CROP PROTECTION PROGRAMME

Facilitating the uptake of pheromone traps for *Maruca vitrata* in West Africa

R8411 (ZA0643)

FINAL TECHNICAL REPORT

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Dr Mark Downham

Natural Resources Institute, University of Greenwich
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Executive Summary

This project aimed to follow up new opportunities for the promotion of the pheromone and botanical technologies to cowpea farmers in West Africa, which had been researched and developed under earlier projects R7441 and R8300. They included exploring routes to commercialisation and using new data on pheromone blends to initiate trap use in other major cowpea producing countries in the region. The project also sought to disseminate previous research findings.

Attempts to begin implementation of pheromone traps for *Maruca vitrata* at new locations in NW Ghana and Nigeria were not possible for organisational and technical reasons, respectively. Although on-farm trap testing did take place at another new location in Burkina Faso, no captures at all were recorded.

On-farm testing of a ‘traps + botanical pesticide’ approach through well-supported FFS in 10 new villages, in Benin and Ghana, confirmed that infestations and yields were comparable (and input costs lower) to those obtained through use of conventional pesticides. However, a ‘pre-extension’ approach employed at previous FFS sites, in which trap use was completely voluntary and supported only by refresher training and free supply of lures, showed uptake by only a minority of farmers. Therefore, at present the traps cannot be said to be a technology capable of being taken up freely and sustainably without the intervention of researchers or extension staff, although significant progress has been made towards this goal. Principal constraints are the current lack of ready sources of traps and lures in locations close to farmers, allied to possible concerns of farmers over the extra requirement for monitoring the traps and collectively acting on capture data, together with a general conservatism regarding what it is still a radically new technology.

Efforts to facilitate uptake of traps at other levels met with mixed success. Plans for a joint marketing study with TechnoServe had to be abandoned for organisational reasons. An informal search by GOAN for a long-term distributor of pheromone lures in Ghana was not successful, although partners GOAN and OBEPAB can act in this capacity in the short-term. More positively, specialist inputs relating to EU pheromone regulations and toxicity were made to project R8430 to assist in drafting revised registration requirements and guidelines for biological pest control agents in Ghana, by EPA. It is understood that the new procedures are likely to be approved by the close of 2006. The CNAC is undertaking a similar revision of its procedures in Benin. Assuming these changes do take place in year or two, they should create a much more favourable environment for pheromone products to achieve wider acceptance and uptake.

Outputs of the present and previous project phases were publicised effectively in a variety of forms, i.e. an end-of-project workshop, a project website and a newsletter article appearing in on-line form and in a published journal. A training video on trap use, for farmers and extension workers, was produced and a discussion document focussing on lessons to be learnt from experiences of implementing pheromone technology in West Africa was written and will be circulated to interested parties in the region.

Background

Research conducted under projects R6659 and R7441 identified an attractive synthetic pheromone blend for the legume podborer, *Maruca vitrata* (Downham *et al*., 2003). Under R7441 effective and practical traps and lures were developed for the first time (Downham *et al.*, 2002; Downham *et al.*, 2004). Trap lures, now commercially available, remain attractive for up to 4 weeks under field conditions, while the most effective traps are those produced from locally available 5-litre plastic jerry-cans. A single trap with lures costs about £3 to produce and operate for one season (this figure includes opportunity labour costs for the farmer and the trap itself is re-usable).

Pheromone trap-catches have been found to occur several days before larval infestations in flowers (Rurema, 2001; Downham, 2003) and thus can be used to provide an early warning of infestations. Based on these findings R7741and the present project (R8300) have developed the use of traps as monitoring tools to aid control of *M. vitrata* by cowpea farmers. For this, the general approach has been of the form 'spray x days after a threshold of y moths per trap is reached'.

The principal collaborator in this work has been IITA at Cotonou, Benin but Farmer Field Schools (FFS), operating under the IFAD-funded PRONAF (*Projet de Niébé pour l'Afrique*) project, have been extensively involved under local leadership of several NARES and NGOs in Benin and Ghana.

On-station trials of the trap-threshold concept have provided evidence of its effectiveness, compared to spraying based on crop stage. On-farm trials during 2002 and 2003 sought to develop an integrated approach in which traps were combined with botanical pesticides for the control of *M. vitrata* as well as other pests; this was compared against treatments using recommended synthetic pesticides (in combination with traps or not) and locally varying farmer practice. Traps were found generally to improve control by optimising the timing of application. Although botanical-based treatment often do not perform as well as conventional pesticides, in terms of yield or infestations, their lower input costs can be sufficient to produce similar economic returns. Where local farmer practice is normally not to spray, due to cost considerations (e.g. northern Benin) combined traps and botanicals treatments do produce large increases in yield and economic return (Downham, 2003 and unreported results from R8300).

Based on accumulated experience the final, developed recommendation is that farmers spray against *M. vitrata* three days after a mean cumulative catch of two moths per trap is reached - where this threshold is based on catches in at least six traps within a village. However the final choice of spray timing and control agent is left to farmers' individual choice, taking into consideration the severity of other, non-*Maruca*, infestations.

Pheromone traps for *M. vitrata* have not worked well outside Benin and Ghana (Downham, 2003), but the recent finding by a PhD student at NRI of a possible extra pheromone component has re-opened the possibility of trapping elsewhere using a modified pheromone blend. Testing the feasibility of this is the subject of an add-on activity recently approved for R8300. Trials at five sites in Burkina Faso, Nigeria, Benin and Ghana have recently commenced and results should be become available from October 2004.

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Rurema, D.-G., 2001. Dynamique des populations de *Maruca vitrata* (Fabricius) (Syn. *Maruca testulalis* Geyer) (Lepidoptere, Pyralidae) dans les cultures de niébé (*Vigna unguiculata*) (L) Walp.: Relation entre infestations larvaires et les vols des adultes sous l'attrait de pheromones. Diplome d'Etudes Superieures Specialisées en Amènagement et Gestion des Ressources Naturelles, Université Nationale du Bénin. 68pp.

Project Purpose

During the course of R8300 new opportunities for the promotion of the pheromone and botanical technologies were identified, these included exploring routes to commercialisation and using new data on pheromone blends to initiate traps use in other major cowpea producing countries in the region. These avenues were followed up in the current project, and previous research findings were also disseminated and publicised to reach a larger audience.

Research Activities & Outputs

1.1 Trap demonstration to organic cowpea farmers in Upper West Region, Ghana

It had previously been established that there exists a small group of farmers who grow organic cowpea in the Upper West region of Ghana. This is marketed with the assistance of the NGO TechnoServe to Nestlé for export use as baby food. It was thought that such a group of farmers might be particularly interested in the use of pheromone traps which might be used to optimise their applications of botanical pesticides. Consequently, it was planned that a farmer field school (FFS) or short course of demonstration of the traps and the trap threshold approach would be arranged and overseen by an existing partner, provisionally GOAN.

Unfortunately, this activity was abandoned by the project leader following firstly, a delay in the response of TechnoServe to messages seeking to make arrangements for the on-farm work, then apparent reluctance from them to be involved when a reply was received. Clearly this occurrence was disappointing but it is hoped that future involvement of TechnoServe and/or the organic cowpea farmer group with pheromone traps for *M. vitrata* is not ruled out. The project leader has made every effort to maintain cordial relations with TechnoServe and indeed answered a list of questions they had regarding their potential involvement. Copies of project dissemination outputs will be sent to them to try to maintain contacts and renew their interest.

TechnoServe are an important NGO in Ghana because they can greatly facilitate new agricultural entrepreneurial initiatives through their business experience in this sector. It would appear they try to do this by assisting the initial start-up through helping with appraising market demand, drafting business plans and accessing credit facilities. They could still be of value in promoting pheromone trap uptake but how their practical involvement can be achieved needs to be re-assessed. Based on the project leader's experience to date the following is suggested in regard to any future approach to TechnoServe:

- The plan for their involvement with a marketing study and business plan – originally suggested as Activity 2.1 below – remains a good one, but it needs to be made clear that no financial or significant staff time investment from them is required, at least initially;
- A good length of time needs to be allowed for this activity (at least a year) with a small but periodic involvement from them to ensure progress in an appropriate direction;

- Only once this is complete should a practical involvement such as the organic cowpea farmer group be contemplated.

1.2 New FFS exploring trap use in Burkina Faso and Nigeria

This activity was proposed to follow-up add-on activities carried out in late-2004 under the previous project phase, R8300, although the results of that were not yet available at the time of submission of the PMF for the current phase. The add-on activities had consisted of a series of replicated, on-station trials to compare attraction of *M. vitrata* to traps using a modified pheromone blend, incorporating a potential new constituent (see R8300 FTR). The overall objective of the add-on trials was to try to identify a blend that would be effective in the important cowpea-producing region of northern Nigeria, to test the pheromone's effectiveness for the first time in Burkina Faso and to test the new- against the standard-blend in areas of Benin and Ghana where the project had already worked.

The intended objective of the present activity assumed a successful outcome to these blend trials in Burkina Faso and Nigeria. It was proposed that some small-scale exposure of farmers in the respective countries, to the technology, would be achieved through FFS. There would be one FFS per country, each to be overseen by the existing PRONAF teams, led by the *Institut de l'environnement et de Recherches Agricoles* (INERA) and the Institiute of Agricultural Research, operating in Burkina Faso and Nigeria, respectively.

In fact the new pheromone blend component provided no improvement in catches in the trial at Kano, Nigeria hence it was not deemed worthwhile proceeding with the planned FFS activities there in 2005. At Bobo-Dioulasso, in western Burkina Faso, the principal blend component alone had been shown to provide good catches (in contrast to previous results from Benin) in 2004. For the 2005 season, after correspondence between the project leader and the leader of the INERA team, Dr C. Dabiré, it was decided to carry out a farmer participatory comparison of the single blend component and the standard 3-component lures in two villages around Kamboinsou, some 250 km to the east of Bobo-Dioulasso. This comparison involved multiple pairs of jerry-can traps positioned in farmers' fields, each baited with one of each lure type. It was hoped that this plan would, at the same time, allow farmers to observe the predictive capacity of traps and provide a check of previous results in respect of pheromone blend. The new site was preferred to Bobo-Dioulasso because no institutional capacity existed there to support on-farm activities.

Unfortunately, despite very high infestations of larvae in cowpea fields around Kamboinsou, no captures of *M. vitrata* moths were recorded in traps baited with either of the two types of lure – in complete contrast to the earlier results at Bobo-Dioulasso. The problem therefore seems to be similar to that encountered previously at Kano, in Nigeria. Discussion of possible explanations took place at the end-of-project workshop (see Activity 3.3 below). Both Kano and Kamboinsou are in different agro-ecological zones to other areas where traps are effective. They are characterised by particularly heavy infestations of *M. vitrata*. One possibility may be that the high densities of female moths effectively out-compete the synthetic lures for the attentions of males. Other factors, physiological or climatic, also remain possibilities. It is also conceivable, given previous findings of geographical variation in blend, that the optimum blend in these particular locations remains to be discovered. Only a further programme of basic research is likely to resolve this question.

1.3 Continuation of FFS programme in Benin and Ashanti and Brong-Ahafo Regions, Ghana and 1.4 Assessment of traps and botanicals use by farmers at previous FFS sites

In regard to Activity 1.3 the intention was that the existing programmes of FFS in Benin and Ghana would be continued, involving 4 - 5 villages per country, but the emphasis would be on involving villages not previously exposed to the technologies. The existing partners, the *Projet de Niébé pour l'Afrique* (PRONAF) and the *Organisation Béninoise pour la Promotion* *de l'Agriculture Biologique* (OBEPAB) in Benin, and the Crops Research Institute (CRI) and the Ghana Organic Agriculture Network (GOAN) in Ghana would oversee these FFS.

For Activity 1.4 it was planned that there would be a monitoring and evaluation exercise in respect of former project sites. These would be revisited prior to the 2005 cowpea season to gauge the proportion of farmers still expecting to use traps and botanicals. This would allow lessons to be drawn regarding dissemination. Existing partners would supply pheromone lures to farmers at these sites (lures would be ordered from a European manufacturer by the partner organisations and re-sold to farmers).

Changes to the above plans were made as follows, as they were seen as likely to lead to successful long-term uptake. They were agreed between all relevant project partners. A '*pre-vulgarisation* (pre-extension) phase was to constitute the 2005 season's activities, with a view to this laying the foundation for a self-sustaining full uptake phase from 2006 (although this could receive support via PRONAF).

The plans were developed during two, 2-day planning workshops held in June (Benin) and August (Ghana) and FFS and allied on-farm activities as set out below commenced September-October and finished in December. The revised plans allowed for:

- 10 villages (6 Benin, 4 Ghana) to host conventional FFS centring on cowpea IPM, including pheromone traps for *Maruca* as well as the use of botanical insecticides – farmers in this case would have no previous exposure to pheromone traps;
- 10 further villages (6 Benin, 4 Ghana), termed the 'pre-extension' villages with previous experience of traps; in this case farmers would manage their own use of traps with minimal support from PRONAF or the project except for supply of lures;
- A socio-economic element to further determine constraints to, and conditions necessary for, an effective transition to self-sustaining uptake.

New FFS sites

The FFS trials in villages whose farmers had not previously experienced traps all followed similar models. Under the auspices of the FFS, and with technical advice and support from a project technician, the trap threshold was applied and compared with standard farmer practice in the area – a broadly similar approach to previous years. Field owners or tenants were included in each FFS, plus a number of other interested individuals, making at least 20 farmers per village. Following introductory talks and training, 6 - 10 traps were positioned in individual cowpea fields around the village at the beginning of the season. Farmers shared information about captures and when the threshold of an average catch of two moths per trap was reached, spraying within three days was advised. They collectively decided the best control agent to apply in their fields – botanical or conventional pesticide – and exactly when to apply it, taking account of the overall pest situation. The FFS were supported by fortnightly FFS meetings and more frequent, informal technician contact.

In the two villages in Ashanti Region, Ghana overseen by CRI the trap threshold approach was combined solely with 3 – 4 sprays of botanical pesticides (neem seed and papaya leaf extracts) and was compared to a farmer practice involving the same number of sprays of conventional pesticides. *M. vitrata* catch and pod infestations were fairly high, but yields and levels of infestations were similar in each treatment. The CRI summary report is at Annex 1.

Few details are available for the GOAN-managed FFS in Brong-Ahafo but the technologies, particularly the botanical pesticides appear to have been well received by the farmers. The GOAN summary report is at Annex 2.

The PRONAF team in Benin managed four FFS, two in Couffo department and two in Les Collines. Of the four, one used with conventional pesticides in both the traps and farmer practice fields, the other three the traps were combined with botanicals (neem or *Hyptis* leaf extracts). Two or three sprays of each application were made in each case. Catches in traps were good, but pod infestations were low and no yield or infestations differences were evident. The PRONAF summary report is at Annex 3.

