FAO-EU Integrated Pest Management (IPM) Programme for Cotton in Asia

In response to the call for information on alternatives to endosulfan by the Persistent Organic Pollutants Review Committee of the Stockholm Convention, the Food and Agriculture Organization of the United Nations (FAO) submits, annexed to this note the information on the FAO-EU IPM Programme for Cotton in Asia as an example.

IPM is an ecosystem approach to crop production and protection that combines different management strategies and practices to grow healthy crops and minimize the use of pesticides. FAO promotes IPM as the preferred approach for crop protection and regards it as a pillar of both sustainable intensification of crop production and pesticide risk reduction.

Pest control in cotton in India relied *inter alia* on some very persistent organochlorine pesticides such as endosulfan (Kooistra et al., 2006 in Mancini et al., 2007).

From 1999 to 2004, FAO implemented the “IPM Programme for Cotton in Asia” in response to the need of cotton producing countries to tackle rising production costs, increasing pollution of environment due to excessive pesticide use, the deteriorating health of farmers and increase in poverty. The Programme funded by EU involved Bangladesh, China, India, Pakistan, the Philippines and Vietnam, which produce about 50% of the world’s cotton.

The adoption of IPM led to a significant reduction of total use of pesticides, including endosulfan. This programme has shown that farmer education through the Farmer Field School approach is key to encourage more sustainable agricultural production. Annexed to this note is the report of this programme and additional relevant publications.
Annex


Increasing the environmental and social sustainability of cotton farming through farmer education in Andhra Pradesh, India

Francesca Mancini a,*, Aad J. Termorshuizen a, Janice L.S. Jiggins b, Ariena H.C. van Bruggen a

a Biological Farming Systems, Wageningen University, Marijkeweg 22, 6709 PG Wageningen, The Netherlands
b Communication and Innovation Studies Group, Wageningen University, Hollandseweg 1, 6700 EW, Wageningen, The Netherlands

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Abstract

Integrated pest management (IPM) has been introduced in India to reduce the serious impact of the use of highly toxic pesticides on people’s health and the environment. However, IPM diffusion has been slow, in part because of the inherent complexity of the approach based on decisions requiring knowledge of ecological principles and local ecological dynamics. Farmer field schools (FFSs) on IPM, conducted for cotton growers in Andhra Pradesh, India, is shown to be an effective educational approach for building the essential knowledge and decision-making skills among farmers for IPM adoption. FFS farmers (73) drastically reduced the use of highly toxic pesticides as a result of increased knowledge on biological control principles. Yield levels were not affected by this reduction, showing that part of the current use of pesticides in cotton cultivation is superfluous. IPM labour demand has been suggested also as limiting IPM diffusion. However, an analysis of the physical labour use, carried out on a sub-sample (43 FFS and 52 control farms), showed that the adoption of IPM in the studied farms did not lead to an increase in the overall physical labour requirement, nor in the total time spent on plant protection.

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1. Introduction

The global use of synthetic pesticides at the beginning of the current millennium exceeded 2.5 million tons per year. World pesticide expenditures were around $32.0 billion (EPA, 2002). The negative consequences on human health, water quality, biodiversity and wild life associated with the release of large quantities of toxic products into the environment increasingly has become a matter of concern (Harper and Zilberman, 1989; Agne et al., 1995).

Cotton cultivation is estimated to receive some 10% of all synthetic pesticides and 20–25% of insecticides applied world-wide each year. Developing countries use approximately 50% of the total (EPA, 2002). India is the third largest cotton producing country in the world; the area under cotton fluctuates between 8 and 9 million ha. Cotton cultivation generates extra cash for family expenses to millions of small-scale farmers. The cotton chain, including processing and textile industries, provides employment to even a larger population of low-salary factory workers, many of them women. Promotion of the industry is an important part of the national strategy for reducing rural poverty. However, the average cotton yields, constrained primarily by water availability and pest attacks, are among the lowest in the world (429 kg/ha, ICAC, 2005).

Pest control in cotton in India largely relies on pyrethroids, highly toxic organophosphate pesticides, and some very persistent organochlorine pesticides such as endosulfan (Kooistra et al., 2006). Repeated and improper applications of insecticides have caused the development of cotton pest resistance and the resurgence of pest outbreaks.
 Farmers have responded with higher doses of chemicals, which have led to ever higher costs of cultivation.

In 1981, the Government of India addressed the aforesaid problems by promoting the adoption of an integrated approach to plant protection that combines biological, cultural and chemical control, namely integrated pest management (IPM) (Hall and Duncan, 1984; USDA, 1993). However, until 1994 no significant, large-scale changes in the management of cotton-based farming systems were observed (Directorate of Plant Protection, 2003). This was because an inherently difficult and labour-intensive method such as IPM (Fernandez-Cornejo, 1998), was disseminated without an adequate investment in farmer education. The dissemination of IPM was based on short field demonstrations of standard technical packages developed in research stations. However, IPM efficiency depends largely on timely management decisions taken on the basis of actual field situations. Unlike traditional chemical control, IPM requires that farmers have in-depth ecological knowledge, analytical ability and practical experience. The farmer field school (FFS) approach was introduced by the Government to address this deficiency. FFSs are season-long educational courses organised in the field for small (25–30) groups of farmers (Kenmore, 1996). The FFSs provide farmers with opportunities to experiment with IPM principles and find locally-relevant pest management solutions. In FFSs, farmers study insect ecology by observing the predatory behaviours of specimens collected from their own fields and reared in insect zoos. Additionally, they collect data on pest and predator abundance in their fields, data that are then analysed in groups, who are encouraged to take informed decisions on plant protection based on the analysis’ results. This process of building farmers’ knowledge and confidence in IPM, as compared to the previous top-down delivery of technical recommendations, is expected to be more effective in supporting the uptake of ecologically-informed farming practices (Bingen, 2004). The curriculum of the FFSs conducted in Andhra Pradesh also covered topics on production practices to enhance plant health and crop productivity, such as optimising doses and application of synthetic fertilisers, water use, and the number of weeding operations.

Up to now, there are no agreed universal standards or indicators to quantify IPM FFS impacts (Van den Berg and Jiggins, 2007), and because IPM practices vary by farming system and context, cross-case comparison between situations or between approaches is both difficult and contentious. In the specific case of this study, farmers who have made a transition towards low pesticide cotton farming as a result of an increase in their ecological knowledge and a more analytical decision-making process are considered IPM practitioners. In terms of labour, cotton is already one of the most intensive crops in India; its labour requirement ranges between 190 and 225 working days/ha (PRDIS, 2003), compared to 29–84 days/ha for maize (Joshi et al., 2005) and 195 days/ha for rice (FAO, 2002). Fernandez-Cornejo (1998) pointed out that labour availability has positive effects on the adoption rate of IPM and the first empirical results of this effect were presented by Beckmann et al. (2005). Therefore, it is important to understand if farms previously using conventional synthetic chemical pest control increase their physical labour requirement when converting to IPM. Evaluation of the changes induced by the introduction of a new system management is needed also to understand the associated social implications. Such changes often are gender differentiated, particularly in countries like India where a sharp gender division of roles is common. For instance, the introduction in 1961 of high-yielding varieties and hybrids has increased women’s labour share in agriculture as a result of the significant technical changes entailed (Bennet, 1992), particularly in areas where cash crops are grown (Duvvury, 1989).

In order to test if developing farmers’ human capital is an effective way to improve the uptake of IPM in cotton, this paper presents an assessment of the changes in agronomic practices, input use (fertiliser, pesticides and physical labour) and yield levels of farmers trained in FFSs. The labour analysis was carried out on gender-disaggregated data to address the gender effects associated with the adoption of IPM. The study also establishes the relation between pesticide use, farmer knowledge on insect ecology, and farmers’ decision-making criteria with respect to pesticide application. The study formed part of a larger Monitoring and Evaluation (M&E) effort (2003–2005), conducted in the same geographical districts, that assessed the impacts of FFSs on the environment (Kooistra, unpublished), farmers’ health (Mancini et al., 2005), and the social capital of farmers (Mancini et al., 2007).

2. Methods

2.1. Study area and sampling

Around 10% of the national acreage under cotton is grown in Andhra Pradesh (AP) with an average yield of 483 kg/ha (1994–2003 average, CAB, 2005; ICAC, 2005). The study was conducted in two districts of AP: Warangal district (IPM1 and C1 villages) and Mahaboobnagar district (IPM2, IPM3, and C2 villages). Cotton was grown as the main crop during the rainy season on 121,260 ha and 22,697 ha, respectively.

In 2002/2003, season-long (July–January) FFSs on cotton IPM were organised in the study districts. A total of 137 households were interviewed for this study, of which 73 were headed by farmers trained in 3 FFSs and 64 by farmers who lived in villages where no FFSs had ever been conducted. FFSs were attended by female members of the household, in some cases accompanied by their husbands. All the farmers who graduated from the 3 FFSs were interviewed. The questionnaires were filled in by the person directly involved in the training, and jointly if more than one member of the household had attended the FFS. Descriptive statistics of the respondents are provided in...
In order to exclude potential diffusion effects, the control villages were selected in the same agro-ecological zone but located 30 km away from the FFS villages. The physical labour survey was carried out for a sub-sample of 43 IPM farms (23 in Warangal district and 20 in Mahaboobnagar district) and for 52 (26 in each district) control farms.

2.2. Data

Data were collected by means of interviews the year before (cropping season 2001/2002) and the year after (2003/2004) the FFSs were conducted. The same household members were interviewed in both years using a standardised questionnaire, which included questions on agronomic practices, physical labour use, ecological knowledge on cotton insects and the criteria used to decide about the application of pesticides.

The questionnaire section on practices included the following operations: irrigation (number per crop cycle), weeding (number per crop cycle), organic as well as inorganic fertilisation (doses in kg of commercial products/ha) and pesticide application (formulated products, doses, and number of applications per crop cycle/ha). The doses of commercial fertilisers were converted into kg/ha of nitrogen, phosphorous and potassium and the doses of formulated pesticides were converted into ml of active ingredients (a.i.)/ha. The use of pesticides was expressed by three variables: PEST: ml of a.i. belonging to WHO toxicity classes I and II; PEST3: ml of a.i. belonging to WHO class III and U (WHO, 2005) and SPRAY: total number of applications including all products.

The questionnaire section on knowledge focused on cotton insect ecology. Three scores were derived from the farmers’ ability to: (1) list the names of the insects commonly found in cotton fields (Identification Score, IS), (2) define whether the listed insects were pests or predators (Functional Score, FS), (3) describe the feeding habits of the insects, the plant damages in the case of pests and the preying capacity in the case of predators (Ecology Score, ES). The number of right answers determined the values assigned to each score.

The questionnaire section on the decision criteria used to apply pesticides contained a multiple-choice question developed on the basis of the common practices used in the area. Farmers could select their answer from the following options: 1-Calendar spraying advised by dealers, 2-Calendar spraying advised by neighbour farmers, 3-Pest abundance or pest damage perceived as too high, 4-Pest abundance in relation to predator abundance. The first two options refer to decisions taken without observing the field situation and are therefore based on pre-fixed application schedules, e.g. calendar-based applications. The third option is based on the evidence of plant damage and/or presence of insects and insect eggs observed in the field but without a systematic assessment of the risk of losses. The last implies an analytical process that takes into consideration a number of observed factors (e.g. general plant health, weather, temperature, soil moisture, predators’ abundance), and interpretation of the relationship among these in order to determine potential losses from pest.

Finally, the questionnaire section on physical labour included a list of 21 agricultural operations, which had been identified previously in collaboration with local farmers. The hours of physical labour required to perform each operation were recorded under four headings: family female labour, family male labour, hired female labour, and hired male labour. Exchange labour is not a common practice in the area and was excluded from the questionnaire.

3. Data analysis

The study compared the pre/post changes of the treatment (FFS) group to the pre/post changes of the control group. The design, called the Double Difference (DD) model, has been proposed as necessary to address the bias

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introduced by a non-random farmer sampling procedure, inherent to FFS evaluation studies because of the purposeful way in which recruitment to a FFS is carried out (Feder et al., 2004a). As the descriptive statistics have shown, even though no specific criteria were used to select FFS participants, socio-economic factors might have favoured the participation of the more progressive, wealthier and educated farmers in the villages studied. The DD model, comparing the changes in performance over time of the treatment group against those of the control group (a two-factor design with a repeated measure of one factor), rather than the simple comparison of treatment and control groups’ behaviour at one point in time, allows for the control of any built-in, systematic, or seasonal, effects other than the training effect.

Data on practices and knowledge were analysed using two units: the farm and the village, in order to isolate potential village effects relating to the different geographical regions in which the FFSs were held and the different people organising the training. Pre and post means of the variables for the five villages and for the total IPM and control sample were compared using the paired \( t \)-test. Means of scores were compared using the non-parametric Wilcoxon Matched-Pairs Signed-Ranks Test (Van der Waerden, 1969). Wherever farm level findings were consistent with village level findings, the discussion presented below focuses on the former.

A canonical correspondence analysis (sensu Ter Braak), a multivariate analysis that allows inclusion of categorical data (Ter Braak and Smilauer, 2002), was performed to determine whether the five villages were, overall, different in respect of the changes undergone and which of the changes contributed most to the distinction between IPM villages and control villages. The data were log-transformed to obtain normality, and subsequently were standardised, and then processed using the software program Canoco (Canonical Variate Analysis (Ter Braak and Smilauer, 2002)) with villages as ‘samples’, and cases (pre-FFS, pre-Control, post-FFS, post-Control) as ‘species’. Best linear combinations to discriminate among the villages were based on the variables that proved to be relevant in the previous analysis: PEST; PEST3; SPRAY; ES and YIELD, and two uncorrelated axes, were calculated.

Data on physical labour use were analysed by a two-way ANOVA with time as the repeated measure, using the PROCGLM procedure in the statistical analysis system SAS version 6 (SAS Institute, 1994).

4. Results

4.1. Analysis of changes in agronomic practices, input use and farmers’ attitude towards pest management

FFS respondents were significantly (4.8 y; \( P < 0.05 \)) younger than control farmers and more educated (more people had completed primary school; \( P < 0.01 \)). There were no significant differences in terms of average farm size (2.7 and 3.2 ha for IPM and control farmers, respectively) and area under cotton cultivation (1.2 and 1.3 ha for IPM and control farmers, respectively) (Table 1).

Early in the season, prior to any FFS training, farmers applied organophosphates at low dosage against sucking pests, particularly jassids (Amrasca biguttulata); aphids (Aphis gossypii) and trips (Thrips tabaci). From the flowering stage to the boll opening pyrethroids, and organophosphates, primarily monocrotophos, quinalphos, chloropyriphos and profenophos, and the only organochlorine pesticide recorded, endosulfan, were used to control the bollworm complex, including American bollworm (Helicoverpa armigera), spotted bollworm (Earias vittella), pink bollworm (Pectinophora gossypiella), and caterpillar (Spodoptera litura). However, the group of farmers who subsequently enrolled in FFSs used lower dosages of pesticides, closer to company and government recommendations, perhaps because of their higher level of education. Pesticides were applied manually, mostly using rucksacks and power pumps.

