Expl. Agric. (2007), volume 43, pp. 97–112 © *2006 Cambridge University Press*
doi:10.1017/S001447970600425X *Printed in the United Kingdom*

EVALUATING COTTON INTEGRATED PEST MANAGEMENT (IPM) FARMER FIELD SCHOOL OUTCOMES USING THE SUSTAINABLE LIVELIHOODS APPROACH IN INDIA

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(*Accepted 8 August 2006*)

SUMMARY

Farmer field schools (FFSs) were conducted in southern India to reduce pesticide input and enhance sustainability of cotton production systems. This study was carried out to determine the additional benefits of FFSs in the social and economic arena, using the sustainable livelihoods (SL) concept to frame the evaluation. Farmers who had participated in the integrated pest management (IPM) FFSs perceived a range of impacts much beyond the adoption of IPM practices. The reduced cost of cultivation allowed for financial recovery from debt and the building of physical assets. IPMFFS households and production systems were perceived by the participants to have become more economically resilient than Non-IPMFFS control groups when faced with adversity. In the participants' view, IPMFFSs also led to enhanced individual and community social well-being, a benefit valued in particular by the women participants. The study tested a new application of the SL conceptual framework as a tool for evaluation.

INTRODUCTION

Farmer field schools (FFSs) provide people-centred learning experiences that promote the empowerment of farmers through education. Weekly training sessions are conducted in the villages for a group of 25–30 farmers by expert facilitators during the cropping season. Unlike most previous integrated pest management (IPM) training held in the country, in FFSs the curriculum is developed in collaboration with farmers to address their most relevant agro-ecological problems with locale-specific solutions. FFSs were first applied on a wide scale in 1989 in Indonesia in order to reduce reliance on pesticides in rice by enhancing farmers' understanding of crop ecology (Kenmore, 1996). In India, FFSs have been organized for a number of crops, and especially with the aim of reducing the massive use of pesticides in cotton production. The training curriculum has engaged researchers, extension agents and farmers in on-site participatory research to compare IPM options with the farmer practices currently in use. IPM management decisions are based on the results of an agro-ecosystem analysis of field observations and measurements carried out by the farmers. The critical

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thinking and dialogue encouraged among participant farmers by the analytical process are considered central to the experiential learning process. Farmers are expected to increase their knowledge but, even more, to master new management skills based on an informed understanding of what is happening in their own fields, and to develop independence from the recommendations circulated by the extension service and pesticide salesmen. These recommendations promote heavy use of agricultural inputs (fertilizers and pesticides) that result in a decline in natural enemies and resurgence of insecticide-resistant pests in rain-fed cotton fields in southern India. As farmers take out loans to pay for the inputs, they become dependent on moneylenders and continued pesticide use, which is frequently ineffective and uneconomic. Any reduction in pesticide use as a result of FFSs is seen as a desirable outcome that increases farmers' profits, but also protects people's health. The extent of pesticide poisoning occurring in the cotton farming communities as a consequence of the massive use of highly toxic products has been documented since the beginning of the 1990s.

This study took place in the context of the FAO-EU-Government of India IPM Programme for Cotton in Asia that was implemented in southern India from 1999 through 2004. The cotton IPMFFSs devoted significant time to team-building activities and emphasized participants' self-development, partnership and collaboration. They led in many instances to local post-FFSs self-development projects following the farmers' own interests. Farmer alumni groups were formed in the villages the year after the conclusion of the schools, not only to continue experimenting on crop production methods but also to organize social activities for the benefit of other members of the community. The IPMFFS sessions also became, in some cases, a space for women to express their views outside the house walls, and an opportunity for them to participate in large farmers' gatherings and in official meetings with policy makers. Women farmers in a selected sample of the cotton IPMFFSs were trained to identify the signs and symptoms of acute poisoning and to analyse the consequences of unsafe pest management behaviour (Mancini *et al.*, 2005). Women were particularly involved in assessing the safety of their households, water sources and food in relation to the storage of chemical products.

It follows that the impacts of the cotton IPMFFSs could be expected to go well beyond a decrease in pesticide use, to include effects on the environment, health, social organization and human capital, i.e. they could be expected to initiate a process of capacity building that leads to people's empowerment. Evaluation methods therefore were needed that go beyond a pre-determined agricultural focus to appreciate the broader effects that might result from educating farmers, and that capture farmers' own appreciation of these values. Participatory methodologies, either used together with conventional methodologies (such as standard questionnaires) or on their own, have gained increasing support (Jiggins, 2003; Mohr, 1999). Some authors even consider 'independent' evaluation as contradictory to the principles of activities that support people's empowerment (Bartlett, 2005). The literature on IPMFFS evaluation offers a number of studies that have addressed specific impact categories, using either qualitative or quantitative methodologies and including participatory, conventional and hybrid approaches (e.g. for pesticide use (Feder *et al.*, 2004; Wu *et al.*, 2005), for

changes in knowledge and attitude (Rola *et al.*, 2002; Reddy and Suryamani, 2004) and for health effects and costs (Rola *et al.*, 1993)).

