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FACTORS LIMITING THE ADOPTION OF IPM PRACTICES BY COTTON FARMERS IN BENIN: A PARTICIPATORY APPROACH

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SUMMARY

Smallholders' acceptance of innovations depends largely on the approach used to take their needs and constraints into account. The adoption of integrated pest management (IPM) strategies by smallholders can lead to a reduction in pesticide use in cotton, as soon as the recommended cropping practices are adapted to local conditions and associated with a threshold-based use of chemicals. To achieve this goal, farmers need to be trained on the biological basis of IPM. To ensure effective and rational implementation of IPM by farmers, it is essential to overcome constraints associated with pest scouting, identifying and preserving beneficial insects, and gaining access to the right inputs on time. In the current African context, where the extension system is sometimes in very poor shape, participatory methods fostered by the 'farmer field school' concept could enable farmers to implement an integrated approach to pest management, while keeping researchers informed about farmers' needs and constraints. Our paper is an attempt to use such a participatory method as a tool to explore farmers' needs and constraints when smallholders are asked to adopt an integrated approach to cotton pest management.

INTRODUCTION

The Integrated Pest Management (IPM) concept is more complex than crop protection alone (Kogan, 1998). IPM requires a thorough knowledge of biological interactions and effective management of available information on the crop and on the surrounding environment. Farmers must widen their approach to production, taking into account social integration and environmental concerns, as well as the impact of their production on society. Cotton IPM has been developed to address several issues: to integrate cropping practices and genetic resistance to pests and diseases; to preserve or enhance the effectiveness of natural enemies; and to reduce pesticide use (Luttrell *et al.*, 1994). In some cases, these components require substantial research and extension investments, while in others, previous results can be used. Farmers' knowledge and awareness of the plant–insect natural balance and pest management need to be increased. In many cases, this can be achieved through the use of participatory techniques, in particular through in-field demonstrations. IPM generally

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implies 'learning' at local and national levels (Norton *et al.*, 1999). At the local level, farmers have to learn to identify crop problems, to analyse available control possibilities and to co-ordinate the measures to be undertaken. At the national level, citizens' awareness of the positive impact of IPM and of the benefits of consuming products obtained through this sustainable strategy must be increased. In Africa, however, it is hard to fulfil these objectives at both levels (Morse and Buhler, 1997). On the one hand, this might be due to the tactical approach adopted over many years for cotton pest control on the smallholdings of West Africa, which involves routine application of broad spectrum insecticide mixtures. On the other hand, the West African cotton sector is undergoing massive changes, in anticipation of privatization. These changes have serious repercussions on the extension system, which has been totally dismantled in some countries. In Benin, the national extension service was previously the main link between research and production, reporting farmers' needs in a bottom-up process and relaying top-down technical advice. But the cotton sector reforms resulted in the collapse of the extension system, and it is now difficult to implement new developments in pest control at the farm level (Sinzogan *et al.*, 2004). Cotton insects are important in their numbers and the damage caused, and smallholders are under stress because of the unpredictable impact of the pest complex on cotton yield (Kees and Meermans, 1991). A learning/training/teaching process, known as the 'farmers field schools' (FFS), is considered to be a successful way to identify the main issues that could be important for the adoption of IPM. The FFS model recognizes the need to involve farmers in technology development and transfer: 'FFS is based on the premise that farmers participating in the program will become researchers testing the various technological options available. During this process they are able to decide what the best alternative is for them in their particular circumstances' (C. A. King, University of Queensland, Australia, personal communication, 2005). A participative approach was implemented for cotton breeding in Benin during the PARCOB Project (Lançon *et al.*, 2004). This paper presents the results of an attempt to teach, train – and learn from – cotton farmers about IPM in Benin.

METHODOLOGY

The current project was developed in Zou Province, Central Benin, over three consecutive cropping seasons (2001–2003). The methodology used was initially elaborated for IPM in rice in Indonesia (Deybe and Vaissayre, 2000). A preliminary survey was implemented during the first year of the study to obtain, through open and semi-structured interviews as well as through group discussions: i) an accurate overview of farmers' knowledge in terms of pest management; and ii) a picture of the current practices of the smallholders involved in cotton production in the province. Zou was selected because, according to climate, farmers have a choice for their main crop, and cotton is competing with other crops (maize, cowpea, beans, groundnuts or vegetables). Training of facilitators was also planned for the first season. Some unexpected problems (a severe drought during the growing season, but also some reluctance from facilitators to break from their 'top-down' working habits and to adopt a participatory standpoint) prevented us from making the most of any FFS during the first season, but it was possible to select villages and to look for farmers on the basis of voluntary participation. During the cropping seasons of 2002 and 2003, the participatory method was implemented in the villages of Kpakpavissa, Damé and Awouignankamé.