The year after the FFSs, all farmers decreased the use of highly and moderately toxic pesticides, which they related to a lower pest load as reported by the national phytosanitary observers. However, the reduction in the case of IPM farmers was equivalent to 75%, whereas control farmers reduced their use of pesticides by 28%. The usage of less harmful or ‘not likely to be harmful’ products (WHO toxicity class III and U) was also remarkably lower the year after (74%) for FFS farmers, while no significant changes in toxicity class were reported by control farmers. Likewise, the total number of pesticide applications, including less toxic products, which was around 8 for the two groups in the pre-survey, was significantly reduced in the case of FFS farmers from 7.9 to 1.7, while no significant differences were recorded in control villages. The yields increased in IPM villages by 19.6% and in control villages by 17.9%; however, the two percentages were not significantly different (Table 2).

There were no significant changes in the number of irrigation and weeding operations, nor in the use of synthetic and organic fertilisers that could be attributed to a clear learning effect and therefore these data are not presented here in full. The use of irrigation, often limited to emergency interventions when the rainfall was not sufficient to meet the water requirement of the crop, did not change across the years. The number of weeding operations slightly decreased for both groups. In 2003/2004, the fertilisation levels were respectively for FFS farmers and control farmers 50 and 100 kg/ha N, 42 and 45 kg/ha P, 35 and 53 kg/ha N for synthetic fertilisers, and 932 and 987 kg/ha for organic manure. The difference in the use of synthetic nitrogen between the two groups occurred prior to the FFS and was determined primarily by the village C2 (140 kg/ha), where presumably subsidised fertilisers had been distributed.

The FFS and control farmers were homogeneous in terms of ecological knowledge in the pre-survey. FFS
farmers significantly improved their ability to identify cotton insects at different development stages from egg to adult (IS), to describe whether the insects were pests or predators (FS), to describe the damage caused by the pest insects, and the preying habits of predators (ES) after the FFSs, whereas no significant changes were recorded for the control group (Table 3).

With respect to the criteria applied to decide about pesticide applications, the majority of the farmers during the baseline year checked the presence of pests in the field. In the post-survey, half of the FFS farmers had shifted to performing a complete agro-ecosystem analysis (including the occurrence of natural enemies) of their own fields. No significant changes were recorded for the control farmers (Table 3). The results of the canonical correspondence analysis confirm these results (Figs. 1 and 2). The three IPM villages had changed remarkably with respect to pesticide variables the year after the schools were held, while the changes in control villages were small (Fig. 1). Interestingly, changes in yield did not go hand in hand with changes in pesticide use, which is illustrative of the inefficiency of the pesticides use to control losses due to pest attacks in at least some of the villages. Also, ecological

Table 2
Yield and pesticide use at the IPM and control farms before (2001/2002) and after (2003/2004) the FFS training per village and for all IPM or control villages together

<table>
<thead>
<tr>
<th>Village code</th>
<th>Yield seedcotton (kg/ha)</th>
<th>Pesticides class I and II (ml a.i./ha)</th>
<th>Pesticides class III and U (ml a.i./ha)</th>
<th>Sprays (no./ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>IPM1</td>
<td>569***</td>
<td>756</td>
<td>1671***</td>
<td>316</td>
</tr>
<tr>
<td>IPM2</td>
<td>926***</td>
<td>1200</td>
<td>731***</td>
<td>256</td>
</tr>
<tr>
<td>IPM3</td>
<td>967ns</td>
<td>988</td>
<td>855***</td>
<td>185</td>
</tr>
<tr>
<td>C1</td>
<td>841*</td>
<td>953</td>
<td>2535***</td>
<td>1664</td>
</tr>
<tr>
<td>C2</td>
<td>477</td>
<td>567</td>
<td>1722ns</td>
<td>1382</td>
</tr>
<tr>
<td>Tot IPM</td>
<td>820**</td>
<td>981</td>
<td>1085.7***</td>
<td>252.3</td>
</tr>
<tr>
<td>Tot C</td>
<td>659**</td>
<td>760</td>
<td>2128***</td>
<td>1533</td>
</tr>
<tr>
<td>Tot IPM</td>
<td>19.6ns</td>
<td>–76.6*</td>
<td>–78.2***</td>
<td>–78.5***</td>
</tr>
<tr>
<td>Tot C</td>
<td>17.9</td>
<td>–28.0</td>
<td>–2.7</td>
<td>–12.2</td>
</tr>
</tbody>
</table>

* P < 0.05, ** P < 0.01, *** P < 0.001, ns = not significant.
In the last two rows the changes expressed as percent of the 2001/2002 values are reported.
b Significance level between all IPM (Tot IPM) and control villages (Tot C) in the same columns.

Table 3
Knowledge and decision-making scores of IPM and control farmers before (2001/2002) and after (2003/2004) the FFS per village and for all IPM or control villages together

<table>
<thead>
<tr>
<th>Village code</th>
<th>Identification score b</th>
<th>Functional score c</th>
<th>Ecological score d</th>
<th>Decision criteria e</th>
</tr>
</thead>
<tbody>
<tr>
<td>IPM1</td>
<td>4.0***</td>
<td>7.7</td>
<td>3.3***</td>
<td>7.3</td>
</tr>
<tr>
<td>IPM2</td>
<td>5.4***</td>
<td>7.2</td>
<td>5.2***</td>
<td>7.3</td>
</tr>
<tr>
<td>IPM3</td>
<td>4.6***</td>
<td>5.5</td>
<td>3.7***</td>
<td>5.4</td>
</tr>
<tr>
<td>C1</td>
<td>5.4***</td>
<td>3.9</td>
<td>4.4ns</td>
<td>3.9</td>
</tr>
<tr>
<td>C2</td>
<td>3.3ns</td>
<td>3.4</td>
<td>3.2ns</td>
<td>3.1</td>
</tr>
<tr>
<td>Tot IPM</td>
<td>4.7***</td>
<td>6.8</td>
<td>4.0***</td>
<td>6.7</td>
</tr>
<tr>
<td>Tot C</td>
<td>4.4*</td>
<td>3.7</td>
<td>3.8ns</td>
<td>3.5</td>
</tr>
</tbody>
</table>

a Significance level between 2001/2002 and 2003/2004 in adjacent columns. * = 0.05, ** = 0.01, *** = 0.001, ns = not significant.
b Identification score: ability to list the names of the insects commonly found in cotton fields.
c Functional score: ability to define whether the listed insects were pests or predators.
d Ecological score: ability to describe the feeding habits of the insects, the plant damages in the case of pests and the preying capacity in the case of predators.
e Decision criteria: 1-Calendar spraying advised by dealers, 2-Calendar spraying advised by neighbour farmers, 3-Pest abundance or pest damage perceived as too high, 4-Pest abundance in relation to predator abundance.

Fig. 1. Canonical correspondence analysis of the three IPM villages (IPM1, IPM2 and IPM3) and two control villages (C1 and C2) before (a, 2001/2002) and after (b, 2003/2004) the FFS based on ml a.i./ha of WHO I and II pesticides (PEST), ml a.i./ha of WHO III and U (PEST3), total number of pesticide applications (SPRAY) and Kg/ha of cotton harvested (YIELD).
knowledge and pesticide use did not explain in a similar way the variation between villages (Fig. 2), although they were negatively correlated (Pearson’s $r = -0.49$), indicating that those farmers who had learned more about pest and predators ecology have reduced their use of moderately and highly toxic pesticides.

4.2. Analysis of physical labour use before and after the FFS

In 2001/2002, the total time required to cultivate one hectare of cotton was on average 1913 h, equivalent to 239 8-hour days, of which 74% was provided by women (23% female family labour and 51% waged female labour) and 26% by men (22% male family labour and 4% male waged labour). Women provided a high share of waged work for weeding and harvesting (Fig. 3). In terms of gender roles, the study confirmed that men performed mostly tasks that involved the use of tools and machines, such as preparing the land for cultivation (ploughing and furrow making), while women were in charge of selecting and sowing seeds, removing stalks, ensuring proper plant populations by thinning the crop or filling the gaps, weeding the field and harvesting the lint. The application of fertilisers and pesticides involved both men and women. However, in the case of pesticide application, there was a sharp gender division between men, who carried out the actual spraying, and women, who prepared the chemical mixture and re-filled the tanks.

Overall, the total physical labour requirement was not significantly different for the IPM farms and the control farms (Table 4). The post-survey recorded a 11.2% and 8.6% decrease in the total physical labour requirement for both IPM and control farms respectively as a result of less time being invested in weeding and harvesting. The higher yields of 2003/2004, although apparently associated with a lower harvesting time, can be explained by a more efficient boll picking. Cotton lint is harvested in a variable number of pickings, up to 7 in the area studied; however, the second and the third picking contribute the most to the final harvest. Farmers are interested in reducing the labour cost by renouncing the last few pickings if the previous have been fruitful.

The total time spent on plant protection measures (pesticide application and IPM) was around 3.3% of the total in 2001/2002 and 5.2% in 2003/2004, for both FFS and control farms. There were no significant differences between the groups before and after in terms of the time spent in plant protection, but there were differences in terms of specific plant protection practices. The control group increased the time spent on applying pesticides by 42.6% and no significant time was spent on IPM practices in either year. Considering that the number of pesticide applications for the control group was the same in both years, it appears that in 2003/2004 control farmers used high-volume sprays. The FFS group reduced the time spent on pesticide application by 48.4% and increased the time spent on IPM 10.9-fold (from 4.8 to 56.3 h) during the post-FFS year. The time spent on IPM practices by the FFS group was slightly higher at the pre-survey period, confirming the hypothesis that this group of farmers was already sensitised towards more ecological plant protection measures at the time of their enrolment in an FFS.

The ratio of female to total work before and after FFSs for the control group and the FFS group were analysed to investigate any changes in gender roles. The only ratios that significantly differed pertained to the plant protection measures and specifically the adoption of IPM. Women in the pre-survey contributed 40% of the total work required for pesticide application, including the time required to fetch water (8–10%) (Table 5). This ratio remained unchanged for the control group in the post-survey. In contrast, the adoption of IPM shifted the female proportion of the total time spent in plant protection from 0.33 to 0.49 i.e. the adoption of IPM resulted in a higher time demand

![Graph](image_url)
of IPM relies in part on regular and accurate field observation, and thus deserves further investigation using more adequate tools for data capture.

5. Discussion

The study shows that the adoption of integrated pest management (IPM) can significantly reduce the use of pesticides on cotton in Andhra Pradesh. Given that farmers trained in IPM through FFS used one sixth of the pesticides used by the control group to obtain the same yield levels, it can also be concluded that the scope for reduction is extremely large. However, this reduction was possible because of the knowledge-intensive, skills-oriented and hands-on educational approach adopted to train farmers in IPM, as suggested by the strong correlation between knowledge level and reduction in pesticide use. The farmers who learned more about biological control principles were able to manage the largest decrements in pesticide usage. These were anticipated impacts of the FFSs, where the curriculum is structured around a weekly field visit to sample insects on plants and leaves. Farmers attending the schools learn to sample plants in the field and leaves on the plants according to a randomised design, and to record the number of insects and eggs visible. On the basis of factors influencing pests’ population dynamics, e.g. climate conditions and food availability, farmers learn to estimate the risks of plant damage and to take informed decisions, both individually and collectively. Empirical evidence on the role of IPM in reducing pesticide use while sustaining yields has been provided for a number of cases, e.g. rice farmers in Indonesia (Fliert, 1993), Vietnam (Huan et al., 1999), and pistachio farmers in Iran (Heidari, 2003). Some studies have also established a positive relation between the reduction in pesticide use and increased knowledge on bio-control principles (Rola et al., 2002; Godtland et al., 2004; Feder et al., 2004b; Sinzogan et al., 2004; Reddy and Suryaman, 2005).

The FFS approach focuses on the importance of judging the necessity for plant protection interventions on the basis of actual field needs, a judgement widely seen as essential to achieve a more sustainable agriculture. In this light, a
replacement of toxic pesticides by other less harmful products is considered an improvement only if the need for these products has also been established through an ecological field assessment. Mere substitution of synthetic pesticides with biocontrol agents or other technologies such as transgenic cotton thus is unlikely to become a definitive solution to sustain agricultural productivity, unless these new technologies are paired with educational programmes for farmers, spray operators, hired workers, and family members who also work on the crop. The cultivation of the genetically modified bollworm-resistant Bt cotton was recently (2002) authorised in India. Although increased yields and profits, along with reduced pesticide applications have been credited to its introduction (Huang et al., 2002), also many cases of poor performance have been reported, particularly in Andhra Pradesh (Kranthi et al., 2005; Sahai and Rehman, 2004). Experiences in China, where Bt cotton has been grown since 1996, have shown that pesticide use is considerably lower if the Bt technology is integrated in improved production systems, rather than considered as a definitive solution to pesticide overuse (Pemsl et al., 2005).

The current study shows that FFS farmers changed their practices as a result of a change in their decision-making process, unlike the control group that continued to apply synthetic pesticides and biocontrol agents at the same rate in terms of number of applications. A similar behavioural difference was observed by Khan et al. (2005) in Pakistan where trained farmers reduced the frequency and doses of pesticide applications as a result of increased decision-making and field observational scores. Yang et al. (2005) reported that in China FFS trained farmers made management decisions on the basis of a cotton ecosystem analysis, whereas control farmers followed a calendar spraying regime in the early stages of the crop and in the later stages made decisions on the basis of the evidence of plant damage. Canonical correspondence analysis (CCA) showed that yield was not correlated with ecological knowledge. This can be explained by the fact that in many cases pesticide use likely has been highly inefficient (i.e. application of unsuitable pesticides, or overusage). Furthermore, other factors may have been limiting to crop yield, notably soil fertility and water availability. CCA originates from community ecology, and especially from vegetation science (Ter Braak and Smilauer, 2002), but it has been applied only very rarely in the social sciences. However, we show here that CCA provides easy insight in the relation between variables that allows more powerful and accurate analysis and more powerful policy conclusions to be drawn.