This study tests an evaluation framework that guides farmers in conceptualizing changes over time in their overall livelihood. It formed part of a larger monitoring and evaluation (M & E) effort (2003–2005) in the same farming communities that has used a mix of conventional and participatory methodologies to triangulate findings. A complementary effort to capture IPMFFS participants' perception of their experience was also made, using a photo-visioning method (Mancini and Jiggins, unpublished data). The framework used in this study draws on the definition of sustainable livelihoods (SL) formulated by Chambers and Conway (1992):

> '*A livelihood is held to comprise the capabilities, assets, and activities required for securing a means of living. A livelihood is considered sustainable when it can cope with and recover from stresses and shocks; maintain or enhance its capabilities and assets in the present and through time, without degrading the natural resource base.*'

The concept was operationalized in the early 1990s by a number of development agencies (e.g. DFID, Oxfam, CARE, UNDP) as a guide to programme development and a sizeable bibliography on this application is available in the on-line libraries of the organizations concerned (www.careinternational.org.uk/CARE+International%27s+Livelihoods+Approach+5214.twl; www.livelihoods.org/index.html; www.dfid.gov.uk; www.undp.org/sl/ Documents/documents.htm). The SL also has been adapted for evaluation purposes (Haan *et al.*, 2002), but has never been used to assess IPMFFSs. The present study has adopted the UK Department for International Development's framework because its operationalization through spider diagramming appeared to be particularly suited to the reaserch objective. It serves as a guide to assessing SL in an holistic but flexible perspective (Haan *et al.*, 2002), without using pre-defined indicators. It allows for links between changes in different capitals to be revealed. The aim of the study was to test the SL framework to document the emic perception of change in people's livelihoods since they attended IPMFFSs (or over the same time period without IPMFFSs for the control groups). Two case studies are presented: case 1 reports farmers' perceptions of changes over time after a favourable cropping season in Warangal District, while case 2 reports farmers' perceptions of change during a severe drought. In conclusion, the article presents an analysis of the limitations and strengths of the framework.

MATERIALS AND METHODS

Study area

Cotton IPMFFSs were held in 2002 in Dharwad District, Karnataka State and in 2003 in Warangal District, Andhra Pradesh State. Cotton was grown as the main crop during the rainy season on 119 and 125×10^3 ha, in Warangal and Dharwad Districts, respectively. Calendar-based applications (up to 19 per season) of pesticides, including applications of highly toxic products (24 % of the total quantity), are practised by the

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Table 1. Sample size of participants in IPMFFS, Non-IPMFFS and control villages by gender.

By gender	IPMFFS	Non-IPMFFS	Control	Total
Men	12	12	23	47
Women	13	9	26	48
Total	25	21	49	95

IPMFFS = participants in IPMFFSs, Non-IPMFFS = farmers living in IPMFFS villages, but not themselves participants, Control = farmers living in villages where IPMFFSs have never been conducted.

majority of growers (PRDIS, 2003). Yet yields, constrained by pest losses, scarcity of water and declines in soil fertility, are among the lowest in the world – 221 kg ha^{-1} for 2004 (ICAC, 2005), against the world average of 603 kg ha^{-1}.

Sampling

Six IPMFFS villages from the pool of schools organized in the two districts, and six control villages within the same agro-ecological zone but at least 20 km away from the IPMFFS villages, were selected for the study. A total of 95 respondents were invited to participate in the assessment. Participation was free and no incentives were provided. The following three categories were included: IPMFFS = male and female farmers trained in IPMFFSs; Non-IPMFFS = farmers living in the IPMFFS villages, but not trained in IPMFFSs; Control = farmers living in villages where IPMFFSs have never been conducted (Table 1). The Non-IPMFFS case was included because the possibility of diffusion of the effects to farmers living in the surrounding areas has been discussed in a number of studies and has led to conflicting conclusions concerning the cost-effectiveness of IPMFFS impacts (van de Fliert, 1993).

Rating of the capital stocks

The SL framework is constructed around the identification of capital assets that individuals can access, augment and manage in the interplay of need and opportunity to sustain their livelihoods. The five capitals are described in brief below, with the entities where IPMFFSs might be expected to have a direct impact indicated in bold:

Natural capital: natural resource stocks from which resource flows are derived, including land, **water, biodiversity** and landscapes;

Social capital: social assets, such as **networks**, **memberships in groups**, **relationships** and the **wider institutions of society**;

Human capital: assets such as **skills**, **knowledge**, **ability to work**, **good health** and creativity;

Physical capital: basic built infrastructure (roads, wells, hospitals, energy and communications), tools and equipment;

Financial capital: financial assets (**savings**, **loans**, credit, remittances, pensions and other transfers).

The framework assumes that a stronger and more sustainable capital base is inherently empowering (Bartlett, 2004). It is content-led; it does not address asset functions or functioning (Dorward *et al.*, 2001).