OBEPAB oversaw two village FFS near to Kandi in northern Benin. In one village farmers decided to combine traps use with neem leaf insecticides (4 sprays) and compared this with the same number of Endosulfan applications; in the other, traps + botanicals was compared with no treatment (in this area it is common not to spray cowpea). Trap captures were quite high but *M. vitrata* pod infestations generally moderate. In the botanicals *vs.* Endosulfan FFS yields were similar in each treatment, but infestations generally lower in Endosulfan fields. Unsurprisingly, the traps and botanicals approach produced greater yields and lower infestations than no sprays in the second village. The OBEPAB summary report is at Annex 4.

No report of activities is available from GOAN, but based on the other three, the FFS trials of 2005 were successful in terms of training of new farmers in the use of traps and the demonstration that a combination of the trap threshold and botanical pesticides could produce similar yields to normal farmer practice involving multiple sprays of conventional pesticides. It is clear from previous economic analyses (R8300 FTR) that the latter would have involved significantly higher input costs.

Pre-extension sites

As with the FFS trials above, CRI, GOAN and OBEPAB supported two villages each and PRONAF four, each of which had previously received FFS training and demonstration in trap use. The general approach however, was much more ‘hands-off’. Each village was provided with pheromone trap lures and with refresher training in trap manufacture and use, but otherwise farmers were left free to decide whether or not to utilise the traps (and botanical pesticides). Contacts with the respective project partner institutions were less frequent and no formal, regular FFS meetings took place.

In the case of the CRI villages only nine out of 24 previously trained farmers adopted some aspect of the traps and botanical technologies, only six of these used the traps. The reasons for this relatively low uptake (despite previous, apparently successful, FFS) are not entirely clear. Clearly there were general concerns about availability of lures, but in this instance this should not have been an issue.

The number of farmers implementing traps in the GOAN sites is not given in their report but one novel observation is made. The accidental trapping of non-target insects in the traps seems to have caused some concern or elicited interest. Apparently farmers want to establish similar traps in other crops (tomato is particularly important in the area) to catch pests there – this is interesting, and could be possible in principle, but the suggestion seems to imply a lack of understanding concerning the specificity of the pheromone lures.

Precise numbers of farmers using the technologies of their own initiative are not available from the PRONAF report, but of the four identified villages, one ‘had to be abandoned’ for reasons not made clear. In regard to the remaining three, some ‘disinterest’ was noted among some farmers resulting from the infrequent visits of the project team. As a result village chiefs were apparently obliged check traps and collate trap catch data in some instances. They, and some farmers whose fields held traps, also tried to claim money for the extra responsibility. The report concludes positively, but suggests that greater technical support may be necessary to ensure greater levels of traps use.

OBEPAB report that in the two villages they oversaw there was no use of the pheromone traps by farmers, although botanical pesticides were taken up enthusiastically – even among farmers not previously included in project activities. In respect of the uptake of botanical pesticides they cited motivations as being economic, social prestige and acquisition of knowledge and the health benefits of not using toxic pesticides. Higher levels of general education and membership of farmer organisations were positively associated with likelihood of uptake. Obstacles were considered to be a lack of physical and financial access to trap materials, lack of time/manpower on the part of farmers for checking plots and lack of posters and training leaflets. The report suggests, like PRONAF, that a greater physical presence of project staff is necessary.

Follow-up surveys at the pre-extension sites

Surveys were undertaken in January 2006 at two villages in each of the five main project areas, le Couffo, les Collines, l'Alibori in Benin and Brong-Ahafo and Ashanti regions in Ghana. Forty-five farmers from each village were surveyed including previous FFS participants/non-participants and trap users/non-users during the pre-extension activities of the 2005 season. As yet only preliminary results are available for the two villages of Couffo and one in les Collines (see Annex 5). These suggest that at these sites 36 – 37% of farmers would be prepared to buy traps, while 34 – 43% and 74 – 80% would buy pheromone lures and ready-made botanical pesticides, respectively. A significant constraint to trap use among the surveyed group – mentioned by one-quarter of farmers – was the time involved in checking the traps three times per week.

Conclusions

Clearly, it is disappointing that despite previous encouraging results with the trap threshold approach (in FFS) uptake of trap use across the sites was low or associated with 'disinterest' where it was used. More frequent visits by technical support personnel may help to overcome these problems, but obviously this cannot continue beyond the short-term. The time taken to monitor traps (and presumably the labour of making traps from them) is a constraint stated by around 25% farmers in les Collines and le Couffo in Benin, although this figure would have to be higher to account for the low level of uptake in other areas. Fuller results for the post-season survey may shed light on this, but it may be that farmers are simply not ready yet, to make a widespread shift to a new (though not totally novel) technology whose rationale departs significantly from their normal experience, and which may still be regarded as potentially risky. Only time and continued exposure to the traps may help with this. One measure to address this might be to present real comparative yield and infestation data (in an appropriate format) to farmers. Those used could be the data obtained in the farmers' home village for the previous year. This might help to overcome fears as to the risks of the technology and its approach.

<u>2.1 Marketing study for traps and botanical pesticides</u>

Discussion with TechnoServe during the previous phase indicated that they would require tangible evidence of farmer demand before they would consider active assistance with commercialisation of trap and botanical pesticides. The project's original aim was to address this through a marketing study to be carried out by the IITA socio-economist. TechnoServe were to be consulted at the outset to delineate Terms of Reference and a report would be produced which would go to them, amongst other stakeholders. The report would have provided sufficient information to enable a generic business plan to be drawn up. It would, for example, have included surveys of farmers to examine levels of adoption of traps and reasons for this, in areas where traps have been previously introduced.

Considering the reticence of TechnoServe, noted under Activity 1.1, some revision of this activity was carried out. The revised 'pre-extension' and socio-economic activities under 1.3 and 1.4 would provide some information on farmer uptake and adoption at previous FFS sites. Some information on willingness-to-pay had been obtained during the previous project phase (see R8300 FTR) while in addition, agreement was reached at the planning workshops that from 2006 GOAN and OBEPAB would act as short-term intermediaries for the purchase and distribution of lures, probably on a cost-recover basis. Most project partners are prohibited by local law or their respective statutes from acting in a commercial capacity.

GOAN volunteered to undertake an informal search to locate a longer-term distributor of pheromone lures but the conclusions (see Annex 2) indicate no success in this regard. This is attributed to two factors: a lack of general publicity about the project or pheromones in Ghana and a lack of specific information concerning the likely commercial viability of the traps and lures. This underlines the need for a formal marketing study. The GOAN report further notes the desire for farmers to be able to buy traps and lures from their local agricultural input supplier.

2.2 Lesson learning in relation to pheromone technology implementation in W. Africa

The NRI project leader, Dr Downham, has overseen CPP-funded research on *M. vitrata* pheromone trapping in West Africa since its inception in 1998 (R , R7441, R8300) and has been involved with cocoa mirid pheromone research in Ghana since 1999 (R7249, R8313, R8448). Based on this experience he undertook to write a discussion document in which specific and general lessons learnt from introducing these still relatively novel components of IPM would be summarised. A draft of this document is included as Annex 6. It is intended that the document will circulated to project partners plus EPA, CNAC and TechnoServe.

The document concludes that, as regards actual and potential constraints to uptake of traps by farmers, some common themes have emerged from the two projects. Among the most serious is the current lack of any pheromone lure, or trap production, capacity within West Africa. Importing elements of the technology from Europe, N. America or SE Asia would be possible, but expensive, while establishing local production has not yet proved possible. Further adaptive or implementation projects could address this difficulty by setting aside funds specifically to be paid to potential private sector manufacturers for initial batches of traps or lures, they might also consider setting up revolving funds to allow farmers to pay for the traps and lures.

Of course a market demand from farmers for the technologies needs to exist for uptake to occur and this yet to be firmly established in both of the cases examined. In the case of the M. vitrata traps the lack of a market for reduced-pesticide cowpea acts as a disincentive for the adoption of traps as monitoring tools which would reduce pesticide usage. The additional labour of checking traps apparently also reduces farmers' willingness to use them in this case, and there also appears to be a general unwillingness to risk the use of an as yet relatively novel technology. Both might prove to apply in the case for cocoa mirid traps too, when practical testing reaches that stage. Similar disincentives for adoption of pheromone traps can be seen if one considers the availability of subsidised pesticides from the cotton sector in Benin and the Government-funded cocoa spraying programme in Ghana.

At the time of writing no specific official registration or regulatory framework exists for biological pest control agents such as pheromones, so the alternative is either to avoid registration altogether or attempt to achieve registration using the existing, unsuitable and onerous system for conventional pesticides. Fortunately the competent authorities in Benin and Ghana, CNAC and EPA, respectively are revising their regulatory procedures. Registration of either the M. vitrata or the cocoa mirid pheromones under the new procedures should facilitate their eventual adoption since they would confer increased confidence in their efficacy and consistency on the part of their users – farmers.

2.3 Inputs to R8430, "Development of biopesticide registration and risk assessment guidelines for Ghana"

The original plan was that the NRI project leader would provide specialist pheromone inputs to proposed activities under the above-named project led by Dr A. Cherry of NRI as an extension to his project R7960. As a result of health problems the project leader was not able to travel to W. Africa until August 2005. For this reason and later conflicting commitments, he was unable to attend R8430 workshops in Accra. However, specialist information concerning EU pheromone regulations and pheromone toxicity was supplied to

Dr Cherry by Prof. D. Hall to assist in drafting appropriate risk assessment and registration guidelines. Progress by the EPA towards this is understood to be good (see R8430 FTR).

3.1 NRI web pages summarising *M. vitrata* pheromone trap research

Web pages were developed within the NRI website summarising research under R7741 and R8300. These can be found at http://www.nri.org/maruca. Material includes previously published accounts of the *M. vitrata* pheromone identification, development of traps and lures as well as unpublished research on the development and implementation of the trap threshold. A list of project publications is given and the two training posters and the training leaflet (outputs of R8300) can be downloaded from the site. It is anticipated that NRI will support these pages for several years to come.

3.2 Research summary for online newsletter

It was planned that a research summary article, also based on outputs of R7441 and R8300, would be produced for the *i.new* IITA online newsletter. This ceased publication in 2004, but instead a two page article was accepted by The International Association for the Plant Protection Sciences (IAPPS) for online publication. This can be accessed from http://www.plantprotection.org/news/NewsApril06.htm and it will also appear in the April 2006 issue of the journal, Crop Protection. The target audience for this, and outputs of Activity 3.1, is agricultural researchers within Africa. A copy of the relevant issue of the IAPPS newsletter, complete with the article appears as Annex 7.

3.3 Further dissemination of practical findings

Practical dissemination focussed on the production of a short training video, to provide instruction in the construction, use and function of pheromone traps for *M. vitrata* to extension workers and farmers. The video was produced by a small Cotonou-based company, Studio Glitholabo, and commissioned by IITA. It is approximately 10 minutes long and makes use of footage of pheromone-trap oriented activities at one of the PRONAF-led FFS taken in October 2005 and uses commentary in French, by an IITA staff member. Fifty copies in V-CD format were produced. Copies will be distributed to all partner and similar organisations within West Africa (including TechnoServe).

It is too early to gauge the reaction of farmers or extension workers, or to judge the practical impact of the video upon eventual uptake. However during the previous project phase farmers in Benin had suggested that more training in trap use would be beneficial, and the video should be a good way of reinforcing practical demonstrations within an FFS forum. The video can be shown relatively easily in a field situation using a lap-top computer.

End-of-project workshop

A workshop was held at IITA, Cotonou 14 – 15 December 2005. Strictly speaking this was an activity of the previous project phase held over for a year because the project leader was unable to travel at that time. A total of 25 people attended the workshop including the project leader, the seven IITA staff most closely associated with the project plus some eight others, two representatives from project partners OBEPAB and INRAB in Benin, one each from CRI and GOAN (Ghana) and one from INERA (Burkina Faso). Finally, Dr J. Boulga of the *Comité d'Agrément et de Contrôle des produits phytosanitaires* (CNAC) of the *Service Protection des Végétaux et Contrôle Phytosanitaire* and Dr P. Prudent, a French entomologist on secondment from CIRAD but working with the cotton programme of INRAB, also attended. Dr Boulga's homologue from the Ghana Environmental Protection Agency, Dr J. Pwamang, was also invited, but was unable to attend. Dr Boulga and Dr Pwamang were invited to provide their overviews of the regulatory position of pheromones in Benin and Ghana, and to allow them to learn more about one possible use of pheromones. EPA had hosted the workshops held under Dr Cherry's "Development of biopesticide registration and risk assessment guidelines for Ghana" project, and Dr Boulga had participated as an observer.

The workshop programme comprised a brief history of the technical development of the traps from the project leader, description of their current use by IITA staff, plus a viewing of an early version of the training video (subsequently re-edited), then project partners gave summaries of their practical experiences with the implementation of the traps since the 2003 season and there were presentations from IITA staff based on surveys of farmers' perceptions concerning the traps and botanical pesticides and on cost-benefit analyses of trap use. On the second day Dr Boulga gave a review of the current and future regulatory status of pheromones in Benin. It was intended that the EPA representative should have done the same for Ghana but, following his non-attendance, Dr H. Braimah of CRI stepped in. He provided his understanding of the position in Ghana, having also participated in some of the EPA workshops that took place under R8430. Finally, attendees split into three working groups to consider existing and potential constraints to implementation of the pheromone traps and how these might be addressed in any possible future project. These were grouped into 'technical', 'socio-economic' and 'policy' constraints (and solutions). Each group provided an outline of its own thoughts on its respective area; these were then discussed further by the project leader with Drs Tamò and Coulibaly from IITA before being written up in a more digested form. This output document is given as Annex 8 and also appears on the project website referred to under Activity 3.1. Its conclusions were fed into the lesson learning document produced under Activity 2.2.

Contribution of Outputs to developmental impact

The project reached 200 – 300 new farmers in 10 villages in central Ghana and in three regions of Benin, through five institutional partners, thus adding to the 500 farmers in 26 villages exposed to the pheromone traps and botanical pesticides during the previous phase of the project (R8300). In combination with botanical pesticides a trap threshold approach can produce yields equivalent to normal farm practice, with reduced input costs and use of toxic pesticides. However, at present the traps cannot be said to be a technology capable of being taken up freely and sustainably without the intervention of researchers or extension staff, although significant progress has been made towards this goal. Principal constraints to full uptake are the current lack of ready sources of traps and lures in locations close to farmers, allied to possible concerns over the extra requirement for monitoring the traps and collectively acting on capture data, together with a general conservatism regarding what it is still a radically new technology. Continued exposure to the traps and practical and moral support from trained extension workers may help to overcome the latter two issues, although it is recognised that such support could only be of limited duration. Ultimately, the private sector will probably have to provide the necessary local production and distribution network for traps and lures. Imminent changes to state regulatory frameworks for pest control products should greatly help this process. Ideas such as the provision of funds to producers initiate production, and to farmer organisations to provide revolving funds for purchase, could be actions for a future promotional initiative, although it remains for specific entrepreneurs to be identified.

A lack of trap captures at an FFS site at Kamboinsou, Burkina Faso has further demonstrated the apparent variable distribution of responsiveness to synthetic pheromones among *M. vitrata* populations in West Africa. Further basic research on the reasons for this will be required before *M. vitrata* pheromone trapping becomes technically feasible in Nigeria and Burkina Faso.

