence interval.

C in each indicator of performance. Reducing the score of C in each indicator makes the proportions of satisfactory and unsatisfactory FFSs decrease.

The project management made efforts to improve the FFS indicator with a score of C. Table 4 shows that all FFS indicators with a score of C decreased over time, the first five of seven indicators with a score of C declining significantly. The three most improved indicators were indicator 3, which is the number of meetings with more than 20 participants; indicator 5, which is the number of women participating in FFS; and indicator 1, which is the number of prepreparation meetings. Respectively, the rate of reduction was 5.07, 4.93, and 3.04 percentage points per year. It is interesting to note that indicator 3 is the most striking improvement. This is an indication of good efforts in improving the quality of FFS, because with more than 20 participants, the process of FFS will run as expected. The declines in all indicators with a score of C impacted on an increase in proportion of highly satisfactory and simultaneous decrease in proportion of satisfactory and unsatisfactory FFS.

Table 4. *Estimated Trend of Indicators with Score of C*

| Indicator | Constant | Trend | Standard error | $R^2$ |
|---|---|---|---|---|
| 1 | 15.84 | - 3.04[a] | 1.23 | 0.669 |
| 2 | 9.43 | - 1.09[a] | 0.54 | 0.571 |
| 3 | 31.05 | - 5.07[a] | 1.71 | 0.746 |
| 4 | 9.66 | - 1.44[a] | 0.65 | 0.624 |
| 5 | 62.23 | - 4.93[a] | 2.22 | 0.622 |
| 6 | 5.44 | - 0.16[b] | 0.48 | 0.036 |
| 7 | 38.46 | - 0.64[b] | 20.116 | 0.000 |

*Note.* Analyzed from M&E Report of Indonesian IPM Training Project.

[a]Significant at 95% confidence interval. [b]Not significant.

The actual reduction in C-scored indicators could happen in highly satisfactory FFS. However, neither the absence nor the presence of C-scored indicators in FFS affected the highly satisfactory FFS performance, even though the possibility existed that a highly satisfactory FFS included one C-scored component. Therefore, it was reasonable for the project management to improve the C-scored indicator. The performance of FFS was represented by a multiplication of all indicators, rather than a summation of them. In other words, the existence of one or more bad indicators significantly affected the performance of FFS. For example, if indicators 3 (the number of participants) and 4 (the completeness of supporting materials) were bad, the total performance of FFS would be poor, despite the other excellent indicators. In spite of the increase in proportion of highly satisfactory FFS, the proportion was still less than 50% by the end of the project. It would be logical to argue that the achievement of the Indonesian IPM Training Project was not too good, because the performance of FFS as the heart of the project was poor.

### 3.2 Impact of FFS Performance

The influence of FFS performance on rice production and pesticide use is shown by a production function estimated from data on farm survey. The production function is given in Table 5. We can see that the FFS performance indeed influences the production of rice. The coefficient of FFS performance, $\delta$, is positive and significant, meaning that a higher quality of FFS leads to a higher productivity. Further, the coefficient of interaction between pesticides and FFS performance, $\phi_2$, is negative and significant, meaning that a higher quality of FFS leads to a reduction in pesticide use.[5]

Table 5. *Estimated Production Function*

| | Variable | | Coefficient | Robust std. error | *t*-ratio |
|---|---|---|---|---|---|
| 1 | Total factor productivity | $A$ | 4.6996[a] | 0.79469 | 5.91 |
| 2 | Land (hectare) | $\alpha_1$ | 0.6617[a] | 0.07862 | 8.42 |
| 3 | Labour (person-day) | $\alpha_2$ | 0.1654[a] | 0.06198 | 2.67 |
| 4 | Fertilizers (kg) | $\alpha_3$ | 0.0242[c] | 0.01431 | 1.69 |
| 5 | Materials (monetary value) | $\alpha_4$ | 0.1910[a] | 0.06729 | 2.84 |
| 6 | Pesticides (monetary value) | $\phi_1$ | 0.0115[c] | 0.00695 | 1.65 |
| 7 | FFS performance • Pesticides | $\phi_2$ | - 0.0064[c] | 0.00379 | - 1.68 |
| 8 | FFS performance (1, 2, 3) | $\delta$ | 0.1339[b] | 0.05677 | 2.36 |
| | $R^2$ | | 0.6238 | | |
| | $F^{7}_{296}$ | | 70.74[a] | | |

*Note.* Dependent variable: rice production. Labour comprises hired and family labour, as well as tractor and animal-equivalent labour; fertilizers comprise nitrogen, phosphates, and potassium; materials comprise seed, compost, and irrigation; pesticides comprise liquid, granule, and powder. *Source.* Regression of farm survey data. [a]Significant at 99% confidence interval. [b]Significant at 95% confidence interval. [c]Significant at 90% confidence interval.