In order to visualize the five capitals and aid analysis, recourse was made to 'spider diagramming'. The participatory assessment consisted of the following steps. First, each respondent was questioned to elicit the meaning of the capitals to the respondents, and the most valued assets in each capital stock, during an interview conducted by trained facilitators. An outline diagram was drawn on a poster sheet and the meanings elicited for each capital stock were listed by the relevant axis of the web (Figure 1). The questions were framed in terms of 'What do you value the most, and in which form, in your livelihood in terms of natural, human, social, physical and financial capitals?' Secondly, the respondents rated the capital stocks identified, for the baseline year (2002) and for the impact year (2004), on a 0–5 scale, with the 0 value (no stock) at the centre of the diagram and the value 5 at the other extreme of each of the axes, corresponding to the respondent's full satisfaction regarding the capital stock in her or his possession. Thereafter any changes made visible between the two reference years were discussed and causes attributed to the changes were noted on the poster sheet. (The possible biases introduced by the recall process concerning estimation of stocks in the baseline year are addressed in the discussion section).

Data analysis

The initial process of generating and interpreting findings was participatory. However, the data were further processed by the authors, using parametric and non-parametric statistical analysis as detailed below, to compare changes reported by the different groups.

Analysis of the elicited meanings of the five capitals. The meanings listed by the respondents under each of the capitals were analysed to determine whether the farmers interviewed in the three sample populations in each of the two cases belong to similar communities of knowledge and understanding. Subsequently, the descriptions of the capital stocks were analysed to capture farmers' livelihoods at the two reference periods. Non-parametric statistical analysis (free-listing and consensus analysis) of the results was carried out using the software Anthropac 4 (Analytic Technologies, Harvard, MA, USA).

Analysis of the capital stocks in the baseline and the year after the IPMFFSs (spider diagrams). The spider diagrams were instrumental to the visualization of changes perceived over time and for making visible respondents' perceptions of the connections between capitals. The visualization became a tool for further reflection and discussion of the attribution of the causes of the changes recorded. Quantitative analysis also was conducted on the rating values (Table 2). Median values of the capitals for the baseline and the impact year were calculated and compared for the three sample populations and the two cases. Significant differences were determined using the Wilcoxon Matched-Pairs Signed-Ranks Test (van der Waerden, 1969), a non-parametric