The hypothesis that the FFSs generate an overall improvement in all production practices was not validated by the findings. Even though the curriculum of the cotton FFSs conducted in Andhra Pradesh had a broader focus than plant protection alone, no accompanying effects other than pesticide reduction can be claimed on the basis of the present study. The use of fertilisers – of particular interest for their consequences for the environment and crop productivity – was not changed by the FFS experience. Similar conclusions were drawn by a complementary environmental assessment of cotton cultivation carried out in the same area (Kooistra, unpublished), and in Pakistan (Khan et al., 2005). This result can be explained by the relatively higher emphasis given to plant protection measures in comparison with other topics in the curriculum. This result also can be interpreted as a confirmation that intensive educational investments are required in order to achieve appreciable changes in farmers’ practices. Despite the improvement in pest management, the yield remained relatively low, therefore it seems advisable to strengthen the training focus on nutrient and water management.

The adoption of IPM did not lead to an increase in the total physical labour requirement, nor in the time allotted to plant protection measures. However, the time spent on applying pesticides for the control group in the post-survey was 3-fold higher than for the FFS group. In the case of chemical control, women continued to work alongside men, but after the adoption of IPM the average ratio female to total work for plant protection increased from 0.3 to 0.5. Availability of female work, particularly at peak times, might therefore influence the adoption rate of IPM. In term of social sustainability, creating female employment in an occupationally and legally safe environment might be seen as a positive effect considering that most of the women belonging to poor households rely on agricultural wages to meet daily basic needs. However, greater female employment has not always enhanced women’s empowerment, particularly in the villages of Andhra Pradesh where women have replaced men in the bonded (unfree) agricultural workforce (Da Corta and Venkatesharlu, 1999). In the physical labour class analysed by this study, the highest share of work was provided by female family members, who thus are likely to be burdened with extra, unremunerated work as a result of IPM adoption.

Yet considering the severe degree of acute pesticide poisoning affecting cotton growers in the studied area (Mancini et al., 2005), the promotion of IPM through implementation of FFSs on a larger scale is a advisable to mitigate the serious consequences that the heavy use of pesticides has caused to people’s health, and especially to women’s health. However, the costs of FFSs compared to other approaches have been debated (Quizon et al., 2001) and can be seen as a factor limiting large-scale public investment in FFSs. As yet, there are few evaluations that have attempted to quantify the development benefits of FFSs beyond the technical gains, such as human capacity, social capital, and institutional building (Mancini et al., 2007). The debate remains open on the cost-benefit issues as well as on how to achieve cost-efficient pest management with complementary efforts of IPM extension, multi-media messages, IPM FFSs and other forms of occupational education, and legislative measures such as removal of certain chemicals from the market. A number of State Governments in India, including AP, are now experimenting with
various models for scaling up IPM FFSs, which warrants proper documentation and evaluation.

6. Conclusions

This study shows that the conventional pesticide practices in cotton in India are unnecessary and that IPM practices can be adopted without sacrificing yield. Considering the well-established impacts of pesticides on the environment and people’s health, there is a need to support the government’s policy to promote the use of ecologically-informed control methods such as IPM. We showed that farmer field schools are an effective way of assisting farmers to develop the skills and understanding necessary to adopt IPM practices. Broadening the IPMFFS curriculum to address issues of plant production, specifically nutrient and water management issues, and produce marketing, is necessary to improve cotton productivity and profitability in India. Finally, women’s labour time may be a limiting factor in wider adoption of IPM in farming systems characterised by strongly-defined gender roles.

The multidimensionality of IPM FFS outcomes (effects on yield, farmer’s income and health, environmental health, increase in human and social capital, etc.) defies conventional approaches to evaluation and demands new methodological and conceptual efforts. More systematic research programmes are needed to understand the overall values of investing in farmer education for sustainable agriculture so as to advise policy makers and funding agencies about appropriate and sustainable ways forward.

Acknowledgements

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Reducing the Incidence of Acute Pesticide Poisoning by Educating Farmers on Integrated Pest Management in South India

FRANCESCA MANCINI, PHD, JANICE L. S. JIGGINS, PHD, MICHAEL O’MALLEY, MD, MPH

Sixty-five farmers reported on pesticide use and the signs and symptoms of acute pesticide poisoning when using two different plant protection strategies: in 2003 using chemical controls and in 2004 using an approach to Integrated Pest Management (IPM) based on an ecological analysis of the field conditions. Exposure to organophosphates was confirmed as a serious risk factor for occupational poisoning. The adoption of IPM reduced the use of pesticides and halved the incidence of acute pesticide poisoning. Overall, the pesticide use spectrum shifted towards lower WHO Hazard Classes. A reduction of adverse health effects was attained through a reduction in exposure to toxic pesticides and behavioural changes. Given that other strategies to reduce the rate of acute poisoning have proven ineffective, interventions aiming to minimize pesticide poisoning in India and in other developing countries with similar rural conditions should focus on restricting the use of highly toxic compounds and educating farmers on IPM. Key words: Pesticide poisoning; organophosphates; Farmer Field School; Integrated Pest Management; cotton

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Synthetic pesticides are widely used in agriculture to control crop losses caused by insects and other pests. In 2007, the global market value for conventional crop protection products reached US$33.4 billion, 9.7% up from the previous year, according to CropLife International. The trends in the use of pesticides in more recent years are unclear, as official statistics on global consumption of active ingredients are not yet available. In OECD countries, the use and handling of pesticides is strictly regulated, while in many developing countries the necessary legislation is still incomplete or not properly enforced.

In 2006, the World Health Organization (WHO) estimated global pesticide poisoning at 3 million cases. However, clinical surveillance has provided compelling evidence that these estimates do not represent the real extent of illness and death by pesticide poisoning, failing either to reflect the actual hospital records or to account for misdiagnosed or nonhospitalized cases.

Reportedly, national authorities fail to keep complete records on non-fatal occupational exposure in developing countries. Pesticide poisoning studies based on questionnaires have shown much higher figures than hospital registries, and directly observed poisoning rates have been recorded at levels even higher than recalled information provided by farmers in questionnaires.

Farmers and agricultural workers perceive the signs and symptoms of acute poisoning as an unavoidable part of their occupation. As signs and symptoms often disappear by themselves, those affected tend to avoid visits to health centers or hospitals, which are often too far away or too expensive to access. In 140 cases of moderate to severe acute pesticide poisoning recorded in a sample of 97 Indian cotton growers during one spraying season of 4 months, poisoned individuals never sought the advice of a doctor. Less predictable forms of contamination, like take-home exposure to pesticides among farm families or entering fields recently sprayed before the no-entry recommended period, have been overlooked in epidemiological assessments, even though the few studies conducted have shown that farm children of pesticide applicators are more highly exposed to pesticides and have higher levels of pesticide metabolites in their urine samples, compared to other farm children and non-farm children. Socio-economic factors such as poverty, malnutrition and illiteracy amplify the adverse consequences of pesticide exposure of poor people.

The implementation of appropriate preventive measures in occupational exposures remains limited by insufficient information among users. Some studies evaluating the effectiveness of Personal Protective Equipment (PPE) in reducing exposure to pesticides have estimated that effective PPE reduces exposure up to 50% in developing countries; others have shown its inadequacy to protect farmers. Hruska and Corriols monitored the cholinesterase levels of farmers who used PPE over two years and found no reduction of exposure to organophosphate insecticides as compared with farmers who did not use the equipment. Atkin has shown the inadequacy of risk reduction programs promoting the use of PPE and training on safe use as a means to contain exposure in the socio-eco-
nomic context of rural India. PPE includes impermeable gear that is usually not affordable or available, nor acceptable to workers in hot climates. The local cotton garments commonly used by Indian farmers do not offer any protection against skin exposure.

McConnell, who studied the epidemic of pesticide poisoning in Nicaragua, listed among the main causes of poisoning the use of acutely toxic pesticides under primitive working conditions which did not allow for safe handling.

The Food and Agriculture Organisation (FAO) of the United Nations (UN) has developed the International Code of Conduct on the Distribution and Use of Pesticides (the Code), which serve as globally accepted voluntary standards of conduct for all public and private entities engaged in, or associated with, the distribution and use of pesticides. The Code recommends that pesticides whose handling and application require the use of PPE that is uncomfortable, expensive, or not readily available should be avoided, especially in the case of small-scale users in tropical climates. Preference should be given to pesticides that require inexpensive personal protective and application equipment and to procedures appropriate to the conditions under which the pesticides are to be handled and used (Article 3.5). According to the Code, the ‘prohibition of the importation, sale and purchase of highly toxic and hazardous products, such as those included in WHO Hazard Classes 1a [extremely hazardous] and 1b [highly hazardous], may be desirable if other control measures or good marketing practices are insufficient to ensure that the products can be handled with acceptable risk to the user’ (Article 7.5).

Due to shortcomings in the implementation of the code, the incidence of pesticide poisoning remains often high in developing countries and among casual or migrant workers in industrial countries. Phasing out the most toxic pesticides (WHO Hazard Class 1), and in particular organophosphate products, has been called for as the only effective intervention to protect farming communities wherever proper use can not be guaran-

METHODS

Data Collection

The study was conducted in three cotton-growing villages in the state of Andhra Pradesh: Sairedapalli and
The use of pesticides in the two districts is among the highest in the country. According to the 2001 census, Mahabubnagar and Warangal districts had total populations of 3,077,050 and 2,818,832, respectively. Cotton is grown as the main crop during the rainy season (Karif) on 121,260 ha in Warangal and 22,697 ha in Mahabubnagar. In each village, one FFS was conducted in 2003 to train 25 farmers.

FFSs were conducted during the cotton cropping season of 2003. The curriculum included weekly training exercises that aimed to increase farmers’ awareness of the hazards of pesticide use. A series of practical exercises were carried out to train farmers on the ways pesticides enter the human body and potential exposure based on liters of products applied, as well as farmers’ behavior in the field with respect to handling, application, storage, and disposal practices.

As part of the FFS curriculum, fifty female farmers monitored their signs and symptoms of acute pesticide poisoning and those of 47 male relatives from August to December 2003. Prior to the start of the monitoring, respondents were trained on the identification of signs and symptoms in four hourly sessions. Discussions were held on the mode of action of different chemical families (organophosphate, carbamate, organochlorine and pyrethroid) and their health effects on the central nervous system. Many of these effects are unspecific and can be caused by other conditions such as extreme fatigue and sun exposure; therefore farmers were trained to examine themselves before and after spraying to establish a link between exposure and the manifestation of illness. Farmers were given guidelines to recognize signs and symptoms during the exercises and throughout the monitoring.

As significant decrements in pesticide application practices have been usually observed a year after the FFSs are concluded in the case of India, in the current study the 2003 assessment was considered a baseline of the pesticide handling practices of the respondents. During the FFS, participants implement and evaluate IPM practices in the experimental plot during the training session, while practices in their own fields are not monitored. However, it cannot be excluded that some of the trained farmers adopt more ecological practices in their respective fields during the training, in which case the impact measured in the current study would result in an underestimation of the actual change. In the subsequent cotton season, a second monitoring was carried out by a subgroup of the female farmers (34) and their male family members (31) from July to December 2004.

The second monitoring activity started a month earlier than the baseline had in the previous year, due to weather-related differences in the cropping season. A detailed description of the reporting methodology used is given in Mancini. In brief, women farmers filled in a form containing a diagnostic pool of 18 signs and symptoms of acute pesticide poisoning after every field exposure to pesticides (spraying in the field, mixing spray solution, refilling spray tanks, and working in field sprayed the same day). Women reported on their own health experience and on those of one male family member working in the field. Additional information on the type and quantity of chemical products used (mL formulated product/L water), operation performed, and hours spent in performing the operation were collected on the form. Forms were reviewed and corrected every week by experienced facilitators.

On the basis of the signs and symptoms reported, forms were assigned to four severity classes: mild poisoning (severity class 1), moderate poisoning (severity class 2), severe poisoning (severity class 3), and forms with no signs and symptoms marked were assigned severity class 0 and classified as asymptomatic. The total number of signs and symptoms (#S&S) reported on each form was also considered as an indicator of poisoning and analysed as a continuous variable in correlation analysis.

The comparison proposed in this study does not have the benefit of a control group, which was initially included in the first monitoring activity but subsequently dropped because of the low response of the farmers not enrolled in the FFSs; therefore it is not possible to control for external factors which may have influenced the health of the population under investigation, such as exposure to a different source of pollution. Individual predisposing factors to specific symptom or sign, such as headache, were controlled for using 2003 as a reference year and calculating individual variation in reporting.

**Data Analysis**

We analysed individual risk factors for symptoms (severity class > 1, classified as probable cases of poisoning) associated with 311 applications in 2003 and 179 applications in 2004, using 2 × 2 tables and odds ratios (OR).
calculated with the public domain software EpiInfo. Specific risk factors included exposure to organophosphate, nicotinoid, pyrethroid, organochlorine, botanical insecticide, miscellaneous (fungicides, gaba receptor inhibiting insecticides and oxadiazine insecticides), and unclassified materials (pesticides reported only with local names, unidentified by study staff and not listed in several standard pesticide databases). Relative toxicity, as indicated by WHO Hazard Classes, was evaluated. Non-chemical factors evaluated included literacy level, gender, year of application (2003 vs. 2004, as a surrogate for the effect of the FFS training), mixing pesticides, spraying pesticides, and performing field work. Significant association between individual factors and probable cases of poisoning was calculated using a Yates-corrected chi-square statistic.

To evaluate possible confounding, factors that proved significant in the univariate analysis and were plausible biological risk factors or plausible protective factors were included in an unconditional logistic regression.29

For those participating in both monitoring years (65 respondents), we also analysed pesticide use; key exposure operations performed, mean number of signs and symptoms per informant, and incidence of poisoning. It was not possible to perform this analysis using Epi-Info so it was performed instead with the analysis pack in Microsoft Excel 2003.

RESULTS

Characteristics of the Respondents

Of the original reporting group (97) in 2003, a total of 65 reported in the 2004 survey. The 2004 group included 34 out of the original 50 female participants directly monitoring their health and 31 out of the original 47 male relatives reporting to the female farmers (Table 1). Of the 2003 respondents who did not report in the 2004 survey, the majority (25) had filled in only 1 or 2 forms in 2003; a likely reason for their attrition may be that they used virtually no pesticides in the year after the training. However, the remaining respondents (9) who reported in 2003 but not in 2004, reported a number of applications ranging from 3 to 8, with one exceptional case of 18. Hence it is possible that at least some of them had dropped out of the monitoring activities in 2004 for reasons unrelated to their continued use of pesticides. These assumptions were not independently verified and, in order to avoid biases in the findings, changes in the pesticide use, exposure level and incidence of health effects were analysed only for farmers who participated in both surveys.

The two monitoring exercises generated a total of 594 forms, including asymptomatic forms. The average age of the respondents was 37 years. Land holding size ranged from marginal (up to 0.8 ha) to small (1–2 ha) (Table 1).