Outputs of the present and previous project phases were publicised effectively in a variety of forms, i.e. an end-of-project workshop, a project website and a newsletter article appearing in on-line form and in a published journal. A training video on trap use, for farmers and extension workers, was produced and a discussion document focussing on lessons to be learnt from experiences of implementing pheromone technology in West Africa was written and will be circulated to interested parties in the region.

Acknowledgements

This project was very much a collaborative effort and was only possible due to the unstinting efforts of many individuals within the partner institutions. The principal collaborators were the International Institute of Tropical Agriculture (IITA) in Benin, but vital contributions were also made in Benin by the *Institut National des Recherches Agricoles du Bénin* and the *Service Protection des Végétaux et Contrôle Phytosanitaire* within the *Projet de Niébé pour l'Afrique* and by the *Organisation Béninoise pour la Promotion de l'Agriculture Biologique*. In Ghana contributors included the Crops Research Institute and the Ghana Organic Agriculture Network.

I would particularly like to thank the following individuals:

- Mme. S. Adetonah, Dr O. Coulibaly, Mr B. Datinon, Mr B. Gbaguidi, Mr D-G. Rurema, Dr M. Tamò (IITA, Cotonou)
- Dr C. Agli, Mr T. Houndete (INRAB)
- Dr S. Vodouhè (OBEPAB)
- Dr H. Braimah (CRI)
- Mr S. Adimado (GOAN)

Biometrician's Signature

Not applicable. There were no substantial new biometric issues to address in the information presented in this report.

ANNEX 1

CRI Summary Report of FFS and Pre-extension activities

Using Pheromones to Monitor and Manage *Maruca vitrata* Populations on Cowpeas in Ghana: A Farmer Field School Approach

H. Braimah[1], M. Owusu-Akyaw[1], M. B. Mochiah[1], H. Azoctiba[2] and E. Agyekum[1]
[1] =*Crop Protection Division, Crops Research Institute, Box 3785, Kumasi*
[2] = *Ministry of Agriculture, Ejura Station, Ashanti Region*

Introduction

Pheromone traps were successfully used to monitor and control the cowpea pod borer, *Maruca vitrata* in Hiawoanwu, Bonyon and Dromankuma in Ejura in the forest savannah transition belt of Ghana during the minor rainy season of 2004. The main idea behind the technology was the use of the principle of pest thresholds to guide the application of pesticides to ensure maximum effectiveness. The technology was disseminated through the farmer field school approach. Farmers who used pheromone traps were encouraged to use only pawpaw (papaya) leaf extract to control flower thrips, and neem seed extract to control *Maruca* when the threshold of two adult *Maruca* per trap was attained. This was meant to minimise the risk of chemical poisoning associated with cowpea pest management and also conserve beneficial organisms. Farmers were however free to use any suitable insecticides once the threshold had been established. The populations and damage of pests as well as performance of of the cowpeas on the fields of these farmers were compared with those of other farmers who continued to use their usual practices of managing cowpea pests.

The seed yields in pheromone monitored fields and fields of farmers own practice were similar. The results showed that when effectively monitored, *Maruca* could be efficiently managed by use of botanical extracts such as neem. They also indicated that cowpea yield losses could not be adequately curtailed by the control of only *Maruca* as seed quality appeared to be more adversely affected in cowpeas that were treated with botanical extracts than in farmers practice because the pods were not adequately protected from pod sucking bugs. This difference in seed quality may not necessarily translate into significant yield losses.
The results were also an indication of the potential to reduce the use of noxious chemical pesticides in the cowpea cultivation and conserve the environment and reduce risk of pesticide poisoning to farmers and consumers.

During the same period in 2005, the groups in Hiawuanwu, Dromankuma and Bonyon were weaned off the FFS and allowed the free hand to either go back to their old practices or adopt the new technology. The frontiers of the project were however expanded to cover two other villages. The number of participant farmers per village was also increased to 20 from 12 to ensure that a good number of farmers benefited from the technology.

The protocols of the 2004 FFS were adopted for the new FFS villages.
Thus as in 2004, farmers were encouraged to stick to the use of pheromone traps to monitor *Maruca* but were allowed a free hand to use any insecticides to control insect pests on their cowpea fields except those specifically designated for cotton and cocoa.

Materials and Methods

Location and Farmers
Two villages, Ejura-Nkwanta and Kasei, both to the North of Ejura, were chosen for the execution of the project. Nkwanta is about 6 km north of Ejura while Kasei is about 2km further north along the same road. Both villages are typical food crop farming villages with cowpea featuring prominently as a commercial crop. The villages were selected using the criteria of ease of access and previous exposure to extension activities. Twenty farmers were selected per village, making a total of 40 farmers. As prescribed in the protocol, farmers in each village were divided into two equal sized groups of ten each. The groups were then assigned the practice of either pheromone monitored pest management or farmer practice. Farms were selected to be within a kilometre radius of each other. Efforts were made to ensure gender balance.

Land Preparation and Planting
Each participating farmer was required to have a minimum field size of 20mX20m. Every farmer in the school had a field larger than the required size (see Table 1). All the planting was done in September and were within seven days of each other. Farmers were encouraged to plant one variety of cowpea where possible, otherwise they were allowed to plant a variety of their choice. Details of the varieties

planted and the planting dates are presented below in Table 1. Indeed except for two farmers in Nkwanta who planted “Asetenapa”, all other participant farmers in both villages planted “Mallam Yaya”.

Other supplies
Ampoules of the *Maruca* pheromone for the execution of the project were provided from IITA Benin Station. Traps were constructed from clear white 5 litre plastic gallon containers. These were constructed locally with the farmers participating. Farmers involved in the pheromone monitored pest management approach each provided a stake on which to mount the trap. Even though it had been decided that farmers of either approach could use any food crop related pesticides to manage *Maruca*, neem seed was made available for farmers who wanted to use it. With the environmental and other advantages of neem and the fact that cultural practices such as early planting and harvesting could be used to escape or reduce the ravages of pod sucking bugs (PSBs) on cowpea most of the farmers engaged in the trap monitored Maruca threshold trial used it.

Field School Activities
Field schools were held fortnightly. A combined school was held for the villages each time it came off but the venue was rotated between the two villages.

Data Collated
The data were collected and collated basically as determined in the prescribed protocol. However with the experience of the team additional data were collated to reflect the seasonal activities, crop phenology and insect/pest spectrum and dynamics

Results

The results have been compiled and are presented in tables attached. No attempts have been made to analyse them but it appears that there will be no significant differences in yield between the farmers practice and the pheromone monitored pest management fields especially within each village group. Yields were comparable for farmers’ practice and pheromone technology. This was probably assisted by the fact that all farmers in both practices planted literally the same variety. Thus yield differences were only attributable to edaphic factors such as soil fertility and the crop and land management practices such as weeding and their timely execution

With these results, the economics and cost benefit analysis may favour the use of the pheromone traps to monitor and manage *Maruca*. This will be very welcome especially when the adverse environmental impact of pesticides and the benefits of the use of botanicals and reduced use of chemical pesticides are considered.

Observations and Farmers Concerns

It was observed that, as in the earlier villages, despite the regular reminders of the need to adopt simple cost saving practices such as germination tests, refilling after germination, thinning out and early weed control many farmers did not adhere to the advice. Discussions on the importance of these practices both on farmers’ fields and during school days indicated that most farmers here were also faced with the dilemma of labour. They also relied on contract labour for planting, weeding and harvesting and thus could not be timely in periods when labour was in short supply due to high demand. Framing practices here were similar to Hiawuanwu and others, with most farmers cropping too many fields of different food crops with similar input and cultural practice requirements to attend to. As a result even with the usual serious and conscious efforts to meet time schedules of various agronomic practices in all cases, it was often not possible to achieve. Poor land preparation, especially deep ploughing not followed by harrowing or levelling, was also observed to contribute to poor plant establishment as it promoted poor distribution of rain water and encouraged runoff.

For varieties, farmers were more interested in those in high demand and thus only few planted any of the so called improved varieties. The setbacks of poor germination after heavy rains and susceptibility to bean blight after establishment did not deter farmers from planting the dominant Mallam Yaya. Mallam Yaya (Yahaya) is a white seeded semi-erect variety which is known to have both a good yield and high demand on the local market. This brought to the fore the need for local research to develop farmer acceptable white varieties that are robust enough to withstand the rough handling at field establishment and are tolerant to major pests and diseases of the locality.

Most of the farmers were impressed by the performance of neem extracts and confessed their willingness to substitute it for their earlier pesticides. In some cases other pesticides were used only after the neem extracts as supplementary control measures. Thus the future of the supply of neem seed and/or extracts and pheromones was a serious concern of farmers who expect to rely on pheromones to monitor their farms and pest in the future. With neem it is possible to collect seed from trees in the locality or import from elsewhere within the country. Same cannot be said about the pheromone. It will therefore be recommendable to have a local distributor to stock the pheromone so that it can be available to needy farmers.

Other concerns mirrored those of the farmers of 2003 and 2004. For example, the ineffectiveness of botanical extracts such as neem and pawpaw on non target pests such as pod sucking bugs, especially during periods of regular rains and dew was of serious concern. As an antidote farmers were encouraged to adopt early harvesting to avoid PSBs. Farmers were also reminded that there was no compulsion for the use of botanical pesticides, provided other chemical pesticides used were meant for food crops and were used only when fields were monitored to determine that the threshold had been attained.. Farmers are interested in botanical materials that will work as effectively as the synthetic pesticides on a regular basis. Thus the way forward is to encourage the production of standard quality neem and other botanical extracts that will guarantee optimal control for target pests and provide a bit of broad spectrum coverage of other pests.

Adoption by pre-extension farmers

The rate of adoption from farmers in previous schools was lower than 50%. Similar concerns as above that had been expressed by farmers in these earlier schools probably accounted for poor pre-extension phase adoption of the technology. Out of 24 farmers who were officially trained under the FFS regime only 9 adopted some aspects of the technology, with 6 using the pheromone traps.

CONCLUSION

The trials and the school programme for the year were very successful. Participant farmers and their associates showed a high level of confidence in the effectiveness of the technology and appeared to be willing to adopt it. It is apparent that adoption on a long term basis will however be achieved only if the concerns of farmers about the availability of the pheromones and good quality botanical formulations in ready to use forms that ensure their effectiveness against major cowpea pest through out the year are addressed.

ANNEX 2

GOAN SUMMARY REPORT OF FFS AND PRE-EXTENSION ACTIVITIES

General Perception of the Pheromone Trap activities for *Maruca vitrata* in West Africa

Introduction

The pheromone trap activity has been implemented from 2003 to 2005. The location for these three years activity is noted for cultivation of tomatoes as a cash crop. Cowpea is cultivated on a moderate level compared to tomatoes. Farmers resort to high utilization of synthetic chemicals in the cultivation of tomatoes, resulting in farmers attitude of using agro - chemicals in many crops, more especially those that will be sold on the market.

Issues

From 2003 to 2004, emphasise was only on Farmer Field School (FFS) where farmers were taken through a detailed FFS curriculum, using organic principles and practices to cultivate cowpea. In addition the 2005 activity comprised FFS and Pre-extension activity.

Overview of the activities could be described as successful based on the technical design of the programme. Farmers have appreciated the importance of using botanicals as a means of controlling insect pest on the field.

In addition the incorporation of small scale composting has gone a long way to enhance farmers' knowledge of using locally available materials to improve their soil fertility status.

The availability of locally existing materials (botanicals) to control insect pest and at the same time farmers realising and understanding the importance that, there are some insects that are not harmful to the crops but rather feed on the harmful insects so as to reduce their population has been very remarkable.

Perception

Perception of farmers in assessing the overall period of the pheromone trap activity could be described as a two-edge cutting knife.

The reason been that, immediately when you interact with farmers who have participated in the FFS training programme, they will attest to the fact that, if they are able to implement or practices what they have learnt and also share the knowledge gained with their colleague farmers, it will go a very long way to improve upon their farming activities and at the same time save money on inputs they would have bought if using conventional farming practices.

However, during the pre-extension phase, it was realised that, farmers find it very tedious to obtain and processed the botanicals introduced during the FFS period. Hence with those constraints, they resort to the use of synthetic chemicals. The use of the pheromone on cowpea fields to monitor maruca presence has been understood, but farmers are of the view that the process of knowing the presence of maruca has also resulted in other insects that could be described as harmful been trapped in the jelly-can containing water. By these observations farmers have expressed the desire of buying the lure and establishing their own traps on other crops of importance to them such as garden eggs, tomatoes, pepper and other leafy vegetable farms. The demand by farmers to buy the lure is very strong in the communities that have had the opportunity of FFS programmes.

Commercialization of the Lure

In line with the design of the activity and discussion initiated by Dr. Dowham, to identify agencies that will be interested in the commercial sense of importing and distributing the lure. Many attempts were made to enquire if some agencies and NGO's will be very much interested in that programme. However, it was realised that, the pheromone trap programme has not gained much publicity in Ghana and I guess West Africa. The importance of using the trap is easily seen, but it is very difficult to ascertain its commercial viability, in the sense that during commercialization, the money earned should able to cater for the cost of all the services involved and at the same time should be profitable. These observations indeed, become manifested when ever discussions are initiated on the topic.

Nevertheless, it was also observed that, at the local or community level, farmers are of the view that once adopting the pheromone trap and the botanicals means that the very input dealer at the community whom they have had so much interaction and have been patronising his products will be out of business because he has no alternative to meet their need. Farmers therefore indicated that, the lure could be made available at the local level where the input dealer will sell to them, in addition farmers wanted to know if there could be availability of neem seed that could be sold to them by the input dealer.

Personal Observation

It is apparent that, farmers like the technology or the practices introduced to them, however, there are still some issues, which borders on the project designed and it will be worth considering, such as:

1. Should there be a possibility of designing the project in such a way that it will transform the product distribution line of local input dealers to encompass that of botanicals, be it prepared or semi-prepared.
2. Should there be an attempt of trying a combination of two lures, be it that of tomatoes or pepper and cowpea etc.

Farmers in the communities (Derma area) have only one cash crop that is tomatoes, therefore with the introduction of cowpea pheromone trap activity there is the general desire to consider cowpea as a second cash crop. In the sense that, every year there is always a tomatoes glut in the major markets nearer to the community that is Kumasi, Techiman and Sunyani markets. Therefore, with the introduction of the cowpea activity some farmers have increase area of cowpea production so as to generate more income.

A farmer said that with the introduction of the botanical cowpea pheromone trap activity, he is not scared of eating cowpea that he has cultivated.

This revelation goes a long way to attest to the fact that, some farmers are aware of the dangers associated with indiscriminate use of synthetic chemicals. But once there are no alternatives and they must cultivate to generate income, the worse method of cultivation is always resorted to.

Recommendation

In view of the overall success of the cowpea pheromone trap activity, it will be remarkable to probe further as to what extent it will be sustainable if one considers issues rose in connection with the design of the project.

I will therefore recommend that the pre-extension phase should be repeated and intensified along side with what ever activity that will be initiated. This will go a long way to assess the possible sustainability of the technology.