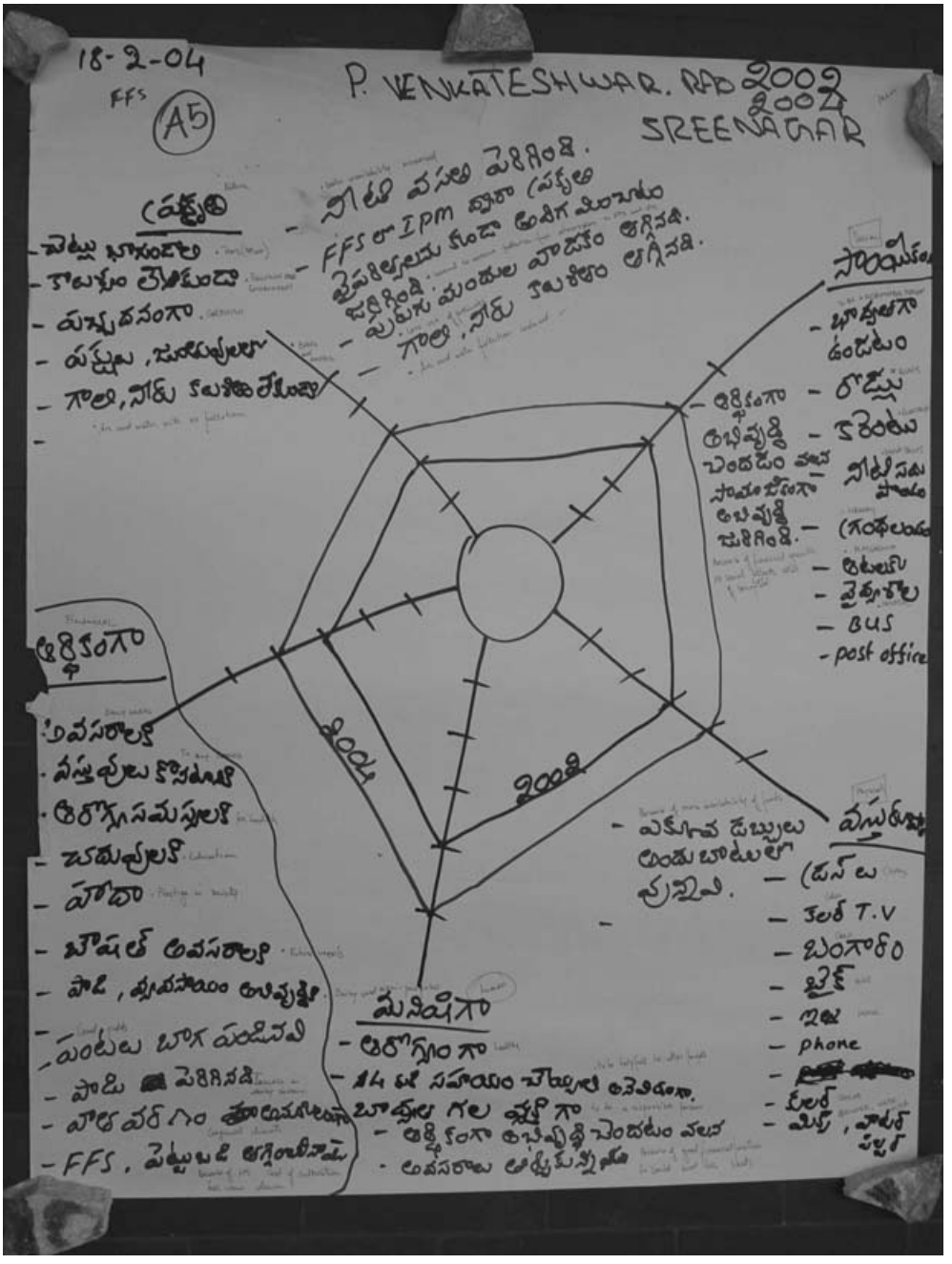

Figure 1. An example of a spider diagram.

alternative to the Student *t* test for ordinal data that applies to two-sample designs involving repeated measures, matched pairs, or 'before' and 'after' measures. The data were also analysed by gender to highlight gendered perceptions of outcomes.

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Table 2. Median values of the five capital stocks in 2002 and 2004 for the three groups.

	N	Year	Natural	Physical	Human	Social	Financial
Warangal District							
FFS	11	2002	2	2	3	3	3
		2004	4	3	4	4	4
Non-FFS	11	2002	2	3	3	3	3
		2004	4	2	4	4	3
Control	24	2002	3	3	3	3	3
		2004	3	3	3	3	3
Dharwad District							
FFS	14	2002	2	2	2	2	2
		2004	2	2	4	4	2.5
Non-FFS	10	2002	2	2	2	1	2.5
		2004	2	1	3	2.5	1
Control	25	2002	3	3	3	3	3
		2004	2	4	4	4	3

The median values indicated the level of satisfaction expressed by the respondents in relation to the capital stocks in their possession in the two reference years.

Stepwise and canonical discriminant analyses were also performed to determine whether the three groups, within and between the cases, could be separated based on the changes in all capitals simultaneously. The analysis also established which of the changes in capitals contributed most to the distinction among groups (IPMFFS, Non-IPMFFS, control) (Afifi and Clark, 1984). The proportions of change in each of the capital assets between years were calculated and log-transformed to obtain normality, and subsequently were standardized (a requirement for discriminant analysis) and then processed using the statistical analysis system SAS version 6 (SAS Institute, 1994).

RESULTS

The consensus among respondents in the entire sample with respect to the meaning of their capital assets was high. The pseudoreliability factor (PRF), which tests whether the one-culture assumption holds, was 0.99 for natural capital, 0.98 for human capital, 0.99 for social capital, 0.98 for financial capital and 0.98 for physical capital. A PRF value close to 1 indicates that no subcultures with systematically different views on a given topic were sampled, but all variability is due to variations in amount of knowledge. The Eigenvectors (three additional factors that assess the salience of the domain) confirmed that the variability was largely explained within the same epistemic community (for further information on the analytical procedure see Ryan *et al.*, 2000). In the authors' view, establishing the degree of consensus regarding the capitals was necessary before a comparative analysis could be carried out. The lists of meanings attributed to the capitals were categorized (Table 3) to describe the main assets perceived as comprising the livelihood of the cotton farmers. Before proceeding further with presentation of the results, the authors summarize the key qualitative aspects of the respondents' livelihood that were elicited in the discussions that resulted from the spider diagramming.

Table 3. Researcher's categorization of farmers' responses, identified under the five capitals (natural, human, social, financial, and physical).

Natural capital	Human	Social	Financial	Physical
Climate and weather	Contact with and support of others		Marriage and ceremonies	
Food	Personal features	Knowledge and information	Food	Transport
Health	Happiness	Services	Household, household goods and basic needs	Gold
	Health	Institutional support	Health	Agriculture
Land			Travel	Clothes
Landscape and nature elements	Social ties and responsibilities	Solidarity	Clothing	Communication
Pests and water	Knowledge and information	Social ties Social work, commitment	Education Future needs	Services Household and household goods
Yields			Agriculture	Food

The same categories might appear under more than one capital according to respondents' reporting.

The participants had rain-fed agriculture as the first or their only source of income. Growing cotton required a high initial cash investment in seeds, fertilizers and pesticides, which was not always regenerated by the marketing of the lint. Sporadic rains, heavy pest loads, and pest outbreaks (bollworms and sucking pests), combined with fluctuating output prices meant that it was a risky activity. Nevertheless, the crop occasionally fetched good financial returns, and it was in hope of this that they continued to grow the crop. Educational opportunities were highly rated, with information, knowledge and training seen as the preferred means for pursuing personal and social growth. A good health status was seen as central to human capital. The majority of the respondents felt the need to be supported by government and local institutions, particularly by the officials of the department of agriculture. However, the respondents also emphasized the importance of developing a higher degree of independence from government institutions by strengthening their own organizations.

We now turn to the more detailed results of the two case studies.