Based on the concept described by Kenmore *et al.* (1994), the FFS methodology matches rather well with African small-scale farming. It is a school without walls where field-collected data are the primary resource (Asiabaka, 2002). The method was implemented in Benin as a set of weekly observations (see Table 1 for an example) made by small groups of farmers in a cotton field, the property of one of the farmers, and situated in the vicinity of the village. Every week, at the end of the observation period, a representative of each small group was invited to describe the main results from the observations made. He was invited to use drawings to describe the cotton plant, the insects observed and the damage, if any. Key points arising from these observations were then discussed by all the FFS-participating farmers. Although some questions could be addressed to the facilitator, farmers were urged to take their own decisions based on the observations they had made. A key point is that they no longer had to apply pesticides according to any calendar or to technical sheets supplied by extension agents or by pesticide retailers, but they were asked to give their reasons for choosing (or rejecting) a cultural practice, or a chemical in response to a pest problem (or what they considered to be a pest problem).

In spite of the fact that the working context concerning the cotton crop was difficult during the project, 10 to 15 farmers participated in the sessions held weekly in each of the villages during the cropping seasons. The results reported in this paper show the global set of practices collected by facilitators during the sessions, in order to obtain as broad a picture as possible of cotton farmers' needs and constraints in Central Benin. The experiences were used to gain a comprehensive insight into how to implement such a participatory process. In addition, the method was extended during the FFS sessions to assess the possibility of implementing integrated crop management (ICM) rather than being simply restricted to IPM. The key purpose of the study was to understand farmers' practices as well as the reasons for adopting or rejecting innovation.

RESULTS AND DISCUSSION

It was not easy to obtain an objective report of the session from facilitators at the beginning of the study, many of them being reluctant to adopt farmers' visions and to report objectively about farmers' perceptions of a technical problem. This is the reason that the results obtained during the first year of the study are not reported in this paper. However, the methodology was successful in three of its main objectives (King, personal communication, 2005): i) the results obtained were not limited to those of the project (IPM), but were extended as integrated management of the cotton crop; ii) the participants were able to make use of their own experience during the training sessions; and iii) the farmers were deeply

Table 1. FFS meetings and issues for the 2002 growing season. Dates of meeting in bold are those following the plan.

Village meetings	Kpakpavissa				Damé				Awouignankamé			
	Date	Topic	Farmers		Date	Topic	Farmers		Date	Topic	Farmers	
			N	%			N	%			N	%
1	20/06	Soil preparation	14	70.0	02/07	Soil preparation and sowing	15	100.0	28/06	Soil preparation	11	68.8
2	**25/06**	Sowing	13	65.0	**13/07**	Thinning and discussion about the demonstration plot	10	66.7	**04/07**	Sowing	10	62.5
3	29/06	Seedling emergence	10	50.0	**20/07**	Fertilizer (basic)	10	66.7	16/07	Weeding and discussion about fertilizer use	10	62.5
4	04/07	Re-sowing, density, herbicides	13	65.0	**27/07**	Weeding	10	66.7	23/07	Thinning and fertilizer (basic)	10	62.5
5	11/07	First weeding and discussion about fertilizers	13	65.0	**03/08**	LEC: thresholds for insecticide use	8	53.3	30/07	Discussion about density	10	62.5
6	13/07	Thinning, fertilizer (basic)	13	65.0	**10/08**	LEC, insect-pest identification	10	66.7	**09/08**	Weeding, LEC: thresholds for insecticide use	10	62.5
7	25/07	LEC	13	65.0	14/08	Fertilizer: top dressing	10	66.7	**16/08**	Fertilizer: top dressing	10	62.5
8	29/07	LEC: Observations	10	50.0	**17/08**	LEC: Observations Ridging	10	66.7	**24/08**	LEC: Observations and spraying	8	50.0
9	03/08	2nd weeding and observation	13	65.0	**24/08**	Pest identification, PGR application	10	66.7	**30/08**	PGR application	10	62.5
10	13/08	Fertilizer: top dressing, ridging	13	65.0	**31/08**	Discussions about cotton cultivars	8	53.3	**06/09**	Pest identification: density × damage	10	62.5
11	**20/08**	Pest identification	9	45.0	**07/09**	Host plants and trap crops	8	53.3	**13/09**	Discussion about beneficial insects	10	62.5
12	**27/08**	PGR application Pest observation	10	50.0	**14/09**	Thresholds and decision process	8	53.3	**20/09**	Pesticide dosage	10	62.5