In view of the commercialization of the lure, I guess that further consultation should be made to design a sustainable and profitable model to implement that. It is gratifying to note that, the two NGO's in the programme also have some partner activities with Agro Eco Consultancy a Dutch based firm with West Africa offices in Ghana. Agro Eco is very much interested in organic agriculture activities and sustainable agriculture. It will be worth encouraging Agro Eco to consider the possibility of designing a programme about the commercialization issue and look for money to implement.

Conclusion

The observation made in this document may have some contradictions in earlier report made, but this contradiction may have arising as a result of the pre-extension phase activity. On the whole this activity has made remarkable success and needs to be sustained.

N.B: The data for 2005 programme will be made available soon.

ANNEX 3

PRONAF-BÉNIN SUMMARY REPORT OF FFS AND PRE-EXTENSION ACTIVITIES

INSTITUT NATIONAL DES RECHERCHES AGRICOLES DU BENIN

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PROJET NIEBE POUR L'AFRIQUE

(PRONAF-BENIN)

RAPPORT D'EXECUTION DES ESSAIS DE PIEGES A PHEROMONE DE *Maruca vitrata* EN MILIEU PAYSAN

Campagne agricole 2005-2006

Introduction

Le piège à phéromone de *Maruca vitrata* est un avertisseur de l'arrivée de ce papillon, ravageur de la culture du niébé. Il fait partie des méthodes de lutte intégrée que PRONAF dissémine à travers les Champs Ecole Paysans (CEP/FFS). A l'instar des autres années, la campagne agricole 2005-2006 a été marquée par le déroulement de cette activité sur les nouveaux sites de FFS/CEP. La particularité de cette année réside dans le fait que cette activité a été introduite dans les anciens sites de FFS/CEP sous forme de pré-vulgarisation avec une plus grande responsabilité des producteurs eux-mêmes. Le présent rapport fait le point d'exécution de la campagne agricole.

Piège à phéromone de *Maruca* sur nouveaux sites de FFS/CEP

Cette activité conduite en bonne et due forme d'expérimentation a été exécutée dans deux villages de chaque département où PRONAF intervient actuellement. Les villages de FFS/CEP sont en même temps ceux de phéromone.

- Dans le département des Collines au Centre du Bénin; les deux villages ayant abrité l'essai sont: Kpakpazoumè dans la Commune de Glazoué et Adjanoudoho dans la Commune de Dassa-Zoumè.
- Dans le département du Couffo au Sud-Ouest du Bénin, ces villages sont: Hounsa et Adamadouhoué tous dans la Commune de Dogbo.

Déroulement des activités

Pour conduire le FFS, 15 producteurs sont choisis par village. Parmi ces participants, 12 sont dégagés selon la situation géographique de leurs champs pour abriter les pièges à phéromone. Des 12 dégagés, 6 ont posé les pièges dans leurs champs et 6 sont considérés comme pratiques paysannes, donc n'ayant pas reçu de piège. Un des 6 champs devant poser les pièges est retenu pour servir de lieu de regroupement pour les activités de FFS qui sont tenues une fois par semaine. Les techniciens des services de CeRPA de chaque localité impliqués dans le FFS/CEP sont ceux qui sont chargés de suivre la collecte des données sur les pièges. La compréhension des producteurs de cette activité était évidente puisqu'ils suivent toute la formation en FFS où des enseignements sont donnés sur la fabrication, l'installation et l'utilisation des pièges à phéromone et des posters distribués à chacun.

Difficultés rencontrées

Les difficultés ici rencontrées sont de deux ordres.

Au niveau de PRONAF-Bénin, la fréquence sur le terrain pour le suivi de cette activité était faible, soit toutes les deux semaines. Les activités de FFS n'ont pas démarré au même moment dans les deux départements puisque les pluies se sont premièrement installées dans les Collines, ce qui a réduit considérablement le suivi équitable des deux zones d'intervention par l'équipe de PRONAF. Cette situation a plus pesé sur les techniciens devant collecter les données dans le Couffo.

Au niveau des producteurs, malgré que des enseignements et instructions soient donnés lors des séances de FFS, certains ont toujours tendance à traiter leurs champs de gestion intégrée de phéromone sans attendre la prise de décision collégiale, grâce à la vigilance des techniciens, ce phénomène a pu être maîtriser.

Les techniciens chargés de la collecte des données dépendent du CeRPA où ils doivent assumer d'autres charges professionnelles. La faible capacité de l'équipe d PRONAF à se rendre sur le terrain (pour des raisons financières), rend alors fastidieux le travail de suivi et de collecte des données en vue de fournir des résultats à bonne date.

Pré-vulgarisation des pièges à phéromone de *Maruca* dans les anciens sites de FFS

C'est une activité qui a nécessité moins de rigueur que la précédente dans la gestion et la collecte des données de façon générale. Elle a été conduite dans les anciens sites de FFS/CEP mais toujours dans les deux départements des Collines et du Couffo. Les villages choisis par département sont:

- Collines: Atchakpa dans la Commune de Savè et Okéo-Owo dans la Commune de Glazoué;
- Couffo: Davihoué dans la Commune de Klouékanmey et Gbaconou dans la Commune d'Aplahoué.

Déroulement

Pour mener cette activité, les producteurs étaient organisés par zone de champ au niveau de chaque village. Elle a pris en compte les producteurs ayant suivi ou non le FFS, mais de toutes les manières, une formation des participants sur la fabrication, l'installation et l'utilisation des pièges à phéromone a été organisée par ceux qui avaient déjà suivi le FFS et ils ont été appuyés par l'équipe de PRONAF au cours de cette formation. Par zone délimitée ou identifiée, 25 producteurs ont été impliqués dans 3 zones par village et parmi les 25 de chaque zone, 6 sont identifiés pour poser les pièges dans leurs champs faire le suivi dès que le seuil est atteint, ils avisent le reste des membres pour les dispositions à prendre dans la gestion du ravageur.

Difficultés rencontrées

Malgré qu'une formation généralisée ait été donnée à tout l'ensemble des producteurs impliqués dans le déroulement de cette activité, le relevé des captures des papillons de Maruca dans les pièges n'a pas été une chose facile pour les producteurs qui avaient suivi le FFS mais, qui n'ont pas été impliqués comme facilitateurs et gestionnaires des pièges à phéromone au préalable. Certains producteurs réclament de l'argent pour avoir porté les pièges dans leurs champs. Aussi, le fait que l'équipe de PRONAF ne passait pas régulièrement pour le suivi a créé de désintéressement chez certains producteurs donnant ainsi plus de travail aux chefs de groupes qui étaient obligés de s'investir pour que la collecte des données soit effective dans tous les champs. Ces derniers réclament des primes spéciales de suivi.

Il était prévu de choisir 2 villages dans les Collines et 2 dans le Couffo pour conduire cette activité de pré-vulgarisation, mais compte tenu de certaines difficultés propres au milieu, le village d'Oké-Owo dans les Collines a dû abandonner.

Conclusions

Au regard de tout ce qui précède, la campagne agricole 2005-2006 a été achevée avec l'accomplissement des activités projetées. Au niveau des nouveaux sites de FFS, tous les 4 villages prévus ont été effectivement opérationnels. Pour la pré-vulgarisation, 3 villages sur 4 prévus ont pu effectivement accomplir la tâche. Des difficultés ont été certes enregistrées au niveau des deux types de sous activités menées mais globalement, le résultat demeure positif car ces activités ont permis à certains d'acquérir de nouvelles connaissances sur les pièges à phéromone de Maruca et à d'autres de revoir ou de se rafraîchir la mémoire par rapport aux anciennes connaissances acquises. Au total, l'assistance technique est toujours nécessaire pour les producteurs quels que soient leurs niveaux d'implication dans les activités surtout celles ayant trait à la recherche.

ANNEX 4

OBEPAB SUMMARY REPORT OF FFS AND PRE-EXTENSION ACTIVITIES

Rapport synthétique des activités Maruca-Phéromone
(2005-2006)
OBEPAB

1. Introduction

Les activités sur Maruca-Phéromone s'insèrent dans le cadre du partenariat PRONAF, IITA et OBEPAB. Les activités de cette année 2005-2006 ont intégré une nouvelle dimension, celle de la pré-vulgarisation. La pré-vulgarisation a été réalisée dans deux anciens villages (Tissarou et Sinanwongourou), alors que l'essai Maruca-Phéromone a été conduit dans deux nouveaux villages (Kpégon et Gansosso). En ce qui concerne l'essai, les activités de terrain ont été assurées par 2 techniciens, à raison d'un par village. Les activités de pré-vulgarisation ont été facilitées par un technicien dans les 2 villages.

L'objectif des activités de cette année est la validation et la dissémination des technologies éprouvées durant la campagne précédente c'est-à-dire le paquet technologique des pièges à phéromone, en utilisant l'approche Farmer Field School.

Le présent rapport synthétique décrit le déroulement des activités Maruca- Phéromone dans les 4 villages et met en relief l'implication des paysans dans ce processus de même que leurs perceptions sur le paquet technologique. Toutes les données techniques (données agronomiques, données sur les traitements, les pièges, les infestations des fleurs et des gousses et les rendements) ont été introduites dans une matrice de données séparée pour les analyses quantitatives.

2. Déroulement des activités

L'approche participative est la démarche qui a servi de fil directeur à la conduite des activités avec l'implication volontaire et active des partenaires locaux que constituent les producteurs à toutes les étapes.

2.1 Préparation des activités

Avant le démarrage des activités proprement dites, des séances d'information et de sensibilisation ont été organisées tant dans les nouveaux villages que dans les anciens. Dans les nouveaux villages (Kpégon et Gansosso), concernés par l'essai, les séances de sensibilisation ont permis d'expliquer aux producteurs les motivations de l'essai pour les y adhérer afin de faciliter l'appropriation ultérieure des résultats. Dans chacun des villages, le chef de village et les leaders locaux ont été mis à contribution pour organiser les séances auxquelles tous les producteurs, en particulier ceux du niébé ont été conviés. Dans les anciens villages (Tissarou et Sinanwongourou) concernés par la pré-vulgarisation, les séances d'information et de sensibilisation, tout en rappelant les méthodes et acquis des essais antérieurs, ont montré les différences méthodologiques avec la pré-vulgarisation et mis l'accent sur la responsabilisation des producteurs dans toute la démarche. En plus des leaders locaux et des producteurs, d'autres acteurs du développement rural du milieu ont pris part à la séance de sensibilisation en ce qui concerne la pré-vulgarisation à savoir : des agents du CeCPA- Kandi, des distributeurs d'intrants, des structures de microfinance et les responsables des différentes fédérations de producteurs. Des posters et dépliants ont servi de support pour les différentes sensibilisations.

Dans tous les villages, les producteurs ont manifesté de volonté à participer aux activités.

2.2 Mise en place des parcelles

Pour la mise en place de l'essai, les producteurs ont offert les sites et ont accompli toutes les activités nécessaires. Dans chacun des villages, 6 producteurs situés dans le même rayon de 500 m x 500 m ont été retenus pour abriter les essais dans le cas des nouveaux villages ou servir de paysans facilitateurs dans le cas des villages de pré-vulgarisation. A chaque niveau, 2 types de traitements ont été considérés : traitements sur seuil avec les extraits aqueux de feuilles de neem et les pratiques paysannes. Les pièges à phéromones de Maruca sont alors installés sur toutes les parcelles de traitement sur seuil.

Dans chacun des deux nouveaux villages, un champ de traitement sur seuil a été retenu pour la formation Farmer Field School durant tout le cycle du niébé. Il faut souligner qu'en plus des 24 producteurs (6 par village) directement impliqués et abritant les pièges à phéromone, d'autres producteurs volontaires ont participé aux activités, soit à travers les formations FFS pour les nouveaux villages, ou à travers les relais des paysans facilitateurs pour les anciens villages. Au total 49 autres producteurs volontaires ont été touchés par les activités du projet.

En ce qui concerne les parcelles, l'unité parcellaire adoptée est de 20 m x 20 m; soit 400 m^2. Toutes les parcelles on été mises en place et semées courant la période du 10 au 15 août 2005. Le matériel végétal utilisé est la variété locale de niébé connue sous le nom de *Antonoumon*. Les pièges à phéromones ont été installés environ 3 semaines après les semis.

2.3 Suivi des activités

S'agissant du suivi des activités, qu'il s'agisse des anciens ou nouveaux villages, les producteurs ont pris une part active dans leur déroulement. Seulement, à la différence des nouveaux producteurs qui sont suivis par les techniciens, les anciens ont été responsabilisés pour la fabrication des pièges, leur installation, le suivi et la collecte des données. Les paysans facilitateurs ont également joué un rôle d'avertisseurs pour les autres producteurs pour les traitements à l'atteinte. Ils ont bénéficié de la facilitation d'un technicien, notamment en ce qui concerne l'enregistrement des données.

3. Quelques constats

Adoption partielle

- Dans les villages qui n'ont plus bénéficié de l'intervention du projet à la 3 années, les producteurs ont adopté:
  - Les traitements raisonnés par l'analyse de l'agroécosystème
  - Utilisation des extraits aqueux de neem pour les traitements du niébé
- Même les producteurs non impliqués ont adopté ces pratiques
- Toutefois, aucun de ces paysans n'a continué à rechercher et utiliser les pièges.

Canaux

- Paysan à paysan: le plus opérationnel: liens filiaux et parentaux
- Séance de sensibilisation
- Les réunions
- Émission radio

Motivations

- Économiques: moins de traitements et utilisation d'extraits de neem rentabilise plus la production
- Sociales: prestige social :recevoir visites de techniciens et participer à des formations;
- Techniques: acquisition de nouvelles connaissances (reconnaissance des ravageurs, leur cycle);
- Autres: préservation de la santé avec l'utilisation des extraits

Déterminant individuels

- Éducation: les instruits plus ouverts à partager avec les autres
- Appartenance à des OP: les réunions au sein des OP constituent un bon créneau de partage et de diffusion

Facteurs favorables

- Institutionnels et autres
- Encadrement rapproché
- Support de sensibilisation en langues locales
- Conscience dangers des pesticides chimiques (interventions OBEPAB
- Implication des élus locaux

Obstacle

Question de l’accès physique et financier des pièges et leurres : disponibilité, prix et modalités de cession

Difficultés rencontrées

- Indisponibilité parfois pour le suivi des parcelles par les paysans: concurrence dans l’allocation de la main d’œuvre: récolte arachide, traitements coton
- Insuffisance de posters et dépliants pour les sensibilisations

Conclusion et perspectives

- Les pièges à phéromone de Maruca constituent une innovation intéressante pour les paysans: motivations économique, sociale, technique
- Toutefois, la question de l’accès physique et financier du matériel risque d’être l’obstacle majeur de son adoption par les paysans
- Cette question devra être réglée en tenant compte du contexte dominant du coton: intrants disponibles à crédit
- Aussi, est-il souhaitable d’inscrire cette technologie dans une dynamique d’autopromotion en mettant un mécanisme social d’appropriation et de pérennisation des acquis: cela peut passer par la structuration des paysans expérimentateurs et facilitateurs en des groupements formels, et leur appui organisationnel.