Case 1: Warangal District

The first case study was carried out after a favourable farming season in Warangal District (Figure 2). In 2003, the rainfall regime was particularly favourable to cotton cultivation, which clearly was reflected in the state yield, 565 kg ha^{-1} (CAB, 2005).

Natural capital. The respondents shared deep concerns about the long-lasting polluting effects caused by deforestation, industry, vehicles and the use of chemical inputs in agriculture. Women claimed that the contamination of fodder by the use of pesticides had reduced the production of milk by cows and buffaloes qualitatively and quantitatively. In the IPMFFS villages, the respondents' environmental concern was mitigated by the reduction in pesticide use in cotton reported by a majority of the respondents, although they said they were still using pesticides on other crops. The perceived benefits of living in a cleaner environment as a result of reduced pesticide

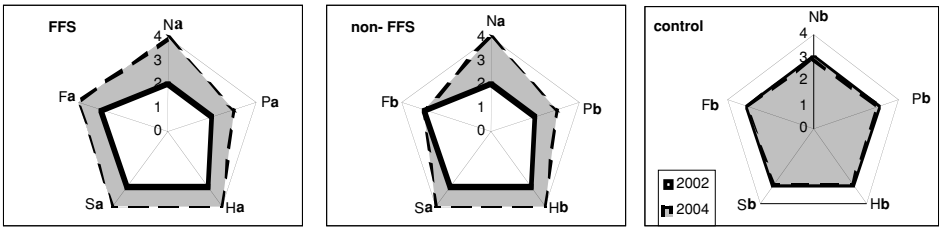

Figure 2. Changes in capital stocks recorded between the baseline year (2002) and the impact year (2004) by three groups of farmers (IPMFFS, Non-IPMFFS and Control) in Warangal District. N = natural capital, P = physical capital, H = human capital, S = social capital, F = financial capital. a = significant ($p < 0.05$); b = non significant.

use on cotton – including gains for both human and livestock health – were indicated in the discussion of the scores of both participants and non-participants in the IPMFFS villages.

Financial and physical capitals. The IPMFFS farmers perceived an improvement in their financial capital while the Non-IPMFFS and control farmers reported no significant change. The respondents related this finding to differences in credit exposure. Most of the Non-IPMFFS and control respondents had purchased pesticides and fertilizers on credit during the cropping season, as is the usual practice. The loans were repaid with the cash generated by the marketing of the lint. The gross margin was neutralized by the high cultivation input costs incurred and by the repayment of interest on their loans. IPMFFS farmers needed less credit as they had significantly reduced their pesticide purchases and had more net profit to invest in repaying debts and/or building physical capital. Where Non-IPMFFS respondents indicated an increase over time in their physical assets, they related this in contrast to other factors, such as land inheritance.

Human and social capitals. IPMFFS and Non-IPMFFS farmers perceived that their social and human capitals had increased, while control farmers perceived no change. The IPMFFS farmers attributed their personal growth to the knowledge and skills acquired through the field schools. The effect in this case was also extended to the Non-IPMFFS respondents. New farmer clubs had been formed after the completion of the IPMFFSs, whose agendas including on-site experimentation as well as social activities designed to help the poorest and most vulnerable (e.g. a mass marriage, a tractor race, small income generating activities such as *neem* seed collection by single women). As a result, the villagers enjoyed stronger social ties and collaboration among themselves. At the same time, in the control villages the respondents noted that various government development schemes had promoted and financially supported the formation of officially registered self-help groups. However, the lack of cohesion, common interest and shared strategies among the members were perceived as limiting the functionality and effectiveness of these groups.

Case 2: Dharwad District

The second case study was carried out at the end of a stressful season (Figure 3). Dharwad District was subject to a severe drought in 2003–2004 and farmers

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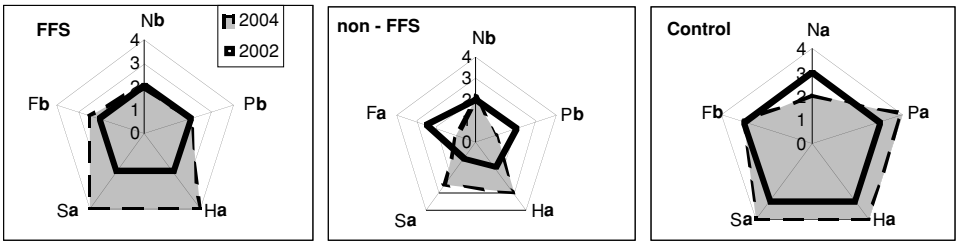

Figure 3. Changes in capital stocks recorded between the baseline year (2002) and the impact year (2004) by three groups of farmers (IPMFFS, Non-IPMFFS and Control) in Dharwad District. N = natural capital, P = physical capital, H = human capital, S = social capital, F = financial capital. a = significant ($p < 0.05$); b = non significant.

experienced dramatic consequences ranging from negligible yields to complete crop failure.

Natural capital. IPMFFS and Non-IPMFFS farmers recorded no significant change in natural capital; control farmers perceived a significant decrease. The lack of rain was the major negative factor cited, which was linked by the respondents to the increasing deforestation over the last decade. IPMFFS farmers were affected by the drought, but their perspective focused on the long-term improvement in the management of their natural resource assets (e.g. soil fertility), which they perceived as an important step towards a more sustainable farm production system.