13	**03/09**	Cultivars and pest identification	10	50.0	**21/09**	Pesticide dosage	8	53.3	**27/09**	Host plants and trap crops	10	62.5
14	**10/09**	Pesticide dosage	11	55.0	**28/09**	Weeding	8	53.3	**04/10**	NO	11	68.8
15	**17/09**	Cultivars	12	60.0	**05/10**	Pest and damage Identification	10	66.7	**11/10**	NO	0	0.0
16	**24/09**	Leaf-eater damage	13	65.0	**12/10**	Pests of cowpea	8	53.3	**18/10**	Pegboard for LEC	8	50.0
17	**01/10**	Host plants and trap crops	13	65.0	**19/10**	Pest damage	8	53.3	**25/10**	Safe use of pesticides and pictogram	10	62.5
18	**08/10**	Pests of cowpea	13	65.0	**26/10**	Demonstration plot	8	53.3	**01/11**	Pests of Cowpea	9	56.3
19	**15/10**	Discussion about early vs late sowing	13	65.0	**02/11**	Farmers pictograms	8	53.3	**08/11**	Defoliation by chemicals	8	50.0
20	**22/10**	Farmer pictograms	10	50.0	**16/11**	Demonstration plot	8	53.3	**15/11**	Farmer pictograms	8	50.0
21	**29/10**	Defoliation by chemicals	12	60.0	**23/11**	Farmers pictograms	8	53.3	**22/11**	Picking cotton: methodology	8	50.0
22	**05/11**	Reason for splitting the picking operation	11	55.0	**30/11**	Defoliation by chemicals	8	53.3	**07/12**	Picking cotton:	10	62.5
23	**19/11**	Farmer pictograms	10	50.0	**07/12**	Discussion about postponing picking	8	53.3	**14/12**	Crop residues management	10	62.5
24	**06/12**	Picking up the demonstration plot	13	65.0	**14/12**	Discussion about yield	8	53.3	**21/12**	Discussion about yield	10	62.5
25	**13/12**	Crop residues management	13	65.0	17/12	Crop residues management	8	53.3				
26	**20/12**	Discussion about yield	10	50.0								
Participation rate (%)				59.2		Participation rate (%)		59.2		Participation rate (%)		57.6

LEC: Lutte Etagée Ciblée ; PGR: Plant growth regulator; NO: No session – although planned, the session had to be postponed.

Table 2. Recommended and actual farmers' practices as discussed during farmer field school sessions.

Operation/practice	Recommendation	Actual practice including variations	Reasons for actual practice
Tillage	With the first rains, ox-driven ploughing	Manual weeding followed by digging	Lack of animals
Ridging	After tillage	Without tillage	Lack of animals
Sowing date	As early as possible	Some late sowing	Competition between crops Lack of labour force
Seed quantity	3–4 per hole	5–10 per hole	Poor seed quality
Thinning	At 3 weeks	Delayed	Lack of labour force
Density	60–80 000 plants ha^{-1}	Lower	Bolls are bigger
Weeding	As soon as weeds emerge	Number limited to 2 or 3, made when weeds are well developed	Lack of labour force
Fertilizer	Basal formulation at tillage, N at flowering	basal formulation and N applied at flowering	Lack of time to apply twice; waiting for crop aspect and claiming to obtain a better long-lasting effect
Spraying	According to thresholds Taking into account natural enemy population density	Calendar based	Lack of knowledge about thresholds and beneficial impact Some people with defective eyesight incapable of seeing the insects
Pesticides	Dosage to be respected	Dosage variations	Overuse due to poor quality Lower use because of the price of pesticides Pesticides bought for cotton are used on other crops
Cotton picking	As early as possible, as often as possible	Once or twice	Lack of labour force
	No use of polyethylene bags	Using polyethylene bags	No alternative
Crop residues	Pulling out and burning	Late or none	Lack of labour force Do not understand the effect

involved in the decision-making process. The result was not only fruitful in terms of farmer‘s empowerment, but also in terms of learning for planning future research.

Farmer practices

The first finding relates to some discrepancies between the recommended management of the cotton crop and the practices actually used by farmers (Table 2). These discrepancies were pinpointed, some of them having a negative impact while others had a neutral or positive impact on crop yield as well as on the environment. The main ones are described below.