ANNEX 5

PRELIMINARY REPORT OF PRE-EXTENSION SURVEY FOLLOW-UP: "PERCEPTION PAYSANNE SUR LA CONNAISSANCE ET L'UTILISATION PRACTIQUE DES PIEGES ET LES EXTRAITS BOTANIQUES PENDANT LA PRE-VULGARISATION AU BENIN (CAS DU COUFFO ET COLLINES)"

'PROJET MARUCA PHEROMONE TRAP'

VOLET SOCIO ECONOMIQUE

Rapport Partial

Perception paysanne sur la connaissance et l'utilisation pratique des pièges et les extraits botaniques pendant la pré-vulgarisation au Bénin (Cas du Couffo et Collines)

Présentée par

Mme ADETONAH Sounkoura

Introduction

Le niébé est l'une des principales légumineuses cultivées en Afrique principalement au Bénin. Mais il est soumis à une forte pression parasitaire dont *Maruca vitrata*. Les dégâts peuvent atteindre 100% si aucun traitement n'est appliqué. Face à ce problème crucial, le projet Maruca Pheromone en collaboration avec l'IITA ont développé et introduit les extraits botaniques à base de neem et papayer comme substitut aux produits chimiques et les pièges à phéromone comme outil technique pour avertir l'arrivée de *M. vitrata* aux paysans pour rationaliser leur traitement. Les paysans ont été suivi depuis un certaines nombre d'années par les agents du projet. Mais cette année les activités ont intégré une nouvelle dimension la pré-vulgarisation avec une plus grande responsabilité des producteurs eux-mêmes sur l'utilisation pratique des pièges et des extraits botaniques dans leur champ. Le but de cette démarche est de voir approximativement le taux d'adoption des pièges et des extraits botaniques par les paysans. Ceci exige à recueillir les opinions des paysans sur l'utilisation pratique des pièges et des extraits botaniques pour une large diffusion.

Objectifs

- Evaluer les perceptions paysannes sur l'utilisation pratiques des pièges à phéromone comme système d'alerte aux villages CEP et non CEP dans la phase de pré vulgarisation;
- Identifier les contraintes et opportunités rencontrées par les paysans au cours de la pré-vulgarisation,
- Discuter de la disponibilité des producteurs à recourir à l'avenir à technologie pour poursuivre la gestion de leur culture.

Méthodologie

Zones d'enquête

L'étude s'est déroulée dans deux pays du projet.

Au Bénin précisément dans le Couffo, les Collines et l'Alibori et au Ghana dans le district d'Ashanti et de Brong Ahafo. Deux villages sont choisis dans chaque zone agro-écologique. Chaque village a été divisé en trois localités à raison de 15 paysans par localité, soit 45 paysans par village.

Ce rapport prendra seulement en compte les deux villages du couffo et un seule village des collines compte tenu de certaines difficultés propres du milieu.

Ainsi on a 90 paysans dans le couffo et 42 paysans dans les collines dont 3 ne sont pas disponibles au moment de l'enquête. Tous les paysans enquêtes pour cette phase de pré vulgarisation ont été choisis de façon raisonnée. Ce qui a permit de prendre en compte toutes les quatre (4) catégories de paysans dans l'échantillon. Il s'agit

- paysans ayant utilisé les pièges et ayant participé au CEP,

- paysans n'ayant pas utilisé les pièges, mais ayant participé au CEP,
- paysans n'ayant pas utilisé les pièges et n'ayant pas participé au CEP,
- paysans ayant utilisé les pièges, mais n'ayant pas participé au CEP.

Les données collectées sont analysées à travers l'utilisation des fréquences simples pour analyser les perceptions paysannes et les contraintes évoquées par les paysans

Résultats et discussion

Perceptions paysannes sur les pièges et extraits botaniques Couffo et Collines pendant la phase de pré-vulgarisation

Les résultats obtenus dans les deux zones ont montré que plus la moitié des paysans enquêtes (60%) dans les collines contre 41% dans le couffo ont entendu parlé des pièges à phéromone avant la pré-vulgarisation (Tableau 1). Ce qui permet de dire que la diffusion de l'information a été faite par les agents de PRONAF avec l'approche FFS ou par d'autres paysans intéressés. Le même pourcentage de paysans qui souhaiterait acheter les pièges dans le couffo est égale à celui ces collines respectivement (36% et 37%). Evidemment de taux parait un peu faible. Mais ce résultat est acceptable et encourageant pour un premier lancement de la phase de pré-vulgarisation avec toutes catégories confondues.

On constate aussi que 43% des paysans enquêtés dans les collines sont prêt à acheter le leurre contre 34% dans le Couffo. La principale raison évoquée par les paysans est l'efficacité de leurre de capter Maruca. Ce constat est fait pendant la phase de pré vulgarisation ou au moment du champ école paysan (FFS) (Tableau 1).

Les paysans enquêtes connaissent l'agriculture biologique à base d'extraits botaniques dans les collines ou dans le Couffo (62% et 92% des paysans) (Tableau 3). Par contre son utilisation par les paysans (46% et 43%) est faible comparativement aux études similaires faites dans les mêmes zones. L'explication donnée est le retard accusé pour la fabrication semi industrielle des produits afin de résoudre le problème de pénibilité de pilage des extraits botaniques. Malgré cette seule contrainte, les paysans désirent toujours acheter les extraits botaniques (cités par 80% et 74% des paysans) en cas de disponibilité (Tableau 3). Ceci interpelle non seulement les responsables du projet, mais aussi le secteur privé, les ONG les entreprises, les institutions et autres pour un partenariat afin que ce problème soit résolu pour de bon. Ces résultats sont conformes à ceux obtenus dans nos études antérieures dans ces deux zones

Contraintes et difficultés liées à l'utilisation des pièges

La contrainte majeure évoquée par les paysans dans le Couffo comme dans les collines est le fait de contrôler 3 fois par jour les pièges à phéromone dans leur champ respectivement (cités par 24% et 26% des paysans). (Tableau 2). Le facteur temps est mis en cause. La réduction à 2 fois par jour peut résoudre ce problème. Quant au vol de pièges, il est très faible et même insignifiant.

Perceptions paysannes sur les modalités de payement souhaité par les paysans

Les principaux modalités de payement souhaités par les paysans sont le crédit remboursable, vente de niébé pour rembourser, le don et enfin le payement par cash à un prix forfaitaire. Mais le crédit remboursable est beaucoup plus cité par les dans le Couffo (27% de paysans) alors que le payement cash à un prix forfaitaire est beaucoup cité par les paysans des Collines (21% des paysans) (Tableau 4). Ce qui n'est pas étonnant dans les collines précisément le village Atchakpa. La création d'une usine de sucrerie dans ce village a permit aux paysans d'avoir des revenus extra agricoles et de payer cash. Par cette opportunité ne s'est pas présentée dans le Couffo, d'où les paysans ont jugé payer par crédit remboursable ou par vente de niébé.

Perceptions des paysans formés et non formés au champ école pendant la pré-vulgarisation dans le ouffo et les collines

La figure 1 montre évidemment que les paysans formés dans les collines ont entendu parler des pièges à phéromone et souhaitent acheter le leurre (60%). Par contre 36% des paysans ont entendu parlé des pièges mais seulement 4% désirent acheter le leurre. Ce qui est tout `a fait normal car les paysans non formés n'ont pas été en contact avec les leurres sauf une seule fois qui est la phase de pré vulgarisation. Ceci met l'accent sur l'importance des Champ Ecole Paysans (CEP) dans la diffusion à grande échelle des pièges à phéromone. La figure 2 illustre bien l'importance de FFS dans le couffo.

Conclusion

Au terme de ces résultats partiels du Couffo et des collines, nous pouvons retenir globalement une acceptabilité des pièges à phéromone et des extraits botaniques par les paysans de différentes catégories sauf ceux n'ayant pas été formes et n'utilisent pas les pièges. Pour cela il faut susciter la création des écoles par les paysans formés afin ces derniers puissent transmettre à leur tour le savoir.

Tableau 1 : Perception des paysans des pièges à phéromone pendant la phase pré-vulgarisation dams le Couffo et Collines

Variables	Couffo	Collines
	% des paysans FFS n=90	% des paysans FFS n=42
Entendu parler des pièges avant	41	60
Souhaiterez acheter les pièges et les utiliser	37	36
Etes prêt à acheter le leurre	34	43
Raisons qui font que les paysans veulent acheter le leurre : - Efficace - Arrêter *Maruca* le ravageur du niébé	 33 2	 41 2
Savoir fabriques les pièges par les paysans	30	36

Tableau 2 : Contraintes pour l'utilisation des pièges pendant la pre vulgarisation par les paysans

Contraintes	Couffo	Collines
	% de paysans n=90	% de paysans n=42
Pas de contraintes	10	26
Contrôle 3 fois par semaine	24	26
Vol de leurre	2	5

Tableau 3 : Perception des paysans des extraits botaniques pendant la phase pré-vulgarisation dams le Couffo et Collines

Variables	Couffo	Collines
	% de paysans n=90	% de paysans n=42
Connaissance avant sur l'agriculture biologique	62	92
Utilisation des extraits botaniques par les paysans	46	43
Prêt à payer les extraits botaniques	80	74

Tableau 4: Modalité de payement souhaité de leurre par les paysans

Modalités de payement	Couffo	Collines
	% de paysans n=90	% de paysans n=42
Crédit remboursable	27	17
Vente du niébé	12	0
Dons aux paysans	5	21
Payement cash à un taux dérisoire	0	21

Figure 1 : Perceptions des paysans formés et non formés au champ école de la pré-vulgarisation dans les collines

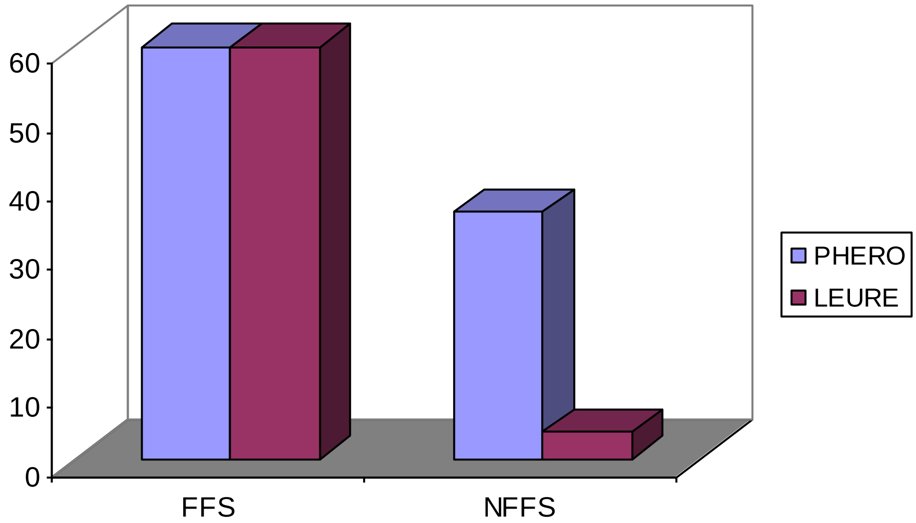
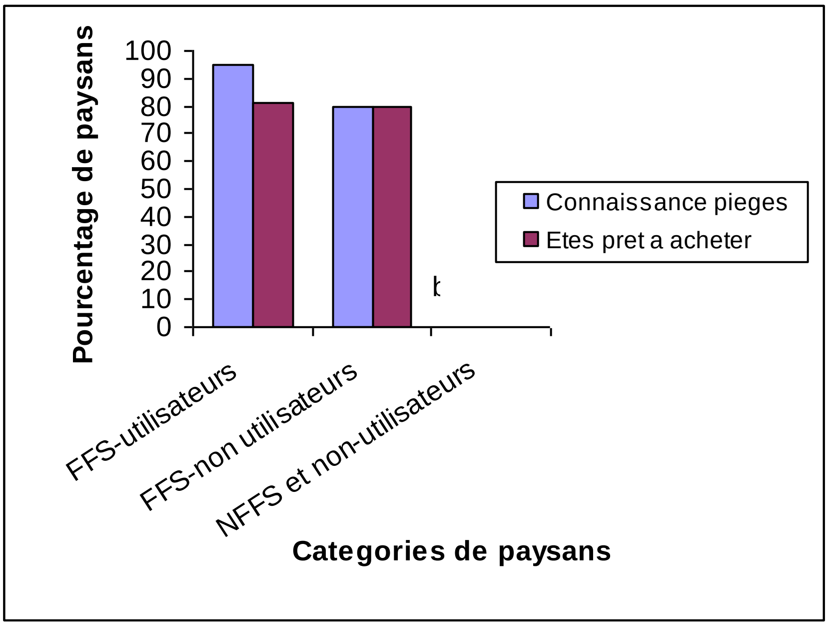


Figure 2 : Perceptions des paysans de différents catégories enquêtés pendant la pré-vulgarisation dans le Couffo



NB: Explication des mots

PHERO= Entendu parler des pieges
LEURE= Souhaiter les acheter
FFS-utilisateurs=paysans ayant participé aux FFS et utilisent les pieges
FFS-non utilisateurs-Paysans ayant participé au FFS et n'utilisent pas les pieges
NFFS-non utilisateurs= Paysans n'ayant pas participé et n'utilisent pas les pieges

ANNEX 6

EXPERIENCES OF DEVELOPING AND INTRODUCING PHEROMONE TECHNOLOGIES FOR INSECT PEST CONTROL IN WEST AFRICA – PROJECT OUTPUT, ACTIVITY 2.2

CROP PROTECTION PROGRAMME

Experiences of developing and introducing pheromone technologies for insect pest control in West Africa

An output of project R8411 (ZA0643)

Dr Mark Downham

Natural Resources Institute, University of Greenwich

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Introduction

The author is a researcher with the Natural Resources Institute of the University of Greenwich, UK with 18 years' experience of research with and implementation of pheromone technologies in developing countries. This document is based on his particular experience of two research initiatives intended to develop pheromone-trap based technologies for the control of insect pests in West Africa. Both were funded by the Crop Protection Programme (CPP) of the UK's Department for International Development (DFID). This document's aim is to derive lessons that can be more generally applied to similar research and development initiatives within the region.

Pheromone traps for monitoring *Maruca vitrata*

Project History, Outcomes and status of implementation

Cowpea is a vital grain legume crop in West Africa, where it is grown mostly by subsistence farmers and provides a cheap source of dietary protein for low-income populations. *Maruca vitrata* Fabricius (Lepidoptera: Pyralidae) the legume podborer, is a key pest. The larvae attack flower buds, flowers and young pods and yield losses range up to 80%. Conventional insecticides can control the pest, but expense often limits their use by poor farmers. Elsewhere, over-use of insecticides not recommended for use on cowpea is leading to increasing health and environmental hazards (e.g. subsidised cotton insecticides in Benin). Thus the development of a technology which could predict the occurrence of the pest, thereby assisting farmers to decide when and where to target their insecticides would represent a significant advance. Pheromone traps have been used to in this way previously with a variety of other agricultural insect pests and this was the approach taken for *M. vitrata*.