Financial and physical capitals. IPMFFS farmers perceived no change in their financial and physical capitals. The IPMFFS farmers explained that they had not incurred major financial losses, despite the drought and the poor harvest, thanks to decreased input purchases and reduced health expenditures. Non-IPMFFS respondents, in contrast, were caught in the usual debt trap because they had not changed their crop management, and they had had to run down their financial and physical assets. In the control villages, farmers reported a financial loss, but the drought had not affected their physical capital assets because of various development interventions in their villages.

Human and social capitals. All respondents perceived that their human and social capitals had increased remarkably. IPMFFS farmers claimed to have developed better decision skills that helped them to relate to the reality of the drought. The most significant improvement was perceived to be an increased ability and confidence in choosing their management practices on the basis of field observations, resulting in cash savings and higher yields. The visibility of these farmers in the district had increased, with the beginnings of collaboration between IPM Clubs, the department of agriculture and local universities. The increase in their human capital was perceived in terms of new knowledge acquired and the establishment of new contacts – effects also reported by the Non-IPMFFS respondents. However, in the latter case, the perceived increase in human capital did not have positive spill over effects on their financial and physical capitals. This finding might support the respondents' comments that skills based on ecologically informed understanding do not spontaneously diffuse as easily as information on simple practices.

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Overall effects of the five capitals

Canonincal discriminant analyses showed that the three groups overall were significantly different with respect to the changes perceived over the years 2002/2004 ($p < 0.0001$ for Warangal District, $p = 0.01$ for Dharwad District) (Figure 4). The control group was the most different from the other two groups in both cases. The factors distinguishing the control group from the other two were the changes perceived by IPMFFS and Non-IPMFFS respondents in natural, physical and social capitals in Warangal District and in social capital in Dharwad District. The data for IPMFFS and Non-IPMFFS respondents were hardly different in the two cases ($p = 0.08$ for Warangal; $p = 0.75$ for Dharwad). This suggests again that there was a substantial impact of the IPMFFSs on non-participants in the same villages, especially in Dharwad District, as already visualized in the spider diagrams. The discriminant analysis also showed that there were significant ($p < 0.0001$) correlations between financial and physical capitals (0.45 and 0.70 for Warangal and Dharwad Districts, respectively), and between social and human capitals (0.44 and 0.51 for the Warangal and Dharwad Districts, respectively). These correlations suggest that variations in the stock of one capital are tightly linked to change in other capital stocks – an effect claimed by IPMFFS respondents but never before substantiated.

Gender-segregated analysis

The scores from the IPMFFS participants and Non-IPMFFS participants were pooled together to perform a gender disaggregated analysis (Figure 5). The analysis of the control data did not show any significant difference between men and women respondents, and they are therefore not included in Figure 5.

The IPMFF intervention appears to have generated gender distinctive outcomes. The baseline values for the social and human capitals were significantly lower for IPMFFS women when compared to Non-IPMFFS men and women. Yet IPMFFS female respondents attributed a high value particularly to gains in their human and social capitals. This might be explained by a selective mechanism in women's enrollment, but on the basis of the criteria adopted to establish IPMFFSs, this explanation can be excluded in this instance. The results also could be explained by a retrospective underestimation of their initial capital stocks. The participation in the IPMFFS might have triggered in some women a process of self-realization of the social boundaries that had restricted them. Women indeed reported that attending the schools was an opportunity to gain recognition of their personal skills and abilities. For instance, three of the women interviewed decided to become farmer trainers at the end of the IPMFFS and at the time of the interview were already conducting their farmer-to-farmer schools in the neighbouring villages. Their current sense of self-fulfilment perhaps exaggerated their recollection of their more subordinate and circumscribed position prior to attending an IPMFFS.

The gender analysis of the aggregated data also revealed a uniform increase in capital stocks to have been reported by the IPMFFSs male respondents, which could be caused by a biased over-reporting, typical of male respondents in response