Farmers generally complied with recommendations on sowing dates. In the event of late planting, it is worth noting that farmers were choosing the most fertile soils for their cotton.

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Ridging was widely practised, but ploughing (which is recommended before ridging) was seldom done, since many farmers hoed their fields manually. Farmers acknowledged that cotton sown on land ploughed using animal traction emerges earlier and grows faster than when the soil is hand-hoed.

There were no 'hard and fast' rules on planting density. Overall, farmers preferred low densities as they like cotton plants with well-developed, widely spaced branches. This point is particularly important, as low densities very often result in poor cotton yields. Farmers throughout the zone are currently sowing around 10 seeds per planting hole, or even more. There are two reasons for this – a poor germination quality of seeds used and a compacted soil surface, needing a large number of seedlings to break through the crust.

Farmers thinned the crop to two plants per hole during the first hoeing round or even later. The main reason for delaying thinning operations was due to the high number of plants per planting hole, resulting from the excessive number of seeds sown. The extended competition between the numerous plants in each hole results in weak, fragile and underdeveloped plants. Other farmers claimed that this was due to the lack of available labour at the time when thinning was done, as workers were involved in harvesting maize and cowpeas.

Farmers based their fertilizer application rates on a visual assessment of the growth of the crop, which they felt was a good indicator of plot fertility. They often increased the recommended rate of fertilizers after submitting a false declaration on the area they were planning to sow with cotton. Researchers recommend split applications of a basal fertilizer (NPK+S+B) and later on a top dressing (N), but all farmers mixed the two types of fertilizer, and most of them made only one application at 30 to 50 days after sowing. They considered that the cotton plants would not have enough fertilizer at the end of their cycle if they complied with the earlier date. Moreover, they stated that they mixed the two types of fertilizer and made just one application due to a lack of time.

FFS plots and farmers' proposals

The second finding relates to practices that farmers considered to be important for their crop management, although they were not taken into account in messages coming from research. It was decided to carry out some of these practices on specific plots (by subdividing the FFS plot), where all interventions were conducted following discussions held between farmers.

Different fertilization levels and sowing dates were added to the initial design. Farmers generally claimed that it was essential to apply large amounts of fertilizer to obtain high yields, and they therefore tended to exceed the recommended rate, but at the end of the season, the result of the cost/benefit ratio was not in accordance with such a position. They also said that the foliage was less green and not as dense in plots fertilized at the recommended rate. In these latter plots, farmers expected lower yields, even if they considered that less dense vegetation could reduce the risk of producing sticky cotton. But as payment for cotton is not according to quality on the local market, such a consideration is not the main one. Farmers noted substantial pink and red bollworm damage in late planted plots.

As the FFS plots were in a zone where a rational approach to chemical control, known as Lutte Etagée Ciblée (LEC) in French-speaking Africa, was under extension, farmers were already aware of the need to scout weekly for pests and damage. The results of these observations were then compared and discussed with the thresholds set in decision-support charts (Silvie *et al.*, 2001). Some farmers had a vague idea of the threshold concept as they were using it in their own fields in a subjective way, while others, despite having been trained in LEC some years earlier, had not retained the information. Many farmers were reluctant to consider a number of insects as a significant threshold, preferring a presence/absence decision plan. Particular emphasis was placed on the 'pest–damage' relationship, which farmers appeared to be unaware of in the initial survey. Surprisingly, many farmers did not seem to know anything about jassids or the damage they cause. They were able to observe typical damage on a susceptible glabrous cultivar, including discoloration and subsequent reddening of the edge of the leaf blade, for the first time. This led on to a discussion on plant resistance characters that everybody considered to be the best way to manage insect pests, but that many farmers associated with a loss of productivity.

The only beneficial insects frequently encountered and easy to observe during the study were associated with aphid colonies: ladybirds and hover flies as predators, and mummies as indicators of some parasitoid activity. With very few exceptions, the farmers considered them all as 'relatives' of aphids and thus as pests! An experiment was conducted with a matchbox containing leaf fragments carrying aphids, in one case with hover fly larvae and in another with ladybird larvae. In both cases, this boosted farmers' awareness of the positive role of these beneficial insects in killing aphids. For some farmers (and not always the older ones), defective eyesight was the reason for insect misidentification (usually ladybird eggs confused with aphids).