Following largely laboratory-based studies at NRI in the early to mid-90s, the author has led the following projects[1] since 1999:

R7441 - Development of pheromone trapping for monitoring and control of the legume podborer, *Maruca vitrata* (syn. *testulalis*) by small-holder farmers in West Africa (1999 – 2003);

R8300 – Implementing pheromone traps and other new technologies for control of cowpea insect pests in West Africa through Farmer Field Schools (2003 – 2005);

R8411 – Facilitating the uptake of pheromone traps for *Maruca vitrata* in West Africa (2005 – 2006).

The principal collaborating institution in this has been the International Institute of Tropical Agriculture, Cotonou, Benin whilst additional project partners were drawn from NGOs and national agricultural research centres in Benin, Ghana and Burkina Faso[2] and some studies were conducted at the IITA station in Kano, Nigeria. A practical approach was developed whereby six or more farmers within a village operate traps in cowpea fields from the beginning of the season. Farmers share information about captures and when the threshold of an average catch of two

[1] Scientific publications produced by the projects are listed as references 1 – 5.

[2] Partner institutions were : in Benin, the *Institut National des Recherches Agricoles du Bénin* (INRAB) and the *Organisation Béninoise pour la Promotion de l'Agriculture Biologique* (OBEPAB) ; in Ghana, the Savanna Agricultural Research Institute (SARI), the Crops Research Institute (CRI) and the Ghana Organic Agriculture Network (GOAN); in Burkina Faso, *l'Institut de l'Environnement et de Recherches Agricoles* (INERA).

moths per trap is reached, spraying within three days is then advised. Farmers decide the best control agent to apply in their fields – botanical or conventional pesticide – and exactly when to apply it, taking account of the overall pest situation.

The first steps towards this were the chemical characterisation of the natural sex pheromone and development of the necessary attractant lures for the traps. Although studies by other researchers in the late 90s had identified one component of the pheromone no field testing had been carried out. Analytical and bioassay studies in the NRI labs confirmed this and found two other minor components. Field trapping experiments using replicated, randomized complete-block designs commenced in 1998 at the IITA station and showed that a three component pheromone blend, of EE10,12-16:Ald (100 μg), EE10,12-16:OH (5μg) and E10-16:Ald (5μg), provided optimal attraction of male *M. vitrata* moths. This was the first time a synthetic pheromone blend had been identified that was more attractive to male *M. vitrata* than virgin female moths under field conditions.

To minimize eventual costs to farmers the team sought to develop traps which could be made locally, by farmers if necessary, to avoid the need to import relatively expensive, commercially available traps. Several different trap designs were evaluated and a locally fabricated water-trap – made by cutting out the sides of a five litre plastic jerry-can – was found to be superior to two imported, commercial trap designs in terms of captures, cost and robustness in use. Moths entering the jerry-can trap are killed by drowning in the water placed inside.

The type and cost of the attractant lures is also an important practical issue so factors such as lure dose and dispenser type, isomeric purity and longevity of the pheromone compounds were all investigated in the on-station experiments. Results showed that shielding of lures from sunlight was unnecessary, attraction to lures with even low-purity pheromone compounds was possible and that polyethylene vial lures containing 0.1 mg of pheromone remained effective for up to four weeks under field conditions. All these findings simplified and reduced the potential cost of lure manufacture and use. Lures are now supplied by a small company, International Pheromone Systems in the UK at a cost of £0.40 per lure for a minimum order of 500 lures.

For utilisation of the traps to be possible practically, demonstration of some consistent relationship between trap-catches of adults and the incidence of larval attack in cowpea fields was necessary. Trap catches and larval infestations were therefore monitored in un-sprayed farmers' fields at several sites around Benin; these showed that for fields sown around the same time, moth captures typically precede larval infestations by several days enabling farmers to determine when they might need to spray. An additional finding was that a possible alternative predictive measure, that of the appearance of flowers in the crop, tended to give a much shorter warning period of infestations than initial trap captures.

Based on these findings, since 2002, empirical testing through on-station trials and farmer field schools (FFS) involving 500 farmers in 26 different villages has gradually evolved the trap-based threshold approach for determining spray timing mentioned above. FFSs operated mainly under the auspices of project partners in Ghana and Benin (some in association with the separate, IITA-managed *Projet de Niébé pour l'Afrique*). Positive outcomes have included:

- Use of traps combined with different insecticides to determine spray timing can be at least as good as normal farmer practices in terms of yield and *M. vitrata* infestation;
- Among farmers with experience of the traps, more than 90% believe traps can help to control *M. vitrata* and on average they are willing to pay US$ 5 – 6 for the traps and lures, which compares with previously estimated costs of fabrication, installation and maintenance for a cropping season of around $5;
- Traps only account for an estimated 4% of the total production costs.

At present there is no commercial production of traps or lures within West Africa. Traps have been made by farmers within the context of FFS and lures have been supplied to the farmers by project partners, having been purchased by IITA from the UK supplier. FFS and on-farm trials since 2002 have developed the trap threshold approach (described above) in combination with botanical insecticides. In 2005 farmers in several villages were given pheromone lures, but otherwise left free to implement trap monitoring (or not) and subsequent spraying. Use of the traps was patchy, although there was slightly greater use of botanical insecticides.

<u>Constraints and obstacles encountered during technical development</u>

Despite the success in developing effective traps and lures for Benin and Ghana, several findings were encountered some of which were merely unexpected and others which have effectively limited the potential impact of the trap monitoring of *M. vitrata*.

Captures of females

A most unexpected finding was the phenomenon of female captures which, depending on time and location have comprised anything up to 50% of total captures. Although this percentage is quite variable the observation of at least some females has been very consistent. The attraction of female M. vitrata to synthetic lures based on the female-produced sex pheromone in traps in this way is very striking and unusual. There appears to be only one other documented case of this occurring among Lepidoptera, i.e. for the noctuid moth, *Trichoplusia ni*. In this case it was subsequently shown that males of this species also produce a pheromone which attracts females under field conditions. The probable explanation was thus attraction of females to previously trapped males. In one M.Sc. study at NRI the possibility of such female *M. vitrata* attraction to a male-produced pheromone was investigated but not supported by wind-tunnel results. The observation that moth captures in individual traps in the field were frequently exclusively female also argues against this explanation. It may be that the pheromone-response behaviour of *M. vitrata* in the field is affected by physiological or host plant-related factors not yet investigated.

Regardless of the explanation, it can be concluded that catches of females probably improve the predictive power of traps, since catches of both sexes should more accurately reflect population events.

Geographical variability in response to traps

Another crucial finding was of significant geographical variation in responses to pheromone traps. In addition to the investigations of pheromone blend in Benin, at various times different blends and lure loadings were compared in trapping experiments in Sri Lanka, India, Kenya, Taiwan and northern Nigeria. Although in most cases some *M. vitrata* adults were trapped, catches were generally too low or inconsistent to be useful. These are all important legume-producing areas – and in West Africa northern Nigeria is particularly dominant in the production of cowpea – thus the ineffectiveness of traps here particularly reduces their potential overall impact.

Prompted in part by this, later re-investigations of the pheromone blend of *M. vitrata* have since been carried out through the Ph.D study of Mr M.N. Hassan, based at NRI. Laboratory experimentation suggested the possible existence of another minor component (*E*)-10-hexadecen-1-ol (E10-16:OH) within the blend. In late 2004 trapping experiments were conducted by Mr Hassan with ICRISAT staff, in pigeonpea fields in southern India. These have showed significantly improved trap catches with blends with including E10-16:OH (the results await publication). Unfortunately, the same compound had little effect on catches in experiments at five locations in Benin, Ghana, Burkina Faso and northern Nigeria. Intriguingly, high catches were obtained in one area of Burkina Faso with lures containing the major blend component, EE-10,12-16:Ald, alone rather than the 'standard' 3-component Benin blend. Moreover, in central Benin the 3-component blend and the EE-10,12-16:Ald alone attracted equal numbers of *M. vitrata*, whereas the 3-component blend was clearly superior in the south.

There are thus two main possible explanations for poor catches in some locations. One may be geographical, genetically-based variation in normal pheromone response, and in these areas the optimal blend remains to be discovered. The other is some kind of behavioural explanation; for example it may be that in areas of high *M. vitrata* attack (such as northern Nigeria) pheromone traps are effectively out-competed by the presence of high densities of adult females, each producing pheromone. Investigating these, or other possible, explanations for low catches in some areas will require further basic research and financial investment.

Lack of quantitative trap capture – infestation relationship

Although trap captures in cowpea fields occur reliably before larval infestations, little evidence of a quantitative relationship between them could be found in an extensive data-set collected from 56 fields in four localities in different parts of Benin during 2000[3]. This has meant that while the traps can function to alert farmers to impending infestations, they cannot give information about their likely severity. Thus the farmer does not know whether he/she can ignore the infestation, if it is going to be light, or whether he/she should prepare for a particularly heavy attack.

This may be considered as a limitation of the traps' usefulness. However, this is probably not as great as at first it might appear since in practice many small-holder farmers would prefer to err on the side of caution and spray even relatively light infestations (which, strictly speaking, might be uneconomic to treat). Thus even if a strong quantitative relation were to be established, any resulting threshold might well be ignored in many cases.

[3] Attempts were made to relate captures to both flower and pod infestations in cowpea fields in the Mono, Borgou, Bohicon and Savè (2 seasons) areas; a weak, but statistically significant relation was found between captures and pod infestations for Mono, however all other regressions were non-significant (Final Technical Report for R7441).

There have been discussions about the non-utility of captures after the existing threshold of two moths per trap is reached. Under the approach as presently implemented insecticide treatments should begin soon after this threshold, when the cowpea is normally flowering, but before many pods are set. For conventional insecticides a single spray at this time is recommended, followed by a second once around 25% of pods have set. For botanical pesticides the threshold dictates the first in a series of 4 – 6 sprays made at 5 – 7 day intervals. At present no use of trap captures is made to decide when, if or over what periods subsequent treatments should be made. However, to this point too, the response can be made that for post-threshold capture data to be useful some kind of quantitative relationship needs to be established and in the experience of the author this seems unlikely to be possible. This said, it could perhaps be attempted in locations other than Benin, where it has not been attempted previously.

Mis-identification of adult M. vitrata *in traps by farmers*

Experience from FFS suggests that some farmers find it difficult to reliably identify adult *M. vitrata* among trap catches. In theory, the traps should only actively attract *M. vitrata* but in practice spiders, ants and other flying insects often find their way into the water. *M. vitrata* can be confused with other moth species, particularly as the distinguishing wing coloration may be lost after 1 – 2 days' immersion in the trap water.

This problem can only be dealt with by training and experience, and by more frequent checking of the traps (three times per week is normal practice). In the longer term other trap designs could, in principle, be adopted – perhaps those having more restricted entry ports, or using a sticky surface to kill and retain insects – but these would undoubtedly involve other difficulties of their own.

Farmers' misapprehensions concerning the mode of action of traps

When presented with a trap for the first time it is perhaps natural that a farmer should assume that by capturing insects the trap will directly reduce damage due to the pest, even though a scientist may know that such an effect will be negligible[4]. Thus, during the project whenever traps were introduced to farmers in a village (within the framework of a FFS) considerable efforts were made to inform and train them in regard to both the technicalities of operation and the intended mode of action – *i.e.* that they had a monitoring rather than a direct control role. Nevertheless, follow-up surveys indicated that in some cases large numbers of farmers had failed to absorb this message and in the absence of the project intervention they would not have used the traps correctly – with adverse consequences.

Of course this could indicate that initial training given by project staff was sometimes inadequate. A more general lesson might be that training should be very thorough and repeated at least once; it should be given by a variety of methods, verbal,

[4] Theoretical studies by Knipling (1979) (Agriculture Handbook 512, USDA, Washington) have shown that for pheromone traps only capturing males, more than 90% of need to be captured in order to significantly reduce overall reproductive rates and therefore damage done by the next, larval generation. The requirement may not be so extreme in cases where females are also trapped (as here with *M. vitrata*), but given the probability that only a minority of the total adult population within an area is trapped it remains highly unlikely that the direct impact of pheromone traps, as currently used, upon pest populations and damage is more than negligible.

practical demonstration and participation, posters etc in order to reinforce the message.

Actual and potential constraints to further implementation

This section discusses the importance of various obstacles likely to be encountered in future to the desired goal of a long-term, self-sustaining uptake of *M. vitrata* pheromone traps in Benin and Ghana. It is based primarily on the experience and knowledge of the author and close colleagues associated with the projects. Many of the points listed derive from the conclusions of an end-of-project workshop for R8411 held at IITA, Cotonou in December 2005 to which project participants and other interested parties were invited.

The hope and expectation of the project team is that farmers will wish to continue using the *M. vitrata* pheromone traps. The challenge is to find long-term, sustainable method of supplying the traps and lures. In the short-term farmers can fabricate traps themselves, as they did in 2004 and 2005 and a possible supply route for the lures could be through one or more of the project's institutional partners, following purchase from the UK supplier. However, project surveys indicate that in the longer-term farmers wish to purchase traps and lures through local, existing agricultural input providers. The farmers who have participated in project could form the initial, core market for these providers with future expansion if the technology is taken up more widely.

Novelty of the monitoring approach

As noted above in the 2005 cowpea season previous FFS graduates with experience of the traps were given pheromone lures and refresher training in trap use, but were otherwise left free to implement trap monitoring. In fact, uptake of trap use across the sites was low or associated with 'disinterest' where it was used. This was disappointing given the previous encouraging results with the trap threshold approach (in FFS). Project partners concluded that more frequent visits by technical support personnel may help to overcome these problems, but this cannot continue beyond the short-term as it runs counter to the aim of having a self-sustaining technology. Lack of trap materials and/or the time/labour of making traps from them may account for some lack of interest (see below). However it may be that farmers are simply not ready yet, to make a widespread shift to a new technology whose *modus operandi* departs significantly from their normal experience, and which may still be regarded as potentially risky. Only time and continued exposure to the traps can help with this. One measure to address this might be to present real comparative yield and infestation data (in an appropriate format) to farmers from their home village. These have generally indicated that the trap+botanicals approach and normal farmer practice perform equally well and so might allay their fears as to the risks of the technology.

Supply of traps

First, considering the possibility of local production of traps by farmers themselves or by individual entrepreneurs operating strictly at a village level, the cost and availability of some of the materials (plastic can, wire, soap and stick) may be a problem. Certainly in surveys in 2005 of farmers around half indicated that availability of some of these raised difficulties. This is probably true in some villages, although the experience of the project team is that these are generally available in markets in provincial towns. In 2002 for Benin typical costs[5] were estimated as: plastic can – CFA 550, soap – CFA 145, wire – CFA 215. These may be cheaper in Ghana where such items are manufactured. On the whole it may be concluded that if use of the traps is considered sufficiently attractive, by farmers, difficulties in obtaining trap materials for local production can be surmounted.

The alternative scenario is one in which traps are made on a large scale in a single location, but clearly the manufacturer and actors in the distribution chain to farmers would need to be convinced of the market demand. One possibility is perhaps to approach an existing producer (in Ghana) of the plastic cans and to ask them to produce a simple modification in which the side walls of the can are cut out to the same pattern as is now done by hand. Clearly, they would need to be assured of adequate sales before they would consider this. A future project could undertake to fund the making of the initial model or template for the trap. Agricultural input suppliers might be convinced to become involved if an initial batch of traps was purchased for them by the project, and this could be reinforced with suitable marketing study to be commissioned by the project.