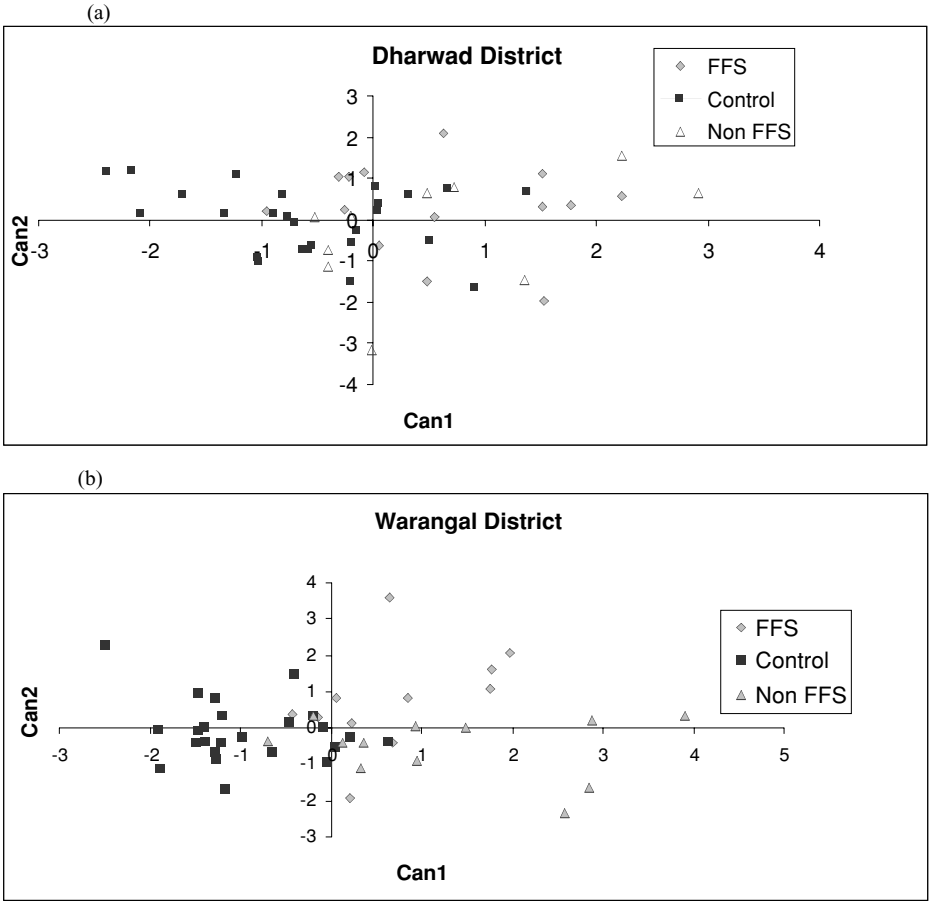

Figure 4. Plot of canonical discriminant variable 2 versus canonical discriminant variable 1 for the three cases (IPMFFS, Non-IPMFFS, and Control) in Warangal District (a) and Dharwad District (b).

to development interventions (Annas, 2003). In order to check for this bias, each individual diagram was retrieved and visualized. The results showed that the apparent uniformity was the result of a compensating effect among diagrams remarkably different from each other. Therefore, the reporting in this case can be considered reliable.

DISCUSSION

The first contribution of this study is the establishment of the inner validity of the IPMFFS intervention. We have shown that, from the IPMFFSs participants' own point of view, the IPMFFS experience yielded significant gains beyond the reduction of pesticide application, such as improved managerial skills, better health, strengthened social ties and connections with institutions, higher self-confidence and social recognition. The analysis of the data carried out by the researchers further showed that these gains partially extended to non-participants in IPMFFS villages

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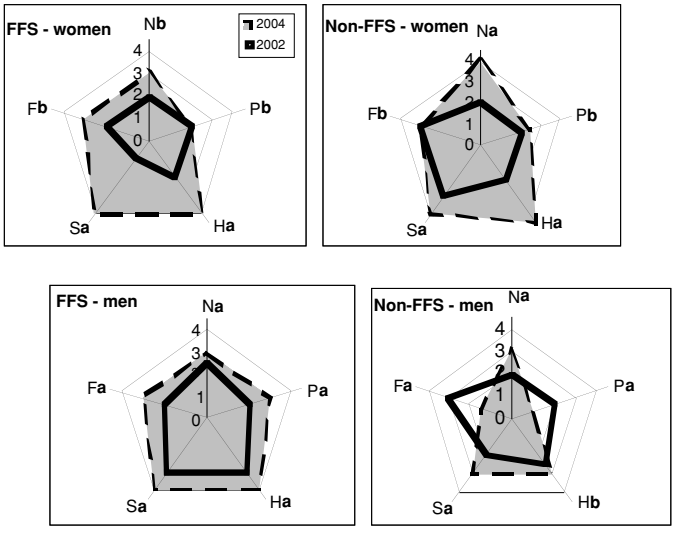

Figure 5. Changes in capital stocks recorded between the baseline year (2002) and the impact year (2004) by three groups (IPMFFS, Non-IPMFFS and Control) of farmers separated into women and men. N = natural capital, P = physical capital, H = human capital, S = social capital, F = financial capital. a = significant ($p < 0.05$); b = non significant.

and not to control farmers in other villages, confirming the existence of a diffusion effect. However, exposed farmers reported that their confidence in implementing the new management practices was not strong enough to translate into a change in behaviour. This supports the argument that an effective, empowering learning process is based on experience, rather than on simple information and technology transfer (Lightfoot *et al.*, 2001).