When it came to applying pesticides, the farmers were worried about measuring product doses. They were also displeased that some products were supplied in containers that had to be shared between several farmers. They were worried about being 'robbed' or tricked by people (including other farmers) replacing some of the product with petrol in the bottle. In this region, as in the rest of Benin, cowpea is, after cotton, the crop most severely affected by pests. Areas cropped with cowpea are much greater than those under cotton. Farmers are therefore very keen to protect this crop, to the extent that most of the farmers who attended the FFS said that they grew cotton to obtain sufficient insecticide to treat their cowpea plots. They all knew that this was forbidden by the National Plant Health Service but said that they had no other choice. The pesticides were sometimes used in even more dangerous ways, e.g. to treat food crop seeds, which is the practice that undoubtedly causes the most lethal accidents, according to the Health Service annual survey.

Even if it is recommended that old cotton plants should be pulled up and buried after harvesting, most farmers indicated that they never did this, as the operation required extra labour and did not generate any clear benefits at an individual level.

Rejection of some of the proposed methods

The third finding relates to the fact that growers felt that some of the proposed innovations were of no real interest, but other innovations that were clearly of interest to farmers were still rejected by them. Several reasons for such a rejection have already been mentioned, and could be combined with more general considerations:

- The archaic nature of the working tools used in southern Benin; farmers considered that tilling the soil with a simple hoe takes much too long, given the large areas to be cropped. They therefore preferred to build their planting ridges directly on untilled soils.
- Some farmers considered themselves as technically self-sufficient, and the oldest farmers often viewed training as a waste of time. The low technical standard kept by some agents in extension services reinforces such a perception.
- Farmers were attached to traditional practices and were wary of change – they often expressed a preference for traditional techniques and were reluctant to adopt new ones. Some were satisfied with the level of production obtained and did not want to try new practices having a cost and uncertain outcomes.
- A lack of inputs or their high price: obtaining insecticides and fertilizers was a problem for farmers, and climatic events such as those experienced in the province in recent years have increased the risk of stakeholders being unable to repay the loans granted for input purchases.
- A lack of arable land and labour: cropland is in short supply in view of the growing population, and cotton does not guarantee as high an income as it did in the past, despite the complex, labour-intensive cropping practices involved. Farmers therefore preferred to abandon this speciality and use the available land for food crops in order to ensure food self-sufficiency.

Technical messages that seem to have been accepted

The fourth finding concerns the adoption of certain recommendations that can only be evaluated in the long term. However, farmers made comments during discussion sessions which suggested that some of the proposed practices stood a good chance of being adopted:

- High planting density is the technique that most impressed farmers. The high-density demonstration plots all gave top yields and, despite their reservations concerning the additional labour required, all farmers expressed an interest and their intention to implement the practice the following season.
- The shortage of arable land in the region means that many farmers wait until they harvest the food crops before planting cotton. This often results in late sowing. The climatic events of recent years have, however, highlighted the importance of early sowing. On the whole, the farmers ultimately agreed that sowing cotton early is a major factor in determining the final yield.
- In view of the performance of the plot planted with treated seeds, the farmers were prepared to buy effectively treated seeds rather than continuing to use the seeds

that they are usually supplied with, as soon as treated seeds have a high germination rate.

- The farmers were aware of the impact of weeds on their crops. They were all convinced that regular hoeing or herbicide use were both crucial for good yields. They were all familiar with herbicides, but some were reluctant to use them because of the cost.
- Beneficial insects: before the FFS, all farmers considered that any insect found in a cotton plot was a pest. The self-paced training sessions enabled the farmers to distinguish between the main pests and auxiliary species, with the aim of preserving the latter.

The most easily adopted practices were primarily those not requiring any additional input purchases or substantial labour. However, the farmers seemed to be most convinced about the benefits of high planting density – although this practise is labour-intensive – given the high yields obtained in the demonstration plots. The appeal of treated seeds will have to be confirmed once the farmers actually have to purchase them and check the financial consequences of having to pay for them.

Creation of specific images to boost farmer awareness

The fifth finding concerns the component of the training programme where farmers were asked to produce drawings about pests and damage the results varied from village to village.

In the first year, all the participants were very enthusiastic and competed with each other to illustrate what they had seen in the field as accurately as possible. The number of posters and drawings produced since then has, however, dwindled. This trend mostly concerned poster production, since the farmers were more willing to produce their own drawings on paper. However, some refused to make drawings. This feature has to be considered carefully inside the group to ensure that the farmers come to the conclusion themselves whether posters and drawings are of benefit to them. Representing knowledge through visual images is extremely useful for research and extension, since it helps to generate a set of images that clearly show how farmers perceive the problems in the field. This could enable research and extension services to improve their own perception of pest problems at the field level and to describe some pests or types of damage differently and, eventually, to produce documents that are more tailored to farmers' concerns. Similarly, the FFS confirmed that farmers interpret pictograms printed on bottles of insecticides or other agricultural inputs in their own unique ways. The crop protection industry has already been forewarned about this problem (Tourneux, 1993) but up to now, no change has occurred.