Comparing this study with the other studies on the impact of the IPM program in Indonesia, I have the following remarks. First, the study conducted by Feder et al. (2004) used samples that were randomly drawn from FFS-graduated farmers from 1993 to 1997. During that period, highly satisfactory FFS was only around 27%, which was relatively low. A plausible explanation of that failure was reported by Feder et al. (2004):

> 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

[5] In a microeconomic concept, this is explainable because the marginal product of pesticides falls, and therefore the use of pesticides should be reduced to maximize profit (Nicholson, 2003).

> 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. There was a relative large rate of farmer absenteeism in school sessions during the period. (p. 59)

This explanation is strongly related to indicators 2, 3, and 4, which account for the synchronization with the rice-growing season, farmer absenteeism in school sessions, and irregularity of supplies of meals and training material. As given in this analysis, the bad performance of FFS is unlikely to provide good impacts on reduction in pesticide use and increase in rice production. If the same study had been conducted with FFS-graduated farmers in 1998–99 where there was a high proportion of highly satisfactory FFS, the observed impact of the IPM program would have been different.

Second, several studies conducted by the IPM promoters (e.g., Ekowarso, 1997; Kusmayadi, 1999; Kuswara, 1998a, 1998b; Oka, 1995; Paiman, 1998a, 1998b; Susianto, Purwadi, & Pontius, 1998; Untung, 1996; Useem, Setti, & Pincus, 1992) mention that there were expected impacts of the IPM program on pesticide use and rice production. These studies were either intentionally or unintentionally conducted in the regions where the performance of FFS was highly satisfactory. These studies purposively showed cases of which IPM implementation in certain regions had been well conducted. It is therefore also reasonable to say that the IPM program did not totally fail, despite the fact that it is unfair to claim that the IPM program has been successful, because the overall standard performance of FFS was not excellent. As objected to by Feder et al. (2004),

> … rather impressive gains cited by promoters of the program likely exaggerate impact because of improper attributions, confusion of selection biases with true program effect, and extrapolation of observations from small non-representative pilot situations and samples to wider population. (p. 58)

The impressive impact of the IPM program on pesticide use reported by Pincus (1991) was based on a pilot project in which the FFSs were mostly under intensive supervision. Two studies conducted by Irham (2001, 2002), for instance, were based on the FFS-graduated farmers after 1997 in a subdistrict of Jogyakarta that was one of the pilot IPM projects. At the time, the quality of FFS had been improved, and thus it was noticeable that IPM had had good impacts. A similar case in which IPM had significant positive impact on efficiency was conducted by Utama (2003) in a pilot IPM project in West Sumatra.

## 4.0 Conclusion

Indonesia introduced IPM technology to reduce pesticide use. IPM technology was also expected to increase rice production because IPM technology addressed not only pest problems but also agronomical practices. Introduction of the technology to rice farmers was undertaken through FFS. Results of the study indicate that the performance of FFS implementation was not as good as expected. On average, the proportion of highly satisfactory FFS was only 32%, ranging from 22% in 1994 to 42% in 1999. The project management had made efforts to improve the performance of FFS implementation. The efforts had resulted in an increase in the number of highly satisfactory FFSs. But by the end of the project, the achievement of highly satisfactory FFS was not more than 50%. The impact of IPM technology on the reduction in pesticide use was significantly dependent on the performance of the FFS. When the performance was excellent, the impact of the IPM program on pesticide use and rice production was significant. The better performance of the FFSs, the higher the level of rice production and the lower the level of pesticide use.

This gives an impression that the overall performance of FFS implementation supports the arguments of Feder et al. (2004), who object to the methodological aspect of the case studies that claim a successful IPM program in Indonesia. The performance of FFS indeed affects the production of rice and the use of pesticides. A better performance of FFS leads to a higher productivity and a lower level of pesticide use. Nevertheless, the studies conducted by the IPM promoters, particularly those with the sole intention of raising the success of the program in some regions, are well intended. There are several highly satisfactory FFSs in some regions that might have significant impacts on pesticide use and rice production (van den Berg, 2004). Based on the fact that the performance levels of FFSs varied across time, it is expected that the critics and the promoters of IPM in Indonesia review the results of corresponding studies.

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