Supply of lures

This lack of local availability has been repeatedly articulated by farmers and project partner organisations and indeed this constraint can be seen as more severe than the problem of trap supply, because there is no immediate prospect of local manufacture of the lures.

Up to the present a UK company has supplied lures for the projects' needs and it has proved difficult to identify an organisation willing to take on the purchase of lures from them and the subsequent distribution (re-sale) to farmers or farmers' organisations at a local level. IITA and state research organisations in the respective countries are barred from any commercial activity of this sort. NGOs such as GOAN and OBEPAB, among the project partners, have indicated willingness in principle to undertake buying and selling of the lures, but their legal status prevents this being on a profit-making basis so this is probably not a long-term solution though it will certainly help in the short-term. Project staff approached the NGO TechnoServe, which operates in Ghana, with a view to obtaining their assistance in finding a willing commercial partner. To date, TechnoServe have proved reluctant to become involved, seeking prior evidence of market demand not yet available before committing themselves. A future project might try to facilitate a commercial venture, as with the traps, by funding an initial purchase of lures by a specific importing agricultural supplier.

The alternative approach is to try to develop lure production in Ghana, with local sales from there. If a potential private sector supplier can be found, funds could be made available to invest in equipment or initial purchase of materials and any new project would contain an element of training provision.

To determine the best approach of these two an economic feasibility study could be undertaken, looking at possible future demand and likely profit margins. In addition, small grants could be made available to farm organisations, or a rural bank, to set up revolving funds to facilitate the purchase of lures (and traps) by farmers.

[5] US$ 1 = CFA 543 and £1 = CFA 957 as at January 2006.

Registration and regulation issues

Allied to the issue of the commercialisation of trap and lure production and distribution is that of the official registration of the products with the relevant national authorities. In principle all pest control products should be registered with the Environmental Protection Agency (EPA), for Ghana, or, in the case of Benin, with the *Comité d'Agrément et de Contrôle des produits phytosanitaires* (CNAC) of the *Service Protection des Végétaux et Contrôle Phytosanitaire*. In practice the registration procedures are only relevant and suitable for conventional pesticides and trying to register a pheromone product through existing procedures would be difficult at best. To the very limited extent that pheromones have been used (on an experimental basis) up to now in the region, no formal registration has taken place.

Despite these difficulties in the long-term there would be obvious benefits to registering pheromone products. Firstly, any large-scale commercialisation could be at risk if the product were not given the official legitimacy of registration; secondly registration would confer a seal of approval in terms of product quality and standardisation since regulatory requirements would mandate this.

Fortunately, the current registration procedures and guidelines are under active review and alteration by EPA in Ghana[6] and it is understood that the new procedures are likely to be approved by the close of 2006. The changes are modelled on new draft guidelines developed and adopted in Kenya (with CPP support) which have allowed the evaluation of an entomopathogenic biopesticide for diamondback moth by the commercial sector. The new guidelines should be much more appropriate to 'biological pest control agents' (BPCA, including pheromones) and less onerous than at present from the point of view of a potential applicant. Moreover it appears that similar changes are contemplated in Benin by CNAC[7], though they are at a less advanced stage. Assuming these changes do take place in year or two, they should create a much more favourable environment for pheromone products to achieve wider acceptance and uptake. Any future project or initiative to further promote uptake of the pheromone traps should have official registration as one of its objectives.

Lack of market demand for reduced-pesticide cowpea

The lack of market demand, or a market premium, for reduced-pesticide or 'biological' cowpea is likely to act as a significant constraint to the adoption of any technology which may result in reductions in the use of conventional insecticides. If the new technology requires more work from the farmer (as with botanical pesticides, at present), imposes greater financial input costs or is perceived by the farmer as novel and carrying a greater potential risk than conventional practices (as may be the case with pheromone traps), it is not unreasonable that the farmer wants to have this recompensed by a price premium on the cowpea yield so produced.

This point has been articulated repeatedly by farmers to project partners and by TechnoServe in discussions with the author. It was raised once more at the end-of-project workshop at Cotonou in December 2005. It can be shown to be the case most strongly with botanical pesticides. Cowpea farmers are reported as saying that

[6] A. Cherry (NRI) and H. Braimah (CRI) pers. comm. – the DFID-CPP funded project R8430, led by Dr Cherry has been instrumental in initiating the review of registration guidelines.

[7] A. Boulga, pers. comm. – Dr Boulga of CNAC was an observer at workshops held in Accra to review the EPA's registration guidelines, under the auspices of project R8430.

they are aware of the health risks associated with consuming insecticide treated cowpea and because of this prefer to consume botanically-treated cowpea themselves. However, they are only able to treat a small proportion of their cowpea with botanicals because these have to be hand produced, and are quite laborious to prepare. They reserve the botanically portion of their crop for themselves but sell the rest on the open market. Because of a general lack of awareness about the health aspects of insecticide-treated cowpea among urban consumers there is no demand for alternatives. If such an alternative attracted a higher price farmers would be willing to invest the extra labour required for its production.

The point may also apply to pheromone traps: whilst their use does not necessarily imply abstaining from the use of conventional pesticides and their cost should not be excessive[8], if the traps are to be made locally this requires extra labour and the use of a trap threshold to decide pesticide timing might be perceived as risky.

It is difficult to see what can be done to alter the market situation for cowpea so as to improve unit financial returns to farmers. Greater awareness among consumers would help, but altering this would be beyond the scope of any project and must be a long-term expectation. The author was informed of a small-scale initiative by TechnoServe in the Upper West Region of Ghana, whereby organic cowpea is grown for export for experimental production of baby-food. Pheromone traps might be of interest to such niche-market farmers but it has not yet been practically feasible to explore this possibility.

Lack of trained technicians

Any future initiative to further promote uptake of the pheromone traps will require a substantial number of field technicians or extension agents capable of imparting knowledge and experience in the use of the traps to farmers. Despite the achievements of the projects to date, project experience in reaching a relatively small number of villages (within the region as a whole) suggests that a sufficiency of these workers does not yet exist and therefore the training of a fairly large number would be required to achieve widespread coverage across the countries. Target persons for training would probably be drawn from DIFOV and CeRPA in Benin and the Ministry of Agriculture extension services in Ghana, whilst some NGO staff might also be covered. Such training activities could supplement similar activities associated with other crop sectors that involve the same persons. They could be complemented by the further production and dissemination of existing poster and leaflet training materials, and would be assisted by their translation into more local languages.

Cocoa mirid pheromone traps

Project History, Outcomes and current status of implementation

70% of world production of cocoa occurs in West Africa with most of this coming from Côte d’Ivoire and Ghana for whom it forms a vital export crop and foreign exchange earner. Plantations are mostly in the hands of poor small-holders farming crop areas of 5 ha or less. Low producer prices and little access to credit are significant obstacles to farm improvement and to combating pests and diseases.

[8] Economic estimates by R8411 suggest total costs associated with trap use comprise only around 4% of all financial inputs.

Cocoa mirids (Heteroptera: Miridae) are the most widespread and injurious of insect pests on cocoa. Crop losses are hard to quantify but most surveys in West Africa have estimated 20-30% yield losses averaged across all farms, whilst poor control can lead to far greater losses. The nymphs and adult mirids feed on the stems, branches and pods, and stems and branches wilt above the point of attack. The feeding punctures can also serve as points of attack by plant pathogenic bacteria and fungi. Both nymphs and adults probe the plant very frequently, hence serious damage can be caused at low population densities (5 – 10 individuals per tree is considered high) which can be hard to detect until damage is already advanced.

There two main mirid species in the region are *Distantiella theobroma* Dist. and *Sahlbergella singularis* Hagl., although the latter now dominates in Ghana. They often aggregate in "pockets" where conditions are particularly favourable, e.g. a break in the shade canopy. Currently, the principal method of control is with insecticides (although good shade management can suppress numbers). The Cocoa Research Institute, Ghana, (CRIG) has shown that effective control can be achieved with four insecticide sprays during August – December, but surveys showed that fewer than 1% of cocoa farmers in Ghana follow spray recommendations, with the vast majority not spraying at all due to cost and other practical difficulties. To address this, over the last four seasons the Government of Ghana has re-instituted a national spray program aimed at treating all cocoa in the country. In the 2003-04 the cost of this was reportedly US$ 35 million[9].

Following an initial request from the Cocoa Research Institute of Ghana (CRIG), since 1998 NRI and CRIG have conducted research to develop pheromone traps for the two principal mirid species, *Distantiella theobroma* Dist. and *Sahlbergella singularis* Hagl. This has taken place under the following CPP projects[10] (in each case in conjunction with other cocoa-related research in association with CABI Bioscience):

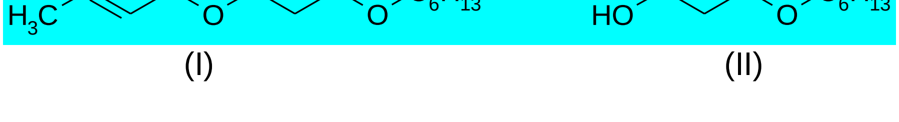
R7249 – Development of mycopesticides and pheromones for cocoa mirids in Ghana (1998 – 2002);

R8313 – Implementation of Cocoa IPM in West Africa (2003 – 2005);

R8448 – Implementation of Cocoa IPM in West Africa (2005 – 2006).

The ultimate aim is to use such traps either for direct control (capture and killing) of the pests or for monitoring. The particular attraction of a monitoring approach is that the normal low and patchy distribution within cocoa plantations renders effective searching or monitoring by other means extremely laborious and time consuming.

Working with unmated female mirids collected at or close to CRIG, laboratory analysis at NRI indicated that the female-produced pheromone of both species contained the same two compounds (I) and (II) below, in similar proportions.



(I) (II)

[9] Source: Daily Graphic (Ghana), 24 October 2003
[10] Scientific publications produced by the project are listed as references 6 – 9.

Replicated trapping experiments took place in cocoa plantations at the CRIG station at Tafo, Ghana. Catches very largely consisted of *S. singularis* and were typically low but variable, reflecting the highly sporadic distribution of the mirids. In experiments with different blends and doses of compounds (I) and (II) the main findings to emerge were:

- Lures containing 1000 µg of (I) and 50 µg of (II) are normally more attractive to male mirids than larger or smaller doses or other ratios of the two compounds;
- only the R-enantiomers of the compounds are attractive;
- positioning of the lures within a trap is not important;
- contradictory results have been obtained in respect of lure longevity – some indicate a period of two weeks before maximum attractiveness is attained, with attractiveness thereafter lasting up to 3 – 4 months; other results suggest catches decline quite quickly after two weeks exposure in traps; a further experiment on this is on-going;
- only traps featuring a sticky, retentive surface were effective;
- several hand-made designs made from a plastic, card-like material called 'Corex' were found to be as effective as imported commercial 'delta' traps;
- traps are suspended from the trunk or lower branches of cocoa trees – the optimal height being around 2 metres;
- some testing of a mass-trapping approach to control of mirids was attempted at CRIG, but the plots were probably too small and close together to show real effects and no differences in pod damage or yield were demonstrated.

The project has also made contacts with the regional Sustainable Tree Crops Program operating within Ghana. STCP trains farmers in a variety of cocoa IPM activities through participatory farmer field schools (FFS). Using these links CRIG staff initiated some preliminary testing of two mirid trap designs in three villages near Kumasi in June 2005. Farmers were enthusiastic to be involved and initial catch results were encouraging. This is the only on-farm use of cocoa mirid traps to date.

Thus, although significant progress has been made, cocoa mirid pheromone trap research and implementation is less advanced than for *M. vitrata* traps. There is still some uncertainty concerning the best pheromone blend and dose, and the length of time over which the lures remain effective. All lures have be produced by NRI and traps or the trap material ("Corex = Corruplast") have all been sourced from within the UK. The UK cost of corex/corruplast is £3-41 per 1 m^2 sheet, which is sufficient for 2 - 3 traps, depending on which design is made. Searches within Ghana for suitable alternative materials have been made, so far without success although these are continuing. In September 2005 it was agreed that CRIG would try to produce a small number of lures on-site using pheromone synthesised at NRI, with a view to transfer of production to CRIG, at least in the short- to medium-term.

<u>Constraints and obstacles encountered during technical development</u>

Capture rates in the traps

In absolute terms, the rates of mirid captures in the traps have always been low and variable in both time and space; for example a particular trap may catch zero or only a handful of mirids over several weeks, while its neighbour only 10 m away attracts 50 or more in the same period – with most of these concentrated into a few nights. This variability presumably reflects the normal distribution of mirids within a cocoa plantation. They are known to occur at low overall densities, often concentrated into 'pockets' in which 5 – 10 individuals represents a high and damaging infestation.

These patterns of trap capture have limited the effectiveness of experiments, inasmuch as the variability in mean capture rates for a given treatment is often very high, thus preventing statistically significant conclusions being drawn from experiments that have lasted several weeks or months. The use of greater replication and rotation of individual trap treatments within replicate blocks can go some way to addressing the problem, but these measures do require significant extra work and space.

Experience has also shown that seasonal population trends have varied somewhat between years, aggravating the aforementioned problems by making it difficult to select even the best approximate period over which to conduct an experiment.

Logistical difficulties

With the exception of on-farm trapping in 2005 all trapping trials have taken place at CRIG. Most of the experimental plots there are necessarily sprayed with pesticides against a variety of pests, including mirids. Only two unsprayed plots have normally been available for trap comparison experiments and this has limited the rate at which experimental progress can be made. The move towards on-farm testing, begun in 2005, may be the solution to the space problem and a bonus has been rather higher rates of capture (see above). Of course, on-farm experimentation presents other, obvious challenges particularly in terms of travel to the site and regular monitoring.

Communications difficulties with the CRIG station at Tafo, 2 – 3 hours drive from Accra, have frequently been problematic. Often for weeks at a time telecommunications links have been extremely difficult or totally blocked – at least from the UK. This has often prevented communication over details of experimentation, visit planning or the transmission of results. The situation has improved significantly over the last two years but even so in recent weeks faxing has been difficult. One example of this provided by the lack of response to a recent order for polyethylene vials (for producing lures) recently made by CRIG.

IPR issues

The first project phase was initiated following an approach by CRIG to NRI to help identify possible mirid pheromones. CRIG have naturally felt a strong 'ownership' of the research and have been anxious that intellectual property rights in the work, and potential financial benefits arising from it, are retained within Ghana. This caused difficulties in earlier stages of the research when CRIG objected to the standard DFID clauses in the CPP project sub-contract relating to IPR. These normally give theoretical ownership of the IPR to DFID as the funding body. These objections were such that practical research had to be suspended for one season.

The matter was eventually resolved to the satisfaction of all parties, when the offending clauses were substantially revised and it was explained that in nominally retaining IPR on any products of the research DFID was merely seeking to keep the benefits available to all who might benefit from it, and not just the immediate parties to the research.