CONCLUSIONS AND PROSPECTS

The FFS approach used to detect farmers' knowledge and approaches to crop management fitted with the description made by Anandajayasekeram *et al.* (2001) in terms of farmer participation, capacity building and empowerment. Such a participative approach provided interesting insights to understand the (lack of) adoption of IPM and ICM approaches. The great regularity of farmers' participation at FFS also indicated farmers' willingness to understand better their crops and to share their knowledge with their neighbours as well as with extension agents and researchers. Such a participative approach was much less appreciated by some facilitators who felt that it was calling their skills (and maybe social position) into question and did not appreciate as much a method leading to farmer empowerment.

The subdivision of the demonstration plot according to the various suggestions made by farmers during the discussions did not lead to marked differences in terms of yield, but were very useful as initiating discussions about the effect of density or fertilizers. In some cases, the reasons for the rejection or adoption of a technical message were relatively easy to pinpoint: lack of labour, access to technology, competition with other crops in the calendar or risk management. In some other cases it was difficult to identify the reasons for farmers' attitudes, either related to self-confidence, or tradition, or because we were unable to understand some needs and constraints. For these issues, more effort should be made to plan the sessions in order to facilitate identification of farmers' demand for technology and assessment of farmers' knowledge at the end of the training sessions. The information obtained will help in the definition of the research agenda, by integrating issues resulting from farmers' knowledge and a better undestanding of farmers' constraints in the IPM recommendations.

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REFERENCES

Anandajayasekeram, P., Mweri, A. M., Zishiri, O. J., Odogola, W., Mkuchu, M. and Phiri, M. (2001) Farmer Field Schools: synthesis of experiences and lessons from FARMESA member countries. *FARMESA, Harare, Zimbabwe.*

Asiabaka, C. (2002). Promoting sustainable extension approaches: Farmer Field School (FFS) and its role in sustainable agricultural development in Africa. *International Journal of Agriculture and Rural Development* 3:46–53.

Deybe, D. and Vaissayre, M. (2000). Are Farmer Field Schools an appropriate extension tool for IPM? The case of rice farmers in Indonesia. *Document de Travail 46*, CIRAD, Montpellier, France.

Kees, A. and Meermans, F. (1991). Integrated Pest Management and African Agriculture. *World Bank Technical Paper N° 142*. The World Bank; Africa Technical Department Series, Washington.

Kenmore, P. E., Gallagher, K. D. and Oii, P. A. C. (1994). Empowering farmers: experiences with Integrated Pest Management. *Entwicklung and Ländlicher Raum* 95:27–28.

Kogan, M. (1998). Integrated Pest Management: historical perspectives and contemporary developments. *Annual Review of Entomology* 43:243–270.

Lançon, J., Lewicki, S., Djaboutou, M., Chaume, J. and Sekloka, E. (2004). Decentralized and participatory cotton breeding in Benin: Farmer-breeders' results are promising. *Experimental Agriculture* 40:419–431.

Luttrell, R. G., Fitt, G. P., Ramalho, F. S. and Sugonayev, E. S. (1994). Cotton pest management: a worldwide perspective. *Annual Review of Entomology* 39:517–526.

Morse, S. and Buhler, W. (1997). *Integrated Pest Management: Ideals and Realities in Developing Countries*. London: Lynne Rienner Publishers.

Norton, G. W., Rajotte, E. G. and Gapud, V. (1999). Participatory research in integrated pest management: lessons from the IPM CRSP. *Agriculture and Human Values* 16:431–439.

Silvie, P., Deguine, J-P., Nibouche, S., Michel, B. and Vaissayre, M. (2001). Potential of threshold-based intervention for cotton pest control by small farmers in West Africa. *Crop Protection* 20;297–301.

Sinzogan, A. A.C., Van Huis, A., Kossou, D. K., Jiggins, J. and Vodouhé, S. (2004). Farmers' knowledge and perception of cotton pests and pest control practices in Benin. *Wageningen Journal of Life Sciences* 52:285–303.

Tourneux, H. (1993). La perception des pictogrammes phytosanitaires par les paysans du Nord-Cameroun. *Coton et Fibres Tropicales* 48:41–56.