RISK FACTOR ANALYSIS OF ACUTE PESTICIDE POISONING

The analyses of single variable risk factors are shown in Table 2. Factors that proved significantly associated with probable poisoning included exposure to organophosphates (OR=2.78, p<0.01), use of WHO Hazard Class II insecticides (OR=2.06, p<0.01), mixing pesticides (OR=1.49, p=0.0476), illiteracy (OR=2.35, p<0.01), and year of exposure (OR2003 vs 2004=3.10, p<0.01). Statistical significance of the health effects of exposure to WHO Hazard Class U products could not be determined due to the low number of exposure cases.

Significant protective factors included male gender (ORmale vs female =0.595, p<0.01), use of WHO Hazard Class U insecticides (OR=0.36, p<0.01), exposure to botanical/organic insecticides (OR=0.38, p<0.01) and performing field work without spraying or mixing (OR=0.28, p<0.01).

Variables included in the multivariate analysis were illiteracy, handling organophosphate insecticides, handling category IV pesticides, performing only field work, and exposure during 2003. Significant risk factors for probable poisoning in this analysis included illiteracy (OR=1.94, p<0.01), exposure during the year 2003...
Changes in the Use of Pesticides, Exposure, and Incidence of Acute Poisoning During and After the Farmer Field Schools

Changes in the use of pesticides. The pesticides applied by the informants significantly changed over the two years. Organophosphates were the most applied in both years, but a reduction of 15% was registered in 2004. The applications of botanical products went up fifteen fold. Some of the moderately to highly toxic pesticides used in 2003, specifically Parathion and Phorate (WHO Hazard Class I), and Dimethoate and Phosalone (WHO Hazard Class II), were not reported in 2004. Exposure to Endosulfan was reduced from nearly 15% to 3% of the total cases of reported use. Applications of Monocrotophos (WHO Hazard Class I), Quinalphos, and Chlorpyriphos (WHO Hazard Class II) also decreased (Figure 1). Overall, the pesticide use spectrum shifted towards lower WHO Hazard Classes (Figure 2).

TABLE 2 Evaluation of Risk Factors and Demographic Variables Associated with Single Exposure to Pesticides (N=490)

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<th>OR</th>
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<th>Upper</th>
<th>Chi-square</th>
<th>p Value*</th>
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*p value obtained by univariate analysis (continued on next page)
Spraying operations. In 2004, women played an enhanced role in the preparation and application of spray mixtures, primarily botanical preparations (43 out of 81 forms) such as nuclear polyhedrosis virus, neem oil, chili-garlic extracts and spinosad (Table 3). A redistribution of plant protection tasks among genders consequent to the adoption of IPM was also observed by Mancini et al. in their gender analysis of labor task allocations.30 Behavioural changes, like informants tending to spend less time working in a recently sprayed field, were also observed.

The average duration of one exposure session in 2003 was 4.45 hours for men and 4.47 hours for women, and, respectively 3.04 hours and 3.06 hours in 2004; the average volumes applied during the session were respectively, 186 and 187 L in 2003, and 148 and 142 L in 2004. Spray parameters of application sessions in 2004 reflect the use of low-volume botanical products such as neem oil and powder.

Respondent-Paired Analysis of Health Effects. The following variables, in addition to the Severity Class variable, were used in the analysis of health effects:

- **Pesticide toxicity**: a score assigned to each reporting form according to the most toxic pesticide used during the reporting session. Pesticide toxicity is defined on the basis of the WHO hazard classification: Class Ia (“extremely hazardous”) scored 1 point, Class Ib (“highly hazardous”) 2 points, Class II (“moderately hazardous”) 3 points, and Class III (“slightly hazardous”) 4 points. Pesticides unlikely to present acute hazard in normal use (class U) were assigned a score of 5 points
- **Individual severity class**: the highest class of poisoning reported in each form by the respondent in the year of reference
- **Individual mean #S&S**: the average number of S&S experienced per exposure session (form) by the respondent in the year of reference

In 2004, the reduction in the use of highly toxic compounds (~31%) was associated with a proportional reduction in the number of cases of Severity Class 3 poisonings reported (~28%). Severity Class was positively correlated to Pesticide Toxicity (Pearson correlation coefficient: 0.46). Moderate poisoning (Severity Class 2) was halved, whereas mild poisoning (Severity Class 1) slightly increased and asymptomatic cases (Severity Class 0) tripled (Figure 3).

The average level of poisoning experienced by the informants over the entire cropping season shifted from moderate (2003) to mild (2004). Correspondingly, the mean number of signs and symptoms experienced decreased. The association between mean #S&S and severity class already established in the first part of the monitoring7 was reconfirmed (Table 4).
DISCUSSION AND CONCLUSIONS

Organophosphates, used broadly in agriculture, were confirmed as a serious risk factor for occupational poisoning in this study. Illiteracy, a social proxy for poverty and malnutrition, aggravated the risk of being poisoned. Andhra Pradesh, and especially Warangal district where part of this assessment was carried out, have some of the largest reported use of organophosphates and the highest reported rates of pesticide poisoning in India.2

In the absence of a control group, it is hard to establish the exact extent of reduction in pesticide use attributable to the IPM training on the basis of the data collected in this study. Other factors, for instance pest pressure, weather conditions, and pesticide market prices might have differed in the two years of the study, leading to different levels of pesticide use. However, an additional questionnaire-based survey, using a double delta design, was carried out with the same group of farmers and a control group over two years.30 According to the survey, the use of pesticides in the district in 2004 was overall lower than in 2003 because of a lower pest load as reported by the phytosanitary service. However, the reduction in the case of FFS trained farmers, in terms of total active ingredient used was almost 50% greater compared to the control group. FFS farmers’ number of applications decreased from 7.8 to 1.7, whereas no significant variation of this indicator was registered for the control group. The most significant change introduced by FFSs in field management was the criteria applied to determine when and whether pesticides would be applied. FFS farmers...
adopted the performance of a complete agro-ecosystem analysis (including the occurrence of natural enemies) of their own fields. In particular, the application of highly toxic organophosphates like monocrotophos and the chlorinated insecticide endosulfan (WHO I and II Hazard Class) were significantly reduced. Consequently, the exposure and incidence of associated adverse health effects of pesticides were minimized. Trained farmers also avoided risky behaviors such as working in recently sprayed fields.

Increase in knowledge of risk associated with pesticide practices, changes in exposure behavior and reduced health risks for IPM-trained farmers are consistent FFS outcomes described also for Sri Lankan farmers cultivating maize and Nicaraguan farmers. In the case of Andean farming communities, the adoption of IPM through FFSs has resulted in a diminished skin exposure and improved neurobehavioural status of potato farmers.4

Limited access to health care, improper administration of antidotes and lack of trained doctors and nurses in hospitals make patient management a rather ineffective option in India as in many other countries with emerging economies. A recent medical study has suggested that the inhibition of cholinesterase enzyme alone does not explain the wide range of disorders observed in association with exposure to organophosphorus products.32 In addition to the well known cholinergic phase observed immediately after exposure, delayed neurotoxic effects can manifest themselves from 7 to 21 days after exposure.33 Generally, the human toxicological effects of pesticides are still poorly understood and researched.34

The use of highly toxic products is currently under close evaluation in countries where their use is much more strictly regulated than in developing countries. As recently as January 2009, the European Parliament has approved a legislative resolution on the Council’s common position for adopting a directive of the European Parliament and establishing a framework for Community action to achieve a sustainable use of pesticides.35

Given that insufficient medical information exists for implementing appropriate preventive measures and therapeutic interventions for occupational exposure, interventions aiming to minimize pesticide poisoning in developing countries need to focus on restricting the use of highly toxic compounds, especially organophosphates.

Stronger regulatory measures might lead to the removal of a significant percentage of chemical products from the market. Concern has been expressed about possible risks to productivity that could be incurred in the absence of other plant protection measures, with negative consequences for food prices and hence for the well-being particularly of poor consumers. In the case presented in this study, ecological

| TABLE 3 Pesticide-handling Operations Performed, by Year and Gender |
|---------------------|---------------------|---------------------|---------------------|---------------------|
| Operations          | 2003                | 2004                | 2003                | 2004                |
|                     | Men     | Women    | Men     | Women    |
| Preparing spray mixture | 5 (5)   | 54 (45)  | 0 (0)   | 81 (73)  |
| Preparing spray mixture AND working in the field | 0 (0)   | 31 (26)  | 0 (0)   | 0 (0)    |
| Working in a recently sprayed field       | 4 (4)   | 21 (17)  | 4 (3)   | 3 (3)    |
| Applying mixtures        | 70 (65) | 12 (10)  | 130 (94)| 27 (24)  |
| Applying mixtures and working in the field | 28 (26) | 3 (2)    | 3 (4)   | 0 (0)    |
| Total                   | 107 (100)| 121 (100)| 137 (100)| 111 (100)|

| TABLE 4 Individual Average Level of Poisoning (Individual Severity Class ) and Individual Average Number of Signs and Symptoms Reported Over the Reporting Period (Individual Mean #S&S), by Year |
|---------------------|---------------------|---------------------|---------------------|---------------------|
|                      | Individual Severity Class* | 2003                | 2004                | Individual mean #S&S | 2003                | 2004                |
| Mean                 | 1,923077             | 1,492308             | 3,409275             | 1,238543             |
| Variance             | 0,697115             | 1,035096             | 4,154002             | 1,288168             |
| Observations         | 65                   | 65                   | 65                   | 65                   |
| Pearson Correlation  | 0,10046              |                      | -0,4074              |                      |
| Hypoththesized Mean Difference | 0                  |                      | 0                    |                      |
| Df                   | 64                   | 64                   | 64                   | 64                   |
| t Stat               | 2,779233             |                      | 6,470338             |                      |
| P(T<=t) one-tail     | 0,003572             |                      | 7,83E-09             |                      |
| t Critical one-tail  | 1,669014             |                      | 1,669014             |                      |
| P(T<=t) two-tail     | 0,007145             |                      | 1,57E-08             |                      |
| t Critical two-tail  | 1,997728             |                      | 1,997728             |                      |

*Severity class: mild poisoning (class 1), moderate poisoning (class 2), severe poisoning (class 3).
farming practices offered viable alternative plant protection options for cotton cultivation in India that did not affect production outcomes.

In order to restore the ecological viability of farming, in terms of impact on the environment and human health, it is necessary that significant investments are made to support the education of farmers on better management practices.

The authors thankfully acknowledge the extensive and valuable reviews and comments of Harry van der Wulp and Peter Kenmore, Plant Production and Protection Division, Agriculture and Consumer Protection Department, FAO, Rome. Special recognition is due to the Indian farmers and facilitators who participated in this project.

References

2. World Health Organisation, Mental Health and Substance abuse Facts and Figures Suicide Prevention: Emerging from Darkness. New Delhi, India, 2006. (http://www.searo.who.int/en/Section1174/Section1199/Section1567/Section18248078.htm)
Environmental Education for Poor Farmers
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Environmental Education for Poor Farmers
This programme completion report for the public acknowledges the close partnership between the Commission of the European Communities (EC) and the Food and Agriculture Organization (FAO) of the United Nations in addressing the issues of poverty alleviation, sustainable agricultural and rural development, environment protection, trade, good governance, human health and education and most of all hopes for the poor through quality farmer education. Both EC and FAO are grateful to the national and state/provincial governments who have supported this initiative and continue to believe in this approach by following up with local funding to sustain the achievements made in their respective countries. The Programme is grateful to the national field staff from governments and NGOs who took up the challenge of educating farmers. To the national and international consultants (especially from European universities and institutions) our grateful thanks for sharing their experience and expertise. Thanks are due to FAO staff in headquarters, regional and country offices for helping in implementing this Programme. To the Italian and Danish Governments, our thanks for supporting the Associate Professional Officer schemes of the FAO that saw two of their nationals working in India and Vietnam, respectively. The Programme had the privilege of hosting two M.Sc. students from Wageningen University, Netherlands in the field site in Vietnam and the synergy of student research and farmer education helped enrich the farmer field research programme.

The publication of this book is a testimony to the thousands of resource-poor farmers who benefited from the Farmer Field School (FFS) approach as reflected in the faces of IPM from the six countries.
In seeking to address the challenges and the opportunities offered by globalisation and to strengthen joint efforts on global environmental and security issues, the EC has identified a number of core development priorities which underline EC-Asian Co-operation. These policies are set down in the 2001 Commission Communication “Europe and Asia: A Strategic Framework for Enhanced Partnerships” and include: Peace and security in Asia; the development of the less prosperous countries of the region, the strengthening of mutual trade and investment flows and the creation of global partnerships and alliances with Asian countries.

In March 1999, the European Commission and the FAO (as the implementing agency) signed a Financing Agreement (ASI/B7-3000/IB/96/150) of an amount of EUR 12 Million for the implementation of the five year programme entitled: “Integrated Pest Management for Cotton in Asia”. Through the successful implementation of the programme, which ends in December 2004, the EC has taken one step further to achieving its objectives.

The EU funded the “IPM Programme for Cotton in Asia” in response to the needs of cotton producing countries to tackle rising production costs, increasing pollution of the environment due to excessive pesticide use, the deteriorating health of farmers and the increase in poverty. Under these conditions, cotton producers face increasing challenges in a globalised market. The IPM Programme for Cotton in Asia is promoting more ecological production methods in Asia, where over 50% of the world’s cotton plantations are. This Programme has shown that farmer education through the Farmer Field School (FFS) approach is key to encouraging more sustainable agricultural production, which is profitable to small-scale producers and acceptable to local and international traders.

The European Commission is pleased to be associated with the FAO in bringing about the benefits of farmer education to small-scale farmers. The Farmer Field School education has helped to empower the farmers working for most of them under rainfed conditions to be more efficient. In this respect, the EU in engaged with FAO in achieving common objectives in reducing poverty in the less prosperous countries through the promotion of sustainable agricultural development. The EU-FAO initiative is supporting the efforts towards peace and security as well as a stable and democratic political environment in participating countries.
FAO is committed to the realization of the Millennium Development Goals (MDGs) set during the Millennium Summit in the year 2000, and its current programme encompasses most of these goals. They include, among others, actions to eradicate poverty and hunger, ensure environmental sustainability and develop a global partnership for development. With more than two thirds of the world’s poor and over 500 million people living in hunger in the Asia and the Pacific region, the Organization, along with the member states, faces tremendous challenges in meeting the MDG of reducing hunger and poverty by half by the year 2015. To strengthen its contributions for achieving the MDGs and for responding more effectively to the needs in the region, the FAO Regional Office for Asia and the Pacific has adopted a regional strategy that includes priorities such as agricultural sector restructuring, decentralized governance and empowerment, effective and equitable management, conservation and sustainable use of natural resources, reduced vulnerability to natural disasters and strengthened biosecurity.