FFS proponents argue that education based on experiential learning is a way to improve the ability of farmers to achieve self-determined objectives, and is a starting point for self-directed development of their own livelihoods (Gallagher, 2002). This study shows that, from the respondents' perspective, education was expected to play a key role in raising their living conditions, by increasing the profitability of agriculture, preserving their own health and conserving the environment. The cotton IPMFFSs addressed these areas directly by providing an opportunity to farmers to improve their farm management skills, reduce cultivation costs, limit pollution as well as occupational exposure to hazardous chemicals, and improve crop productivity. Some of these results have been established also by external evaluation conducted with sub-sets of the sample; for the environmental impact see Kooistra *et al.* (2005) and for changes in practices Mancini *et al.* (2006). However, it is also clear from the discussions elicited by the spider diagramming in this study that the effectiveness of the IPMFFSs could have been enhanced by broadening the focus from a single crop to a broader systems approach, to address other matters, such as water management, crop rotation, crop diversification and marketing.

https://doi.org/10.1017/S001447970600425X Published online by Cambridge University Press

The first case in Warangal District indicates that conventional cotton farming does not generate enough returns to uplift farmers' livelihoods even in favourable cropping conditions. Profits barely balance the cost of crop production and household expenditures. A necessary step to improving profitability is to cut the costs of production. According to the IPMFFS respondents the adoption of IPM had contributed to a certain extent to improving their financial assets. The second case in Dharwad District shows the vulnerability of farmers' livelihoods in the face of natural stresses. IPMFFS farmers felt that their production systems had become more resilient – they coped with the drought without having to run down their physical and financial assets thanks to the adoption of a lower-risk crop management strategy. However, some farmers also noted problems persisting with IPM, linked to the non-availability of IPM inputs in the market, especially insect traps and biological control agents.

The study also revealed that the process of personal growth stimulated by participation in IPMFFSs was particularly relevant to women and it confirms the importance of increasing women' access to educational programmes. But it also showed that the increased household cash flow – perceived by both men and women IPMFFS participants – translated into the purchase of new physical assets mostly for men. This brings forward the question of who benefits from improved household cash flows and whether the curriculum was effective in ensuring fair benefits for both genders.

DFID suggests that empowerment can be understood in terms of individuals and groups securing greater influence over or satisfaction of one of more of the five capitals. This study has shown that IPMFFSs in this sense were an empowering experience for the participants. The longer term effects and impacts go beyond the scope of the present study; however, the question of where immediately empowering personal change leads in terms of enduring change in the circumstances of people's lives remains a legitimate enquiry.

Comments on the framework

The aim of the study was to test a framework to document the emic perception of change in people's livelihoods over time. The SL framework based on the five capitals proved to be valuable for this purpose. It offered conceptual clarity and research manageability in field conditions, was easily understood by farmers and allowed for an easy visualization of correlated and inter-linked aspects, often difficult to establish in open or structured interviews. It supported a process of interactive reflection by making a visual record of the discussion available to the respondents. It had a number of otherwise hard to capture evaluative functions, such as analysis of interactions among capitals, based on the respondents' self-reporting. However, a number of limitations were also encountered: (1) the quantification of changes over time between groups is meaningful in the context of a comparative analysis only if the internal validity of shared conceptual meaning is established; (2) no objective measurements of the claims and perceptions are generated by this method; (3) on the analytical front, the consensus analysis does not have clear threshold values and the strength of consensus

cannot be measured; (4) the baseline data were derived from recall information and therefore capture a retrospective perception of the level of baseline capital stocks. However, this limitation extended to the control farmers as well (and since the aim of the study was to quantify the level of satisfaction of IPMFFS participants and not to the measure the actual capital stocks, this is not a disabling limitation in this case); and (5) the authors relied on translated texts and this might have limited their appreciation of subtle differences among the respondents' reports. Limitations number (4) and (5) are not inherent in the method itself. The authors also have considered other possible sources of bias: the non-control villages' long association with the IPMFFSs and the programme's emphasis on farmers' empowerment that might have led to an over-reporting of the actual impact. In an attempt to check the validity of the respondents' reporting, all 95 individual spider-diagrams were compared to each other. The variation between the diagrams was high, but the risk of over-reporting cannot be entirely ruled out.

CONCLUSIONS

IPMFFSs in the two cases studied were found to have had broader effects than simply those relating to pest management. By use of a method that investigates these effects in terms of the components of sustainable livelihoods, it has been shown that farmers do place values on these effects, and do perceive the inter-dependency of impacts in one domain and others. The results revealed a number of surprises, such as perceived impacts on fodder quality and animal health that might result from reduced pesticide use that merit further study. The method chosen also highlights the value of searching for innovative ways to capture and analyse impacts that can otherwise be dismissed or overlooked as merely accidental outcomes of investing in farmer education for self-development.

Acknowledgements. Particular recognition is due to the Indian farmers who participated in the study. The authors are grateful to the EU-FAO IPM Programme for cotton in Asia for providing necessary financial help in carrying out this project. Special thanks go to P. Kenmore, P. Ooi, G. Walter-Echols, D. von Werner and P. Palanyswamy, who have been a continuous source of professional inspiration. The authors thankfully acknowledge the valuable contributions and comments of the following: Cathy Farnworth, Henk van den Berg, Jonathan Hellin and the 'social learning group' at Wageningen University. Special thanks go to Aad Termorshuizen, Biological Faming Systems Group at Wageningen University for his careful revision and editing of the paper. Dagani Praveen and Anjum, IPM expert facilitators were key persons in conducting the field study.

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