The FAO-EU IPM Programme for Cotton in Asia fits well into this regional strategy; it has shown that farmer field schools are an effective method of empowering and mobilising farm families and of developing the enhanced management skills necessary for a sustainable pro-poor and environmentally-friendly agricultural and rural development. The experiences gained from this Programme will benefit many ongoing and future endeavours to reduce poverty and conserve precious natural resources. The FAO Regional Office in Bangkok is proud to have been associated with this Programme. I am pleased to take this opportunity to express my most sincere appreciation to the European Commission for having provided the financial resources, to FAO staff in the headquarters, the regional office and the field, and to our cooperation partners in the participating countries who all have contributed to the Programme’s success and significant impact.

He Changchui
Assistant Director-General and
FAO Regional Representative for Asia and the Pacific
The FAO-EU IPM Programme on Cotton in Asia demonstrates again that IPM is more than pest management and offers an entry point to improve the farming system as a whole. It provides ecological sustainability, as it protects the environment; it improves social stability, as it is institutionalized at local level; it helps the poor, as it reduces farmers’ dependence on procured inputs and lessens their vulnerability. In combination with farmer field schools, IPM is an effective instrument to link poverty reduction and environmental management.

The FAO-EU Programme has addressed a major source of pesticide misuse and overuse in Asia. It has established the large potential for pesticide reduction and the socio-economic benefits that can come from it. I would like to thank the European Commission for entrusting FAO with the implementation of this regional project that has achieved important outcomes in terms of economics, environment including agro-biodiversity, and human and animal health and has shown the potential to improve the livelihoods of millions of poor farmers.

Niek van der Graaff
Chief, Plant Protection Service
Food and Agricultural Organization
of the United Nations
More than half of the world’s cotton is produced by Asian farmers, the majority of them small landholders with plot sizes of less than one-half hectare. Within Asia, cotton production is diverse and this diversity manifests itself among the countries participating in the FAO-EU Integrated Pest Management (IPM) Programme for Cotton in Asia. Three of the Programme countries are major contributors to the total world cotton harvest: China producing 20 percent, India 14 percent and Pakistan 10 percent. The other three member countries are very minor participants, each representing less than one-tenth of one percent of world production. Since project initiation in 1999 there have been considerable fluctuations in world production, consumption and prices. With consumption outpacing production, international cotton prices rose 24 percent in 2003-04, the highest in six years.

All member countries have important cotton-processing and textile industries employing millions of low-salary factory workers, many of them women. However, more cotton is consumed in these industries than is produced in the countries; thus, valuable foreign exchange is spent on imports. Given the importance of cotton in their national economies, the Cotton IPM Programme was very relevant in terms of trade, reducing environmental contamination from heavy pesticide use, improving health of farming communities, promoting complex and autonomous management skills, and meeting requirements of WTO regimes that come into force in 2005.

The FAO-EU Programme was implemented to contribute to rural poverty alleviation and to protect agro-biodiversity through an ecosystem-based production and pest management approach. After establishing a training capacity of more than 50,000 farmers per year, participating countries are poised to take on major rural poverty alleviation and environmental protection activities.
Rural Poverty and Cotton

FAO-EU Programme member countries produce 45% of the world’s cotton, but employ more than 70% of its cotton growers, many of them living in poverty. Despite rapidly developing economies, three-quarters of the world’s poor still live in Asia. For more than 20 million small-scale farmers there, cotton is the only crop that gives them extra cash for family expenses. For example, in Pakistan 70-80% of the programme’s farmers live below the poverty line. For this reason, cotton production is actively promoted as an important part of the rural development strategy in most member countries. However, cotton also has its drawbacks, as it is by far the largest user of pesticides, adding health problems to poverty and deteriorating environmental conditions.

Cotton production involves the whole family, and women play an important role. They not only supply up to 70% of the labour inputs, they also contribute to many crop and pest management decisions and allocation of scarce family resources, even in male dominated societies. When husbands look for work elsewhere, women find themselves in charge of all crop management decisions. Though not specified in the original project document as main beneficiaries, the Programme focused its attention on strengthening the management capacities of small-scale farmers and women. It continuously monitored whether farmer education activities reached the right group of beneficiaries. According to the impact assessment sample, the number of participants living below one dollar per day averaged from 47% to 92% for the different countries. Women participation steadily increased over the years.

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Source: World Development Indicators, World Bank 2004
Cotton Plot Sizes of Project Beneficiaries
Country averages of impact assessment samples

World Cotton Farmers
Estimated Total: ~29 million
FAO-EU Programme Member Countries: ~20 million (70%)
More pesticides are used on cotton than on any other crop. For example, in India and Pakistan, in excess of 50% of all pesticides in these countries are applied to cotton. In many areas, cotton is sprayed 15-20 times during the season. Overall, an estimated 30% of all pesticides used in Asia are applied to cotton, representing a value of US$ 1.5 billion every year. Considering that integrated pest management experience has shown that more than half these applications are unnecessary, substantial savings of US$ 500-1,000 million annually are possible.

Insecticides currently represent 15-25% of the cotton production cost in China, India, Pakistan and Philippines, if labour costs are included. Looking at small farmers’ actual financial outlay, the percentage is even higher.

Over the past decade, rising insecticide costs have lowered the returns on growing cotton and resulted in declining cotton areas, especially in the Yangtse and Yellow River basins of China, in India and in the Philippines. Excessive pesticide use has been associated with build-up of pest resistance, decline in populations of natural enemies, degradation of the environment, and serious health problems among those spraying and picking cotton.

Many pesticides used in cotton belong to the highly toxic WHO Class I group of chemicals. Detoxifying pest control strategies and replacing them with a more sustainable and environmentally friendly cotton production system was a major objective of the FAO-EU Programme.
Annual Pesticide Usage in Asia
without Japan, Near East and CIS
400,000 ton a.i. *; US$ 5,600,000,000

Indian farmers fall prey to deadly pesticides

BANGALORE, Wed. — Long-term exposure to pesticides has killed more than 500 cotton farmers in the southern Indian city of Warangal and more are falling prey to the chemicals, activists claim.

Four Indian non-governmental organizations, which form part of a fact-finding team to investigate the deaths, in a report said that amounts of chemicals were used in Warangal district of Andhra Pradesh State during the season from June to September last year.

“Deaths among medical officers, lawyers and advocates went unreported,” said Margaret Reddy, chief of Centre for Resources Education, an anti-poverty body.

In a separate discussion, the report said that more than 500 people had died due to exposure to pesticides in the whole of Warangal district in September.

The organisations, in a letter to the city police, said that the Warangal farmers used both mechanised and manual spraying machines, which resulted in deaths.

The report said the government should consider curbing the use of pesticides.
Problems associated with heavy pesticide use are widely recognised and include health effects on applicators, field workers and consumers. Detrimental effects on agro-biodiversity and ecological functions such as natural pest suppression, soil fertility and pollination have also been observed. Ground water contamination with pesticides and percolating into drinking water resources is widespread. Recent reports about contaminated soft drinks and bottled water in India highlighted the environmental and health hazards associated with excessive use of insecticides in cotton.

Phytosanitary standards, pesticide residues and environmentally and socially unacceptable cultivation practices are increasingly used as barriers to international trade, and consumers in importing countries are rejecting questionable products. Instead of investing in expensive pesticide residue laboratories and testing, IPM aims to address the problem at the source and produce low-pesticide healthy crops in an environmentally friendly and socially acceptable manner. In this way, an uninterrupted access to local and foreign markets can be secured.

Farmers who have observed and understood ecological interactions through self-discovery exercises during farmer field schools become highly motivated protectors of natural enemies in their fields. They avoid using pesticides out of conviction, not because they are told to. IPM significantly increases the biodiversity in agricultural fields by conserving natural enemies and maintaining a sound ecological balance.
Farmer field schools empower farmers to create a safer working environment for themselves and their families. By becoming aware of negative health effects and ways to reduce pesticide applications, farmers can live without the fear of being poisoned, endangering their families and communities, and consuming contaminated farm products.
The Programme formulation was carried out in June 1993 and six years elapsed before the Implementing Agreement between FAO and the EC was signed by the EC and FAO in February/March 1999. The project officially started on 17 October 1999 with the arrival of the first team leader. Much had changed in the six years since the project document was originally formulated. This made it necessary to reassess assumptions and strategies and revise workplans, outputs and schedules. EC supported flexible Programme planning and adjustment which was a decisive factor for staff enthusiasm and innovation during implementation.

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<td>Budget</td>
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The development objective in the Programme document focused only on cotton production, i.e. “sustainable, profitable and environmentally sound production of cotton in the participating countries, through the development and practice of IPM by farmers and extension staff.”

In the years between project formulation and actual implementation, farmer field schools emerged as the key ingredient of successful IPM and a powerful instrument of farmer capacity building. Therefore, farmer empowerment and informed decision-making also became key goals for the FAO-EU Programme, yet this was not reflected in the stated development objective of the Programme. Therefore, the mid-term evaluation suggested a more appropriate development objective: “Farmers in a cotton-based production system, through observation and experimentation, are empowered to solve pest and other production problems in their own fields.” This development objective effectively shifted the emphasis from cotton production to human resource development and more accurately reflected what the Programme was actually trying to achieve in the field.

The original ‘cotton production’ objective, however, influenced the choice of partners in some of the Programme countries. In the three countries where cotton was only a minor national crop, the partner was the national cotton production company, for which farmer empowerment was a secondary objective to increased cotton production. All countries except for Pakistan had previous IPM projects on rice and/or vegetables, and had already trained field school facilitators.

The Programme was financed for five years and involved building training capacity and an operational framework. This would naturally lead to a deployment of facilitators and the building of both effective institutional structures and sustainable farmer groups.
### Programme Objective

“Sustainable, profitable and environmentally sound production of cotton in participating countries, through the development, promotion and practice of IPM by farmers and extension staff”

<table>
<thead>
<tr>
<th>Immediate Objectives</th>
<th>Targets*</th>
<th>Follow-up Activities</th>
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| 1. To develop a cadre of IPM facilitators from existing extension or field plant protection staff to educate farmers in farmer field schools | 21 ToF courses and more than 1,000 IPM facilitators  
  capacity to educate 50,000 farmers per year  
  at least 3,829 FFS and 90,000 farmers trained  
  focus on skills to organise FFS | build sustainable management systems to utilise full training capacity  
  focus on poverty alleviation potential of IPM-FFS  
  focus on cropping system management  
  reach critical mass of farmers for local reinforcement and farmer-to-farmer spread to new areas |
| 2. To promote co-operation for cotton IPM among governments, research institutions, development agencies, extension services and farmers’ and other non-governmental organisations and to improve access for all interested parties to information from within and outside of the Programme area. | increased number of contacts, exchanges and agreements between organisations concerned with IPM and cotton production in Asia  
  production of newsletters, electronic website and technical reports | build sustainable FFS farmer alumni groups and farmer self-help organisations  
  build local, provincial and national umbrella organisations for farmer mobilisation and empowerment  
  promote farmer field research for adaptation of new technologies and knowledge generation |
| 3. National policies on plant protection in cotton re-oriented to support IPM development in the six Programme countries. | results of training programmes and impact studies will be widely available  
  IPM policies for cotton will have been reviewed,  
  evidence of policy change will come in the form of policy statements, sector plans and programme documents prepared by national governments | use impact study evidence for policy dialogue to conserve agro-biodiversity and reduce poverty  
  redirect extension policies to focus on rural adult education and self-help capacity for male and female farmer groups  
  institutionalise quality and impact monitoring to build effective learning organisations |

* based on the revised targets in the Inception Report of 2000
In order to achieve the Programme objectives, country projects concentrated their efforts on developing training capacity to educate cotton farmers about the agro-ecosystem and about how to verify and further develop environmentally friendly pest control strategies. The biggest challenge the project faced was how to bring high quality education efficiently to large numbers of farmers, each one with only a small plot of cotton.

Like any skill, the new pest and production management skills needed to be repeatedly practiced by farmers under the guidance of an expert facilitator until they were mastered independently. In the Cotton IPM Programme, skills training took place in weekly, season-long practical sessions called Farmer Field Schools (FFS). To achieve and maintain a high quality farmer education, extension agents and fellow farmers were extensively trained in season-long Training of Facilitator (ToF) courses.

The originally targeted number of 21 ToF and 1,000 facilitators was found to be too low to achieve a sustainable training capacity of more than 50,000 farmers per year. Therefore, additional courses had to be scheduled for both government extension agents and farmer facilitators.

Farmer field schools and integrated pest management are a powerful combination of strategies for farmers growing diverse crops such as rice, vegetables or cotton to achieve comprehensive sustainable development. This approach has been particularly successful with small-scale farmers searching for a way out of the vicious cycle of increasing costs and reduced profits. Such cycles have occurred where ecological processes in the fields have been disrupted by the excessive use of pesticides and other agricultural inputs.
Farmer field schools are also suitable for educating farmers in the complex management skills necessary for a modern, market-oriented economy. Therefore, farmer education is a trans-sectoral field that addresses a number of development issues:

- Poverty alleviation and sustainable livelihoods
- Protection of the environment and natural resources
- Food safety, safe trade and international treaties
- Health and safety at work
- Good governance, self-reliance and efficiency of state institutions
- Education and gender equality
The Programme started in October 1999 with a one-year inception phase. The Inception Report of June 2000 set the output targets for the Programme as a whole. In consultations between FAO and EC it was decided at that time to have additional country IPM officers and to investigate the effect of genetically modified Bt cotton in China. Since these new activities had not been included in the original budget of Euro 12 million, an additional $2 million was requested. This planning flexibility for adding quality and addressing critical new areas was a factor for enthusiasm and innovation during Programme implementation.

The Programme became fully operational in 2001. Project Management Units were established in each participating country, and these were coordinated by the Programme Management Unit located at the FAO Regional Office for Asia and the Pacific in Bangkok, Thailand. From 2001 onward, annual work plans were prepared and routinely monitored. A quarter of all funds were spent in China, followed by India with 19% and Bangladesh, Pakistan and Vietnam with 11-12% each. Only 4% were invested in the Philippines. Comparatively little was spent in Pakistan relative to the number of cotton farmers because the Asian Development Bank and the Arab Gulf Fund funded two complementary cotton IPM projects. The projects were implemented as one under the National IPM Programme.
The mid-term review mission recommended expanding the successful Programme to more countries and other crops. The EC concluded that the Programme with its objectives did “not correspond to the strategic priorities outlined in the EC Strategy Paper and Indicative Programme for Multi-Country Programmes in Asia 2005-2006”. As a result, participating countries were challenged to provide their own funding in order to implement farmer field schools with the trained facilitators in 2004.

The final review mission in 2004 concluded that the Programme had a significant impact in participating countries. However, it also recognised the critical need for continued technical assistance for a successful realisation of the follow-up programme expansion plans of India and Pakistan.
FAO-EU IPM Programme for Cotton in Asia: Environmental Education for Poor Farmers
The central ingredient in the FAO-EU IPM Programme for Cotton in Asia was the farmer field school (FFS), which had already demonstrated its rural development potential in rice and vegetables cultivation systems in Asia. Like in other crops, educating farmers on IPM in cotton involved FFS on an ecology-based pest control approach that sought to maximise economic benefits to farmers while protecting health and the environment.

The four principles of IPM are
1. Grow a healthy crop;
2. Base decisions on understanding the field agro-ecosystem, including the role of natural enemies;
3. Regular and careful observation of the field;
4. Farmers are experts.

An FFS in IPM involves facilitated season-long experiential learning by farmers in village groups. Through the FFS, farmers become IPM experts and pest managers of their own crops. The FFS approach differs from conventional extension programmes insofar as it does not pass on instructions to farmers, but aims to raise their educational level through experiential learning and the enhancement of human and social skills.

In the FAO-EU Programme, FFS facilitators learned their skills in season-long Training of Facilitators courses. The participants were usually recruited from extension services, but also included NGO staff and experienced farmers. Continued training of new facilitators was expected to have a compounding effect over several years to allow for an expansion and intensification of the Programme. It was theorised that the number of trained farmers in a given location needed to reach a critical level before IPM knowledge and practice would become the norm in the farming community.
The farmer field school (FFS) was the primary learning approach used to educate farmers about IPM through a season-long learning experience. FFS are schools without walls, organised in the fields of participating farmers. About 25-30 participants meet in the morning for a half day each week for one entire season, from the pre-planting period until after the harvest. At each FFS meeting, the members break into small groups to make detailed observations of the crop and field conditions on two study plots: an IPM plot, and a ‘farmer practice’ plot. Observations are recorded, discussed, and interpreted by the group with assistance from the FFS facilitator. This analytical process, which is usually carried out by comparing drawings of what was observed, is called “cotton ecosystem analysis”.

FFS participants evaluate the balance among the observed pests and their natural enemies and then decide collectively on the field management practices for the coming week. The whole concept of FFS is to help farmers become better decision makers, and the approach encourages self-motivated discovery learning.

**FFS Activities Distribution**

2003 averages of 500 FFS in hours per season; average total: 74.9 hours

- Special Topics, 10.8
- Insect Zoo, 6.1
- Field Trials/Cultivation, 8.7
- Group Dynamics, 6.2
- Review, 5.6
- Other, 8.1
- FFS Organisation, 5.2
- Cotton Ecosystem Analysis, 22.9
FFS farmers carry out additional field experiments, such as defoliation studies to learn about plant-physiological compensation after damage. They set up “insect zoos” to study predation and parasitism. Special topics also studied in the FFS include the effects of pesticides on natural enemies and on human health, as well as improvement and maintenance of soil fertility. Group dynamics activities aim to build stronger farmer cohesion, trust and cooperation.

FFS curricula are usually decided in a joint effort involving farmer participants, FFS facilitators and consultant researchers, who collaborate on both the content and the set-up of field experiments.

In the course of the FAO-EU Programme, a total of 3,661 FFS were organised, educating nearly 94,000 farmers. Sixty-one percent of these were financed from EU funds. The Programme succeeded in building a training capacity of more than 50,000 farmers per year. With the help from National and State/Provincial Governments and other donors, two-thirds of the available facilitators conducted FFS in 2004, reaching more than 30,000 farmers in China, India and Pakistan.
Farmer-to-farmer field schools (F2FS) involved skilled farmer-facilitators training other farmers in an FFS, allowing enthusiastic FFS graduates to share their new skills and experience with fellow farmers. It was demonstrated to be a major component of sustainable IPM practice. In the Programme member countries, such field schools were first implemented in Vietnam in 2000 and 2001. This was followed by China and Bangladesh in 2002 and India and Pakistan in 2003. Farmer-to-farmer field schools complemented the regular FFS by government facilitators, established ownership among farmers and thereby contributed to the long-term development and sustainability of IPM.

Farmer-facilitators were selected from among farmer field school graduates. Before conducting their own farmer field schools, they attended a farmer ToF (FToF) course. At the FAO-EU Programme, more than 12,000 farmers were educated by fellow farmers. Especially in India, China and Pakistan, farmer-to-farmer education has become an important vehicle for IPM expansion.
Farmers as facilitators have as advantages their extensive farming experience and that they “think like farmers”. However, the cost benefit of using farmer-facilitators needs further investigation, since their operational range and availability is more limited than that of government staff. In the long run, the major role of farmer-facilitators may be as alumni group leaders for follow-up knowledge-generation and social mobilisation activities, rather than as facilitators of new FFS.
Although they were not part of the original project design, increased attention was given to the sustainability of FFS alumni groups. It was stressed that an FFS starts with the graduation ceremony; it does not end with it. Consequently, FFS became an important entry point to a wide range of multi-disciplinary farmer field research and social mobilisation activities.

Post-FFS activities can be divided into farmer-to-farmer education; cotton production related field trials; IPM initiatives on other crops; income generation; and social/community activities.

Most country projects actively supported farmer research through the Participatory Technology Development approach. Farmers decided on the issues to be studied, many of which stemmed from topics raised during FFS sessions. Examples of such research were: conservation and improvement of soil fertility through the use of compost and nitrogen-fixing crops; efficient use of fertilisers; the testing of cotton varieties; evaluating Bt cotton in Shandong and Hubei provinces of China, experimentation with spacing and planting densities; the use of trap crops to reduce pest damage; the timing and dosage of pesticide applications; and the use of ‘organic’ pesticides such as neem-tree extracts, nucleopolyhedrosis virus (NPV) solutions, garlic and chilli mixtures, soap, etc. In Pakistan, additional training in field experimentation was offered to prepare farmers for a more scientific approach.

Many FFS alumni groups also applied the IPM principles to other crops. For example, female participants in Bangladesh considered their participation in cotton IPM useful since they could apply the principles learned to vegetables.

Many farmer clubs generated income through membership fees, communal cotton production, production and sale of neem-tree based pesticides,
artificially reared natural enemies (*Trichogramma*) or vermi-compost. In Bangladesh, one group started a communal dairy farm and another group gave credit to members to allow them to postpone their sale of cotton until a time when prices were higher.

Some alumni clubs embarked on social-cultural activities for the benefit of the village. In India, mass-marriages were arranged for poor villagers who could not afford the costs involved in a wedding; in Bangladesh, literacy classes were organised; in Pakistan, communities built bridges over irrigation canals and set up clinics, and women alumni organised sewing and vegetable seed production activities for extra income.
Training of Facilitators (ToF) is a field-based, season-long residential learning experience involving up to 30 future facilitators at a time. During the course, participants improve their technical expertise in IPM; develop participatory, non-formal adult education training skills; and enhance their management and experimental capabilities. The curriculum consisted of ecosystem analysis; crop development and management; decision-making; participatory educational process; organisation and planning; gender sensitivity; and group dynamics. It was annually revised based on previous experiences. During the ToF courses, participants practised FFS implementation by conducting full-season ‘practice FFS’ as part of the curriculum. After graduation they were able to implement FFS independently.

The original prime objective of the FAO-EU IPM Programme was to develop a cadre of IPM facilitators capable of educating 50,000 farmers per year. During the Programme, 54 season-long ToF courses were conducted, of which 25 were EU financed (against 21 planned). A total of 1,542 participants graduated from these courses. Most graduates were government field and extension staff, but they also included NGO employees in some countries. In China, Vietnam and the Philippines, additional 285 IPM facilitators that had previously been trained in rice or vegetable FFS were given refresher courses to conduct cotton FFS.

However, it was not only training capacity that needed to be developed, but also management capacity. As the Programme grew, an increasing number of the most experienced field staff were therefore assigned to assist in project implementation as district and provincial coordinators and expert facilitator coaches.
ToF Courses and Graduates in the Programme Countries  2000-2004

<table>
<thead>
<tr>
<th>Country</th>
<th>Total FAO-EU Programme</th>
<th>Government/Others</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. Graduates</td>
<td>No. Graduates</td>
</tr>
<tr>
<td><strong>BANGLADESH</strong></td>
<td>3</td>
<td>103</td>
</tr>
<tr>
<td><strong>CHINA</strong></td>
<td>8</td>
<td>225</td>
</tr>
<tr>
<td><strong>INDIA</strong></td>
<td>26</td>
<td>687</td>
</tr>
<tr>
<td><strong>PAKISTAN</strong></td>
<td>12</td>
<td>325</td>
</tr>
<tr>
<td><strong>PHILIPPINES</strong></td>
<td>1</td>
<td>80</td>
</tr>
<tr>
<td><strong>VIETNAM</strong></td>
<td>4</td>
<td>122</td>
</tr>
<tr>
<td><strong>TOTAL PROGRAMME</strong></td>
<td>54</td>
<td>1,542</td>
</tr>
</tbody>
</table>

Maintaining the quality of FFS implementation was a major Programme concern. Impact assessment activities helped focus attention on project results and clarified country strategies for goal achievement. The Programme improved its monitoring and reporting system and developed checklists for key processes; it started *Annual Planning and Refresher Practica* to strengthen facilitation skills and organisational development; it set up farmer and facilitator research activities for continuous learning, knowledge generation and improvement; it established farmer alumni groups and district facilitator meetings as “quality circles” to self-assess and improve project activities.
Neither the training nor utilisation of farmer facilitators was envisaged in the original Programme document. However, based on the developments and experiences of the FAO Regional Community IPM Programme, farmer facilitators were already widely adopted at the start of the Programme in 1999.

Following this trend, all Cotton IPM member countries except the Philippines organised farmer ToF (ToF) courses. By the end of 2004, 979 FFS alumni were trained as farmer facilitators in 44 FToF; of these, 33 were EU-funded.

The training of farmer-facilitators varied from country to country. In Bangladesh and Vietnam, FToF were season-long experiences, starting with 10-14 day refresher courses focusing on organising FFS and facilitation skills. This was followed by weekly sessions and practice FFS. In China, FToF lasted for only 10 days during which farmer-facilitators were trained in aspects of FFS organisation, including facilitation skills and technical issues. In Pakistan, farmers met 3 days per week for an entire season and conducted a practice-FFS. In India, after a 2-week introductory course, farmers were teamed up with experienced facilitators to conduct field schools.

As this activity emerged in the penultimate year of the Programme, it challenged national IPM programmes to sustain the use and expansion of farmer facilitators, which are seen as an important element for the long-term sustainability and expansion of IPM-FFS activities.
<table>
<thead>
<tr>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>BANGLADESH</td>
<td>6/90</td>
<td>6/90</td>
<td>-/ -</td>
</tr>
<tr>
<td>CHINA</td>
<td>16/296</td>
<td>16/296</td>
<td>-/ -</td>
</tr>
<tr>
<td>INDIA</td>
<td>11/376</td>
<td>3/105</td>
<td>8/271</td>
</tr>
<tr>
<td>PAKISTAN</td>
<td>5/154</td>
<td>2/71</td>
<td>3/83</td>
</tr>
<tr>
<td>PHILIPPINES</td>
<td>-/-</td>
<td>-/-</td>
<td>-/-</td>
</tr>
<tr>
<td>VIETNAM</td>
<td>6/63</td>
<td>6/63</td>
<td>-/ -</td>
</tr>
<tr>
<td>TOTAL PROGRAMME</td>
<td>44/979</td>
<td>33/625</td>
<td>11/354</td>
</tr>
</tbody>
</table>

In view of the importance of expanding cotton IPM through farmer-to-farmer education, it was vital to monitor the effectiveness of farmer facilitators. The Indian project developed a model for quality assurance monitoring of FFS, F2FS and alumni groups. District officers monitored administrative aspects while 3-4 FFS facilitators monitored technical and communication aspects. In Pakistan, IPM and FFS quality indicators were developed and field-tested.
The FAO-EU IPM Programme for Cotton in Asia had six participating countries: Bangladesh, China, India, Pakistan, Philippines and Vietnam. While most Programme activities were financed by the European Union, additional contributions and funding came from national and local governments, and even from farmers. In Pakistan, the FAO-EU Programme was implemented together with an Asian Development Bank cotton IPM project and an Arab Gulf Fund contribution under the umbrella of the National IPM Programme.

Project results were achieved at three different levels: farmers, institutions and policy. Project activities on each of these levels followed one and the same learning cycle starting with observation and collection of data, proceeding to their collective analysis and discussion, and coming full circle with the planning of new and improved activities. Thus, in the cycle, learning farmers were augmented by learning facilitators and institutions in order to achieve a complete and holistic system development approach that may affect national policies and regulations.
In Bangladesh, the project succeeded in training the number of field school facilitators required to reach the targeted number of farmers in the main cotton growing districts. Half of these facilitators were farmers themselves. However, they still need to conduct enough farmer field schools to reach the critical numbers of farmers necessary for a durable momentum for community change.

The Programme has been able to set the direction for change in the minds of 3,700 farmer beneficiaries. Cotton IPM alumni have shown enhanced management of their cotton fields and also applied newly-acquired confidence and skills to managing other crops, not to mention certain aspects of their personal lives. Compared to their neighbours, FFS farmers have shown themselves more ready to share their knowledge and help other farmers in such activities as field trials. Potential leaders amongst IPM alumni have emerged. These core groups of farmers have become a valuable resource to their communities, improving the conditions of poor farmers in terms of income-generating capacity, food security, occupational health and environmental conservation. In effect, the project helped mobilise the country’s social capacity in cotton growing districts.

FFS graduates have been able to reduce their pesticide applications from 15-20 to 2-3 sprays per season, with the consequent positive impact on the environment, farmers’ health, cotton yield and income. Moreover, with new strategies, such as intercropping vegetables with cotton, farmers have discovered through their own field studies that they can increase profits by as much as 75% compared to growing cotton alone. The success of the project is reflected in the enthusiasm and interest of the farmers, who have started applying IPM in their own fields or experimenting with new
ideas. On field days, neighbouring farmers, village leaders and elders have enjoyed learning about the IPM process from FFS farmers interacting with them. The positive experience has inspired many FFS graduates to help as farmer facilitators. Besides being a more cost-effective training alternative, the initial group of farmer facilitators demonstrated that they could successfully conduct field schools and supplement the government’s rural extension system.

COUNTRY PROFILE

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>% Rural poverty</td>
<td>53%</td>
</tr>
<tr>
<td>Annual pesticide use</td>
<td>12,000 t</td>
</tr>
<tr>
<td>Cotton area</td>
<td>40,000 ha</td>
</tr>
<tr>
<td>Cotton farmers</td>
<td>80,000</td>
</tr>
<tr>
<td>FFS farmer cotton plot size</td>
<td>0.35 ha</td>
</tr>
</tbody>
</table>

PROJECT PROFILE

Project implementing institution:
Cotton Development Board (CDB) with support from the Department of Agricultural Extension

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>No. ToF / FToF</td>
<td>9</td>
</tr>
<tr>
<td>No. IPM-FFS facilitators</td>
<td>193</td>
</tr>
<tr>
<td>No. FFS / F2FS</td>
<td>148</td>
</tr>
<tr>
<td>No. FFS farmers</td>
<td>3,700</td>
</tr>
</tbody>
</table>
In the vast cotton production areas of the Yangtse and Yellow River basins in China, the cotton IPM project focused its attention on about two dozen townships in the provinces of Anhui, Hubei and Shandong, and a few locations in Henan and Sichuan. The Programme succeeded in establishing a strong team of young and gender balanced facilitators. ‘Science by farmers’ and team building were major components of the facilitator training curriculum. Farmer education in IPM resulted in reducing pesticide applications from around 12 to 7 per season, both for farmers directly participating in FFS and their neighbours.

The FAO-EU project in China was successful according to a number of criteria. In spite of the Government’s strong push towards higher production through genetically modified Bt cotton, IPM remains a vital component of the country’s long-term cotton strategy and is relevant to the country’s perceived needs. IPM field schools can add significant value to the use of Bt cotton. The commitment of provincial and local governments to co-financing FFS throughout the project period is a strong indication of national interest in IPM implementation. However, there is a need to extend IPM methods to entire farming systems and for the conservation of China’s rich agro-biodiversity.

Farmer research showed that Bt cotton reduces the need for pesticide applications against bollworm and thereby complements IPM, but may not contribute substantially to profitability due to its higher seed cost. An independent study conducted in cooperation with Hannover University in Germany demonstrated the importance of seed quality for the benefits that can be achieved from Bt cotton. The normal farmer practice of saving seed or purchasing low-priced uncertified new Bt seed may lead to substantially reduced bollworm control. The Hannover study also showed that Bt varieties alone
without IPM did not always lead to a lower number of sprays and that high quality seed with no sprays resulted in only average yields. Since the adoption of Bt, farmers have reported the emergence of previously unreported insects as new pest problems and pesticide use appears to be on the rise again in some Bt cotton areas, signalling a sustained need for IPM despite the widespread adoption of Bt cotton.

Farmers’ perception on changes of cotton insects since Bt adoption

<table>
<thead>
<tr>
<th>Insect</th>
<th>Decrease</th>
<th>Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>White butterfly</td>
<td></td>
<td>71.7%</td>
</tr>
<tr>
<td>Lygus bug</td>
<td></td>
<td>44%</td>
</tr>
<tr>
<td>7 spot ladybird</td>
<td>53.5%</td>
<td></td>
</tr>
<tr>
<td>Small lady bird</td>
<td></td>
<td>56.5%</td>
</tr>
<tr>
<td>Boll weevil</td>
<td></td>
<td>52.6%</td>
</tr>
<tr>
<td>White fly</td>
<td></td>
<td>98.5%</td>
</tr>
<tr>
<td>Aphid</td>
<td>53%</td>
<td></td>
</tr>
<tr>
<td>Cotton bollworm</td>
<td>99.3%</td>
<td></td>
</tr>
<tr>
<td>Spider mite</td>
<td></td>
<td>59.7%</td>
</tr>
</tbody>
</table>

From: D. Pemsl, Productivity Analysis of Bt-Cotton: A case study from China, 2003
The FAO-EU project had a remarkable impact in the central Indian States of Karnataka and Maharashtra and to a lesser extent in Andhra Pradesh. In those states, farmer field schools have been accepted as the model for government-farmer interaction, and state funds have been allocated to continue and expand project activities. To secure the success of these ambitious plans, continued technical assistance is required, otherwise a decade of substantial IPM gains in India and the achievements of the FAO-EU Programme might become undone.

The project achieved its implementation targets due to the keen interest of the State governments and cooperating NGOs in sustainable rural development. A total of 26 ToF were conducted, as compared to a target of seven, and 1,456 FFS compared to 1,220. State governments contributed significantly to the continuity of the IPM-FFS programme. They assigned 600 trained extension staff to promote IPM in 2004 and allocated funds for ToF, FFS and F2FS, as well as for the support of 380 FFS alumni groups. State governments also contracted NGOs or individual farmer facilitators (IPM entrepreneurs) to conduct FFS on cotton and other crops.

NGOs were significant partners in project implementation, especially on organic cotton and in their support of farmer clubs. The project employed
a special officer in charge of NGO liaisons. A total of 109 NGO staff were trained as facilitators and conducted their own FFS with financial support from the project or state governments. One NGO, which was also in charge of the impact assessment study, continued to develop sustainability and quality assurance for its own FFS.

Women’s participation in FFS increased from 7% in 2000 to 20% in 2004. This was particularly significant since a socio-economic and gender analysis of cotton production showed that: women provide 64% of the work; the crop is often collaboratively managed by husband and wife; and 50% of female-headed and marginal (women-run) households grow cotton. To stimulate women’s participation, 66 FFS were held exclusively for women (where husbands attended as ‘observers’), many of them illiterate. Exercises on pesticide poisoning and the adverse effect of pesticides on the environment and community health helped to stimulate the women’s interest in FFS and strengthened their decision-making power and control over resources.

### COUNTRY PROFILE

<table>
<thead>
<tr>
<th>Metric</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Rural poverty</td>
<td>30.2%</td>
</tr>
<tr>
<td>Annual pesticide use</td>
<td>40,000 t</td>
</tr>
<tr>
<td>Cotton area</td>
<td>8,800,000 ha</td>
</tr>
<tr>
<td>Cotton farmers</td>
<td>10,000,000</td>
</tr>
<tr>
<td>FFS farmer cotton plot size</td>
<td>1.8 ha</td>
</tr>
</tbody>
</table>

### PROJECT PROFILE

Project implementing institution:
Directorate of Plant Protection Quarantine and Storage, Department of Agriculture

<table>
<thead>
<tr>
<th>Metric</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. ToF / FToF</td>
<td>37</td>
</tr>
<tr>
<td>No. IPM-FFS facilitators</td>
<td>1,106</td>
</tr>
<tr>
<td>No. FFS / F2FS</td>
<td>1,456</td>
</tr>
<tr>
<td>No. FFS farmers</td>
<td>35,828</td>
</tr>
</tbody>
</table>
The FAO-EU Programme had perhaps its greatest impact in Pakistan. The country did not have previous experience with IPM field schools, and yet, as of 2004, the two main cotton producing provinces, Sindh and Punjab, have embraced IPM farmer field schools as the dominant interface between government and farmers. FFS fills a need that regular extension apparently has not been able to satisfy. Senior officials have acknowledged IPM-FFS as an approach that is able to enlist farmers in rural development programmes. Therefore, Sindh Province has included FFS expertise in the job description of its agricultural officers, and Punjab has launched a major programme expansion initiative to conduct 3,500 year-long FFS in cotton-wheat management over the next 4 years. Reduction of production costs through lower pesticide use is recognised as an important element in the competitive position of Pakistani cotton in the world market.

In Pakistan, the FAO-EU Programme helped establish a strong National IPM Programme which not only became the joint implementing unit for the EU and ADB funded projects, but also addressed pesticide policy issues with ministerial decision-makers. Despite a powerful pesticide industry, the country has embarked upon its own National IPM Project that will cover four provinces and last five years. This project will be entirely funded from national and provincial sources. However, the young National IPM Programme requires continued technical assistance in order to become a significant player in sustainable rural development and poverty reduction. Impact studies in Pakistan have shown that the number of FFS farmers below the official poverty line was reduced by 12% as compared to a control group within three years.

NGOs and inter-governmental agencies such as CABI Bioscience, World Wildlife Fund, Caritas,
Plan Pakistan, and local welfare associations became active partners in the implementation of FFS. To encourage women’s participation, an AGFUND initiated project on “Pesticide Risk Reduction for Women in Pakistan” focused on training female facilitators to reach rural women in the traditional, gender-segregated society through Women Open Schools. Emphasis was on the toxicity and health risks of pesticides, but other elements in the cotton-based farming systems were also included. A total of 968 rural women participated in this programme with additional support from Programme funds.

Significant social mobilisation and empowerment was evident from the formation of officially registered farmer alumni associations and associations of IPM facilitators offering facilitation services and farmer club support. In 2004, five of the latter organisations were contracted to implement 80 FFS.
Only a few project activities were implemented in the Philippines due to the minor importance of cotton in the country. Increased production costs and very low profits received by Filipino farmers for their cotton have led to a sharp reduction in the cotton area from 30,000 ha at the time of project formulation to 1,000 ha at project start. Even though there exists a strong National IPM Programme that has created a favourable policy climate for farmer field schools, cotton was no longer the crop to focus on.

Jointly implemented by the Cotton Development Authority (CODA) and the National IPM Programme, project activities focused on supporting existing facilitators from local government units in conducting FFS on cotton. A major problem encountered during the training was identifying enough cotton farmers. In Luzon, over 40% of all cotton growers were educated in FFS between 2001 and 2003. The Programme later shifted its attention to the cotton growing areas of Mindanao and Negros Oriental.

Cotton production is financed largely by private companies who contract with farmers for their output in return for seeds and other inputs (including pesticides) provided in kind. Under the project, CODA made an effort to gain the support of private companies for the FFS approach and
IPM in general. Acceptance of the project’s goals by the private companies would seem to be key for sustained implementation of project activities.

Cotton is the primary source of fiber for the Philippines’ important textile industry. It accounts for about 53% of the total fiber requirements of the country’s spinning mills. Without a significant domestic production of cotton, the country relies heavily on imports, averaging 58,000 metric tons valued at US$ 47 million, from the major cotton exporters such as the USA, Australia, and Pakistan.

Cotton production is potentially a technically feasible and economically viable industry in the Philippines, as proven by almost two decades of experience. In 1992, the cotton area reached over 35,000 hectares distributed over 25 provinces nationwide. During those early years, support services were provided by the government through PhilCotton. But when the government privatised commercial cotton production, the private business sector could not sustain a mutually profitable relationship with the cotton farmers. The advancement of the industry was constrained by inaccessible credit, policies favouring cheap imports and inadequate extension assistance.
In Vietnam, the FAO-EU project was implemented by the Vietnam Cotton Company (VCC) with some collaboration from the National IPM Programme, which has extensive experience with FFS in rice and vegetables. Every season, VCC signs contracts with growers under which it provides technical support, seeds, and inputs - including pesticides - and buys the crop at an agreed price. However, from the farmers' point of view, the economics of cotton production has deteriorated since 2002. In this setting, FFS education in farmer empowerment and independent decision-making appeared not to be well placed. Since pesticide use in rainfed cotton had already been reduced to 1-2 sprays per season, there was little opportunity for significant pesticide reduction, and farmer benefits from IPM-FFS came mostly from a better ecological understanding and increased confidence in field experimentation and knowledge generation.

By the end of the project, a total of 122 government facilitators from VCC and the National IPM Programme were trained. By March 2004, over 10,000 farmers had participated in cotton IPM farmer field schools.

The project commissioned a number of special studies. These included a gender study conducted by the Vietnam Women’s Union; a study on biological control-based integrated management of sucking cotton pests; and an impact assessment study. Both of the latter were conducted by the University of Agriculture and Forestry in Ho Chi Minh City. Two students from Wageningen Agricultural University in the Netherlands carried out field research on predatory wasps that are natural enemies of caterpillar pests in cotton.
IPM is well established in Vietnam and FFS are conducted well. However, there was only minimal financial support for IPM-FFS from national sources. While Vietnam’s official policy promotes IPM, some of the operational aspects still need to be strengthened and defined.
The focus of the Programme Management Unit in Bangkok was to add value to the country projects through regional workshops, exchanges and studies. Much of the Programme’s success was due to its regional character that

- accelerated implementation by promoting competition
- shared costs on common issues
- enhanced sustainability through optimising resources
- shared experience and knowledge
- avoided pitfalls
- built a regional database and expertise on impact assessment and
- promoted a better understanding between countries in Asia.

The following regional workshops and meetings were held:

- **Cotton IPM Planning and Curriculum Workshop**, Bangkok, Thailand, 28 February - 2 March 2000
- **Regional Workshop on Helping Farmers to Understand Microbial Organisms Used to Manage Pests**, Chainat, Thailand, 11 - 17 February 2001
- **International Meeting on Bt Cotton Study in China**, Bangkok, Thailand, 4 - 5 May 2001
- **Regional Meeting on Planning and Evaluation**, Ho Chi Minh City, Vietnam, 10 - 15 September 2001
- **Regional Workshop on FFS/ToF Curriculum Evaluation to Strengthen Farmer Education**, Dhaka, Bangladesh, 11 - 20 March 2002
- International Course on Weed Ecology for Cotton IPM, Pangasinan, Philippines, 22-29 September 2002
- Programme Steering Committee Meeting, Chizhou, Anhui, China, 8-15 September 2002
- Regional Seminar of IPM Impact Assessment, Ayutthaya, Thailand, 30 March - 4 April 2003
- Regional Workshop on Enhancing Facilitation Skills of IPM Facilitators, Cebu City, Philippines, 14 - 23 September 2003
- Regional Workshop on IPM-FFS Impact, Bangkok, Thailand, 30 June - 3 June 2004
- Regional Policy Seminar on IPM-FFS Impact, Bangkok, Thailand, 4 June 2004
Impact assessment was an integral part of the FAO-EU Programme, and it was used as an instrument for strategic planning and organisational development. In preparation for the seven impact assessment studies conducted by independent investigators, each country’s project stakeholders engaged in an intensive dialogue to define the impact targets and to formulate objectively verifiable indicators for successful implementation. This process was extended to FFS implementation by engaging farmers in monitoring and evaluation. Thus, systematic progress and quality monitoring of the Programme supplemented formal impact studies in assessing the direction and success of the Programme.

Cost-benefit analysis showed an internal rate of return on investment of 16% for the period of Programme implementation and only three seasons of project-funded farmer field schools. This confirms the high economic worth of investment in farmer education. It was conservatively assumed that the benefits from IPM-FFS would only occur with 80% of the project-trained farmers for a period of two years after training. Potential benefits from the Programme’s substantial long-term investments in training capacity were not included in these calculations.

Backed by credible evidence and convincing results of having increased farmer income while lowering environmental risks from pesticides, impact assessment also became a tool for policy discussions with ministerial decision-makers. At a Regional Policy Seminar on IPM-FFS Impact in June 2004, results from the impact studies in five countries were presented and discussed. It was concluded that the Programme contributed to the Millennium Development Goals of reducing poverty, empowerment of women and environmental sustainability, and to international treaties such as the International Programme on Chemical Safety, the Stockholm Convention on Persistent Organic Pollutants, the Rotterdam Convention for Prior Informed Consent and the Convention on Biological Diversity.
By targeting small-scale farmers and relying on ecological processes rather than expensive inputs, the FAO-EU Programme contributed positively to rural poverty alleviation. FFS graduates were shown to benefit from significantly higher profits which could be used for better nutrition, child education or debt reduction, ensuring a brighter future for their families.

As a result of IPM-FFS, the gross margin income (gross revenue from sales minus cash expenditures) of FFS farmers increased substantially by an average of $175 per ha or 23% relative to the control groups. This increase in income came mainly from two sources: higher cotton yields and reduced pesticide expenditures. While the average yield in the control group declined by 5% between the sample years, FFS farmers managed to increase their yields by 3% over the same period giving them a significant advantage of 8% more yield over control farmers while having reduced their pesticide costs by 46% or an average of $32 per ha.
Neighbours of FFS farmers also increased their income, though to a lesser degree. Compared to the control group, their gain was only $57 or 7%. These results indicate that there is a slight diffusion of benefits from FFS farmers to their neighbours in the same village. However, the decisive skills that determine the full economic benefit were only acquired by FFS participants. While attitudes, some kinds of knowledge and simple skills may easily diffuse to non-FFS farmers, the more complex skills of ecology-based pest management and informed decision-making that determined higher incomes was only found among FFS participants.

Since FFS participants were predominantly small-scale, poor and disadvantaged farmers, their household income increases contributed to poverty reduction. Figures from Pakistan showed that before the FFS education 71% of the participants were below the poverty line. After the FFS, this number fell to 55%, while it only fell by 4% in the control group. This 12% net decline in poverty over three years demonstrates the huge potential of IPM-FFS programmes to reduce rural poverty.
IPM significantly increased the biodiversity in agricultural fields by conserving natural enemies and maintaining sound ecological balances. By having observed and understood ecological interactions through self-discovery exercises during FFS, farmers became highly motivated guardians of natural enemies in their fields and avoided using pesticides out of conviction rather than because they were instructed to do so.

By targeting the crop that receives the biggest share of pesticides in Asia, the Cotton IPM Programme helped reduce environmental risks from toxic chemicals and improved biodiversity in large rural areas.

Overall results from the impact studies showed that after attending FFS, farmers reduced their insecticide use by an average of 43% relative to control farmers, who in some cases had even increased their usage. In addition, there was a noticeable effect on the entire village, as the FFS neighbours also reduced their insecticides by an average of 34%. After having heard about the bad effects of pesticides, these farmers simply followed their FFS neighbours, but without having gained the latters’ decision-making skills. The accumulated annual pesticide reduction is estimated at 1,800 tons fewer pesticides used on about 250,000 ha.
More differentiated analyses arrived at by computing the Environmental Impact Quotient (EIQ) for the pest control practices of FFS participants, suggested that the reduction in terms of environmental risk exceeded that of the pesticide amount. This indicates that FFS farmers selectively reduced the most harmful products because they understood their effects on the natural enemies in the environment.

Positive effects of IPM on the biodiversity in cotton fields were evident from data collected during FFS. Results consistently showed more natural enemies and higher species diversity in IPM plots as compared to the farmer’s fields. This was confirmed by post-FFS observations conducted in China which found that the late-season populations of spiders and ladybird beetles increased two to three fold. In Pakistan, the average predator-pest ratio increased from 0.72 in farmer fields to 1.06 in IPM plots. A comparison study in Bangladesh and India showed that the total number of insect species found in cotton fields increased by 45% in IPM fields. This increase was found to be mainly due to natural enemies, namely predators and parasitoids, which were almost absent in the conventional farmer practice plots.

Other positive environmental effects from IPM come from a reduction of nitrogen fertilizer and a rational “intercropping” with weeds, as a source of fodder for the animals or as herbs for human consumption. Though minor, the increase in plant biomass in IPM fields positively contributes to the absorption of carbon from the atmosphere.
Impact study data from countries with small plot sizes such as China and Vietnam indicated few poisoning cases. However, in India and Pakistan, where farmers spray two to three hectares, an average of three to eight workdays per season was lost due to poisoning, and medical expenditures of $14-36 per household were reported.

A detailed study in three Indian villages revealed that the incidences of pesticide poisoning were far more frequent than commonly reported. A group of 97 male and female farmers self-monitored for poisoning signs and symptoms within 24 hours after spraying pesticides for a period of 4 months. Of the 325 records, severe poisonings (seizures, unconsciousness) happened in 6% of cases; 38% recorded moderate signs such as nausea, tremors or blurred vision; and 39% had mild signs and symptoms such as dizziness, burning eyes, skin rashes or excessive salivation. Only in 16% of the sprays were no signs or symptoms recorded. Results showed that women farmers were also exposed to pesticides, as they frequently helped with the mixing of the pesticides or worked in the field during spray operations.
Consequently they were as often affected as male farmers who actually carried out the spraying. Surprisingly, low income marginal farmers with less than two hectares were found to be ten times more often subject to severe poisoning (10.2%) than landlords (1.0%) with more than eight hectares of land, showing that it is the poor who bear most of the burden from pesticide poisoning. The study also revealed that farmers sought medical treatments or stopped working only in severe cases — which are the only ones that enter official statistics.

Studies conducted in Pakistan showed that not only pesticide applicators are affected by pesticide poisoning, but also the thousands of farm workers - mostly women and children - who pick the cotton. Of the sample investigated, almost all (87%) women reported pesticide related sickness during the picking season and an average loss of five workdays, which is considerable as cotton picking may be the only opportunity for them to earn some cash during a year. The investigations showed that cholinesterase, an enzyme necessary for the proper functioning of the nervous system, was reduced to hazardous levels among 42% of such women. Results from these studies became the basis for a documentary film titled “Hands Picking Poison”.

IPM-FFS not only aims to eliminate unnecessary pesticide applications, it also aims to detoxify the farming environment by specifically removing highly toxic WHO Class I compounds. In Pakistan, for example, FFS farmers reduced the use of this class by 54%, while it more than doubled in the control group over the same period.
FS empowers farmers to create a safer working environment for themselves and their families. By becoming aware of negative health effects and ways to reduce pesticide applications, farmers can live without the fear of becoming poisoned, endangering their families and communities, or consuming contaminated farm products.

By improving their observation skills and analytical capacities through self-discovery learning exercises (e.g. ecosystem analysis and insect zoos) farmers enhance management skills, which can then be applied to many aspects of life.

Pre- and post-FFS ballot box tests generally showed a 20-30% increase in scores. The impact studies verified that FFS farmers retained their knowledge and skills, and results showed that FFS graduates had higher levels of pest recognition, knowledge of natural enemies, improved observation, record keeping and decision-making skills than non-FFS and control farmers. There was little diffusion of newly gained knowledge and skills to exposed farmers in the same village, confirming that - contrary to information and recommendations - skills have to be individually learned and practiced, and do not diffuse to neighbours.

Social recognition was used in Pakistan as an indicator of the organisational capacities of FFS farmers. It measured the degree to which FFS graduates were consulted by fellow farmers. The score increased significantly for FFS graduates, but not for exposed farmers and control farmers.
Interestingly, not only the educated farmers enjoyed increased social recognition, but also illiterate farmers.

By encouraging women to attend FFS, the project provided new learning opportunities to women and increased social awareness of gender roles. The average female participation in FFS was 21%, ranging from 2% in Pakistan to 33% in China. Because mixed FFS groups are culturally unacceptable in certain societies, special FFS for women were set up in India, Pakistan and Bangladesh.

FFS graduation ceremonies were to mark the beginning of a learning process, not its end. Though this could not be followed up in the course of the Programme, experience has shown that through it farmers have been enabled to generate new knowledge, conduct field experiments and organise themselves better. In 2004, the Pakistan National IPM Programme organised three farmer congresses for representatives from 180 alumni FFS who decided to organise themselves into a national organisation. By the end of the Programme there existed on village and district levels 56 registered FFS-alumni chapters that were devoted to continuing farmer education on a self-help basis. In India, the Governments of Karnataka and Maharashtra and Andhra Pradesh provided financial support for 380 alumni groups to continue knowledge generating and community development.
Once again, farmer field schools and integrated pest management have proven to be a powerful combination for achieving comprehensive sustainable development for small-scale farmers who are searching for a way out of the vicious cycle of increasing costs and reduced profits. These result from the disrupted ecological processes in their fields which are caused by excessive use of pesticides and other agricultural inputs. In the short period of implementation, the FAO-EU Programme has demonstrated that this approach not only increases the income of poor farmers, it also enables them to conserve agricultural biodiversity, improve community health, become better managers of their resources and work more effectively with fellow farmers in a self-reliant manner to improve the livelihoods of their families and communities.

The achievements of the Programme were confirmed during two independent review missions that were carried out in 2002 and 2004:

A mid-term review took place from 27 October to 18 November, 2002.
Jeff Waage - Team Leader, IPM specialist
Robert Moore - Evaluation specialist
(FAO Evaluation Service)
Marc Debois - Environment specialist
(EU representative)
Lawrence Shaw - Agricultural economist
Edith van Walsum - Rural development/gender specialist
Piao Yongfan - Representative of member countries

A final project review took place from 13 August to 3 September, 2004.
Niels Röling - Team Leader, Agricultural Knowledge and Information Systems
Robert Moore - Evaluation Specialist
(FAO Evaluation Service)
Sandhya Chatterji - Rural development/gender specialist
Alida Laurense - IPM specialist
Josef Margraf - Environment specialist
Iftikhar Ahmad - Representative of member countries
The mid-term review team concluded that the Programme was well on track to meeting its objectives. There was strong evidence of post-FFS changed farming practices, farmer engagement and enthusiasm, and governments were committed to supporting and co-financing training activities. Convincing plans to realise the targets of 21 TOF and at least 3,800 FFS were in place, as well as a system for impact analysis. The review team strongly supported the new emphasis by the Programme on the training and evaluation of farmer facilitators as a basis for potential Programme expansion and intensification.

In view of this good progress, the review team recommended that the country projects place more emphasis on building collaboration (i.e. with NGOs, researchers, and the private sector) and supporting policy change, particularly with respect to national IPM initiatives and pesticide regulation. With such an emphasis, promising initial steps in certain countries could be shared across the Programme.

The review team examined several specific activities. Studies undertaken by farmers and facilitators in China on IPM and genetically modified Bt cotton have shown the critical role which IPM education plays in the success of biotechnology for development. The Programme has made a concerted and valuable effort to understand the role of women in cotton IPM, and
now should act on this to increase their involvement in training and other project activities. Information coordination and dissemination within the Programme should now also include outward communication. Health, specifically pesticide effects, and pesticide regulation were identified as emerging issues deserving more attention by the country projects in future.

The review team paid particular attention to the challenging issue of the spread and sustainability of IPM. It concluded that this requires exploration of scaling-up models for farmer education, action at the national level to reduce pesticide use on cotton, and steady engagement of the research community and NGOs. It was recommended that the Programme make important steps in this direction (e.g. increasing FTOF), even though a full evaluation of this potential would not be achieved in the Programme period. The review team therefore recommended that an identification mission be made in 2003 to explore opportunities for extending the Programme to more countries and, perhaps, to other farming systems with unsustainable and unhealthy pesticide dependency.
The final review team concluded that the FAO-EU Programme has had a significant impact in participating countries where cotton is an important crop (i.e. China, India, Pakistan), in terms of uptake of results by national governments. In countries where cotton cultivation is a minor activity, such as Bangladesh, the Philippines and Vietnam, the farmer field school approach has demonstrated the rigour of this approach in enhancing skills of farmers to improve their livelihoods in a cotton-based cropping system.

Overall, the Programme has been especially successful in China, India and Pakistan. This impact has convinced the review team that farmer field schools should receive high priority, also in terms of awareness raising. Major donors such as the EC and many staff within the FAO itself are familiar with IPM as a technical subject, but not of the farmer field school as an essential component of it.

It was recognised that the Programme has made a major contribution to the development of the IPM-FFS approach. This was mainly due to the fact that the Programme had built in impact assessment and quality monitoring from the start. These activities have led to new and useful insights into the risks and vulnerabilities of the field school approach that should be actively pursued to further develop the approach.
The success of the Programme in convincing governments of major developing countries of its value, led the review team to the conclusion that FAO should move away from its emphasis on crops, IPM, pesticides, etc., and towards a new framing of the farmer field school within the international donor community. This reframing should emphasise biodiversity, poverty reduction, the education of rural people, water management and other Millennium Development Goals in which field schools have a proven track record.
REMAINING CRITICAL ISSUES AND OPPORTUNITIES

Recognising the achievements made and the lessons learned, the potential for a major activity on rural poverty alleviation would be a natural follow-up. This environmental risk reduction activity would improve the livelihoods of millions of small-scale cotton farmers resulting in protecting the agro-biodiversity of cotton-based production systems. By fully exploiting the FFS training capacity of more than 50,000 farmers per year and supporting partner countries in their efforts to expand and integrate this approach into their rural development and extension reform strategies, a target of improving the livelihoods of 3-5 million small-scale farmers is within reach.

The commitments by provincial and local governments in China, India and Pakistan are at risk of falling apart or being sidetracked. Failures of the ambitious expansion plans could seriously throw back IPM-FFS promotion in Asia. In order to secure the investments made by the FAO-EU Programme, several critical issues and opportunities remain for the countries, where the Programme has had a significant impact:

**China**
- Cotton IPM needs to be extended to Western China and to include other crops, and should also address conservation of China’s precious agro-biodiversity.
- Additional impact assessment studies involving more villages and ecological conditions and long-term data are necessary to give a more comprehensive picture.
- Genetically modified Bt cotton is of concern due to the apparent emergence of new pest problems and a rise in pesticide uses. Lessons learnt from China are relevant to India and Pakistan.
India
- The planned rapid expansion of FFS by State Governments requires investments in quality assurance, follow-up and refresher training in educational and empowerment aspects which are not yet in place.
- A national IPM Programme could facilitate expansion into other states
- Umbrella FFS alumni organisations could provide important incentives for group sustainability, especially for rural women.
- Impact assessment studies should investigate the long-term impact on the farmers educated in 2001.
- Experiences in organic cotton cultivation, gender issues and health monitoring as follow-ups to IPM-FFS should be shared with other countries.

Pakistan
- The locally-funded National IPM Project faces risks related to organisational aspects such as inflexible release of funds for FFS implementation.
- The rapid expansion of IPM-FFS planned by Punjab demands exceptional attention to quality assurance and improved facilitation skills.
- The newly formed local and regional associations for FFS alumni farmers and IPM facilitators risk disillusionment without start-up assistance and a supporting umbrella structure.
- Impact assessment studies should be expanded and should investigate the long-term (3-4 years after FFS) impact.

Potential for Major Impact on Small-scale Farmer Livelihoods
Environmental Education for Poor farmers