Actual and potential constraints to further implementation

Field testing the traps for monitoring or control

From the descriptions above it should be clear that cocoa mirid traps still require a considerable amount of further technical development before they can represent feasible options for practical use by farmers. Although a fair amount of progress has been made, substantial doubts remain concerning the precise pheromone blend for optimal attraction and the longevity of effectiveness of the lures under field conditions. Once these parameters have been determined it will still remain to determine whether, and how, the traps are best used in a monitoring role or for direct control by 'mass-trapping'.

As monitoring tools trap catches would act as advance warning of infestations. As with the *Maruca vitrata* traps, some threshold would serve as the trigger for a control intervention, such as insecticide spraying. This approach assumes the existence of a consistent relationship between trap catches and infestations or yield loss/damage.

To determine the relationship, traps would have to be deployed in plantations and catches monitored through the season, along with various measures of damage, infestation and yield. It will then require detailed statistical and economic analysis to establish the action threshold on the basis of the results. This threshold would then be validated in on-farm trials. Given the variability in catches, large numbers of traps, in several locations, would need to be deployed to give a good chance of finding a relationship between catches and damage. The required number might be estimated from existing on-station data.

Mass-trapping has the advantage that it is an easy concept to understand and carry out – traps are put out, they trap the pests and subsequent damage is reduced. However, in the case (as here) where it is males that are trapped it is usually true that very high percentages (>90%) need to be trapped to have an impact on subsequent infestations. This is because males are usually capable of multiple matings so even a few un-trapped individuals are sufficient to inseminate all or most of the females. That said, cocoa mirids do not appear to be very mobile pests which will tend to improve the chances of success, at least locally.

Although some information on this strategy has been obtained from the trial at CRIG, the plots used are rather small and the data so far do not give great cause for optimism, but this could change particularly if it could be shown that the fecundity or fertility rates of females in trapped plots were reduced compared to those in un-trapped plots.

The broad approach needed to test mass-trapping would be to test one or more density of traps against an un-trapped treatment, at each of at least 5 – 6 sites. For preference plots should be as large as possible, at least 0.25 hectares. This is to avoid the significant 'edge effects' associated with smaller plots, in this case brought about by possible immigration of mirids from un-trapped areas outside. Obviously a large plot will require more traps and testing several densities of trap would multiply the logistical difficulties. As above, catches would be monitored through the season, along with various measures of damage, infestation and yield, and an independent measure of mirid density such as the standard manual searching technique developed by CRIG.

Trap and lure manufacture and supply

Although trap and lure supply are not yet a serious constraint to uptake by farmers – because the best method of using the traps has yet to be determined – in time it will become so. Essentially the options are similar to those for *M. vitrata* lure and trap supply. Traps could be made locally, probably not by farmers because the corex material is not something normally sold on local markets. However they could be manufactured in Ghana (or W. Africa) using imported or locally produced plastic sheeting, or they could be imported directly from European, N. American or even Asian suppliers.

Provisional plans were made such that CRIG would make the traps using whatever suitable plastic sheet material they could obtain within Ghana. However, little progress has been made in finding a suitable source of this material. A more promising approach might be for local plastics factories to be asked to make the traps in a ready-moulded form using a corex substitute. A potential start on this might be made if a future project set aside funds to enable a company to be contracted to produce several hundred traps in this way.

Similarly, lures could be produced outside Ghana and imported, or some form of local manufacture could be sought. As with the traps, in principal local manufacture should make the lures cheaper to farmers. In addition, CRIG have indicated that they would prefer to keep control of the technology and to reap any financial reward from its sale, hence a provisional plan was agreed to set up a facility for production of the lures at CRIG. CRIG have one staff member suitably trained to do this, and detailed instructions on lure preparation additionally provided by NRI. However, obvious constraints are the communications difficulties referred to above (the need to be able to reliably order equipment and consumables) and the absence of reliable gas-chromatographic and other analytical equipment for ensuring quality control of the lures.

The issue of IPR, and the related one of precisely how any lures could be marketed, needs to be progressed by CRIG and COCOBOD if use of traps is ever to become a practical reality. Obvious questions are, assuming CRIG manufacture of lures and other local fabrication of traps, how will they be marketed to farmers? On what basis: at subsidised, cost-recovery or profit-making prices? Will they be available to farmers in other cocoa-producing countries? A different but similarly vital consideration is how will trap use by farmers fit with the current government-subsidised national spraying programme for cocoa? What incentive will farmers have for using traps to help control the mirids when they receive free insecticidal control of the pests?

The CRIG director has stated his desire to consider the feasibility of patenting some aspect of the traps or lures, or their use, in order to defend the IPR in the technology. If this can be achieved this would be a very reasonable step, particularly in view of the potential introduction of the technology to other countries (some tentative steps have been taken in Cameroon). Some urgent attention needs to be given to this and the above questions. Making progress on lure and trap production, along with the related IPR issues, will be of vital importance to any prospect of using pheromone traps in Ghana or elsewhere. All will need to feature strongly in future initiatives and could be specific objectives of a possible future project. CRIG will need to acquire some equipment to be able to undertake quality control of any lures it produces and consideration should be given to training additional staff in the necessary skills.

Finally, the cocoa mirid traps and lures will need to conform to Ghanaian official registration and regulatory requirements, particularly if they are produced by a state entity such as CRIG. Although, as noted above under the discussion of *M. vitrata* pheromone traps, these are being reviewed (and probably eased) by the responsible body, the EPA, it is suggested that the necessary official steps will need to be taken at some point, once the technical effectiveness of the traps is definitely established.

Summary and conclusions

This review of two projects both having the objectives of developing and implementing the use of pheromone traps for two different insect pests in West Africa has shown that a variety of obstacles may be encountered during the technical development stage. These include low and variable catches, geographical variability in response of the target insect species and a variety of communication and logistical difficulties all of which may hamper progress. Appropriate care in site selection and experimental design can solve many of the first two sets of difficulties, while persistence and commitment are needed in the latter! Despite the relative specificity of pheromone traps, sometimes non-target species are trapped and confusion and mis-identification by inexperienced farmers or extension personnel can be an obstacle to practical implementation. Care needs to be taken in explaining the expected mode of action of traps to farmers to avoid misconceptions: for example, traps deployed to act as monitoring tools can often be considered to have a direct controlling effect by farmers, when in reality this is not the case.

As regards actual and potential constraints to uptake of traps by farmers, some common themes have emerged from the two projects. Among the most serious is the current lack of any pheromone lure, or trap production, capacity within West Africa. Importing elements of the technology from Europe, N. America or SE Asia would be possible, but expensive, while establishing local production has not yet proved possible. Further adaptive or implementation projects could address this difficulty by setting aside funds specifically to be paid to potential private sector manufacturers for initial batches of traps or lures, they might also consider setting up revolving funds to allow farmers to pay for the traps and lures.

Of course a market demand from farmers for the technologies needs to exist for uptake to occur and this yet to be firmly established in both of the cases examined. In the case of the *M. vitrata* traps the lack of a market for reduced-pesticide cowpea acts as a disincentive for the adoption of traps as monitoring tools which would reduce pesticide usage. The additional labour of checking traps apparently also reduces farmers' willingness to use them in this case, and there also appears to be a general unwillingness to risk the use of an as yet relatively novel technology. Both might prove to apply in the case for cocoa mirid traps too, when practical testing reaches that stage. Similar disincentives for adoption of pheromone traps can be seen if one considers the availability of subsidised pesticides from the cotton sector in Benin and the Government-funded cocoa spraying programme in Ghana.

At the time of writing no specific official registration or regulatory framework exists for biological pest control agents such as pheromones, so the alternative is either to avoid registration altogether or attempt to achieve registration using the existing, unsuitable and onerous system for conventional pesticides. Fortunately the competent authorities in Benin and Ghana, CNAC and EPA, respectively are revising their regulatory procedures. Registration of either the *M. vitrata* or the cocoa mirid pheromones under the new procedures should facilitate their eventual adoption since they would confer increased confidence in their efficacy and consistency on the part of their users – farmers.

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ANNEX 7

COPY OF ARTICLE FOR IAPPS ON-LINE NEWSLETTER FOR APRIL 2006

IMPLEMENTING PHEROMONE TRAP TECHNOLOGIES FOR COWPEA FARMERS IN WEST AFRICA

Cowpea is a vital grain legume crop in West Africa, where it is grown mostly by subsistence farmers and provides a cheap source of dietary protein for low-income populations. *Maruca vitrata*, the legume podborer, is a key pest. The larvae attack flower buds, flowers and young pods and yield losses range up to 80%. Conventional insecticides can control the pest, but expense often limits their use by poor farmers. Elsewhere, over-use of insecticides not recommended for use on cowpea (e.g. in Benin farmers often use subsidised cotton insecticides) is leading to increasing health and environmental hazards. Thus the development of a technology which can predict the occurrence of the pest, thereby assisting farmers to decide when and where to target their insecticides, represents a significant advance.

With funding from the UK's Department for International Development (DFID), a team of researchers from the Natural Resources Institute, UK and the International Institute of Tropical Agriculture in Benin have developed pheromone traps for detecting the appearance of *M. vitrata* in cowpea fields. Working with NGOs and national agricultural research centres in Benin, Ghana and Burkina Faso the team has developed a practical approach whereby six or more farmers within a village operate traps in cowpea fields from the beginning of the season. Farmers share information about captures and when the threshold of an average catch of two moths per trap is reached, spraying within three days is then advised. Farmers decide the best control agent to apply in their fields – botanical or conventional pesticide – and exactly when to apply it, taking account of the overall pest situation.

The first step to developing the traps had been to identify the sex pheromone of *M. vitrata* and develop the necessary attractant lures for traps. Although studies by other researchers in the late 90s identified one component of the pheromone no field testing had been carried out. Analytical and bioassay studies in the NRI labs confirmed this and found two other minor

components. Field trapping experiments commenced in 1998 at IITA in Benin and clearly indicated that a three component pheromone blend provided optimal attraction of male *M. vitrata* moths. This was the first time a synthetic pheromone blend had been identified that was more attractive to male *M. vitrata* than virgin female moths under field conditions.

To minimize eventual costs to farmers the team sought to develop traps which could be made locally, by farmers if necessary. Several different designs were evaluated and a locally fabricated water-trap – made by cutting out the sides of a five liter plastic jerry-can – was found to be superior to imported, commercial trap designs. Moths entering the jerry-can trap are killed by drowning in the water placed inside.

The type and cost of the attractant lures is also an important practical issue so factors such as oxidation, isomeric purity and longevity of the pheromone compounds were all investigated. Results showed that shielding of lures from sunlight was unnecessary, attraction to even low-purity lures was possible and 0.1 mg polyethylene vial lures remained effective for up to four weeks under field conditions. All these findings simplified and cheapened the potential cost of lure manufacture and use. Lures are now supplied by a small company in the UK.

For utilization of the traps to be possible practically, demonstration of some consistent relationship between trap-catches of adults and the incidence of larval attack in cowpea fields was necessary. So trap catches and larval infestations were monitored in un-sprayed farmers' fields; these quickly showed that for fields sown around the same time, moth captures typically precede larval infestations by several days enabling farmers to determine *when* they might need to spray. An additional finding was that a possible alternative predictive measure, that of the appearance of flowers in the crop, tended to give a much shorter warning period of infestations than initial trap captures.

Based on these findings, since 2002, empirical testing through on-station trials and farmer field schools (FFS) involving 500 farmers in 26 different villages has gradually evolved the trap-based threshold approach for determining spray timing mentioned above. FFSs operated mainly under the auspices of project partners GOAN and CRI in Ghana and OBEPAB and INRAB in Benin (the latter in association with the IITA-managed *Projet de Niébé pour l'Afrique*). Positive outcomes include:

- Use of traps combined with different insecticides to determine spray timing can be at least as good as normal farmer practices in terms of yield and *M. vitrata* infestation;
- Among farmers with experience of the traps, more than 90% believe traps can help to control *M. vitrata* and on average they are willing to pay US$ 5 – 6 for the traps and lures, which compares with previously estimated costs of fabrication, installation and maintenance for a cropping season of around $5;
- Traps only account for an estimated 4% of the total production costs.

We hope and expect that farmers will wish to continue using the *M. vitrata* pheromone traps. The challenge is to find long-term, sustainable method of supplying the traps and lures. In the short-term farmers can fabricate traps themselves and a possible supply route for the lures could be through one or more of the project's institutional partners, following purchase from the UK supplier. However, project surveys indicate that in the longer-term farmers wish to purchase traps, lures and botanical pesticides through local, existing agricultural input providers. The farmers who have participated in the project could form the initial, core market for these providers with future expansion if the technology is taken up more widely.

For more information:
Dr. Mark Downham
NRI, Chatham, UK
E-mail: m.c.a.downham@gre.ac.uk

ANNEX 8

SUMMARY OF CONCLUSIONS OF END-OF-PROJECT WORKSHOP, COTONOU, DECEMBER 2005.

<u>Digest of Working Group Ideas for a Further Phase (from December 2005 workshop)</u>

The suggested constraints to implementation of *Maruca* pheromone traps can be grouped into three areas: technical, socio-economic and policy related. These together with a summary of possible remedial actions to be undertaken in a further phase are given below.

Technical Constraints

<u>Insufficient Capacity within Extension Services</u>
Increasing the capacity of local extensions agents (National programmes and partner organisations) for interacting with farmers to disseminate the trapping and botanical technologies would greatly assist their further uptake at the farm level. There could be an initial training-of-trainers activity, one per country, during which as many individual extension agents as possible are trained in the technologies. These would then go on to train lead-farmers in their respective areas, with these farmers in turn passing on the message to their peers. Training farmers to avoid mis-identification of *Maruca* in the traps would be one specific objective but more generally the instruction would concern how to use the traps and the rationale underlying their use. The scale of this training would depend on available budgets; verification and validation of the secondary level training would need to be carried out. Suggestions were that training could build on or complement similar activities in other, related sectors e.g. cotton in northern Benin, vegetables in the transition zone of Ghana. Such projects or initiatives remain to be identified.
Specific output: increased capacity of local extension agents to disseminate trapping technology.

<u>Efficacy of traps in areas of high population pressure</u>
Traps do not seem to work in certain geographical locations, specifically northern Nigeria and parts of Burkina Faso. These are areas typically having particularly high *Maruca* populations or infestations. Clearly investigation of this can be considered basic research. One idea might be that high densities of females effectively out-compete the traps for captures of males. Aspects to consider might be re-investigation of different blends in various locations, behaviour of the insect, influence of cowpea variety, physiological factors, climatic factors, particularly temperature extremes (re-examine effect of exposure and shielding, increase lure dose at Kano, Burkina), modification of trap design to minimise accidental trap captures.
Specific output: an improved, cheap, durable, effective trap for Kano and Burkina, with improvement through farmer participation where appropriate.

<u>Need for further innovations to control *Maruca*</u>
More generally two new areas for research are:
- NPV for *Maruca* – identified from Taiwan recently, initial testing at IITA in 2006
- Bt cowpea – still at development stage in US, on-station trials not expected until 2007/8 and at farm level later still

Neither of these could be picked up by DFID’s upcoming Research into Use programme but eventually funds from the expected geographical – sustainable agriculture programmes might play a role.

Socio-Economic Constraints

Costs and availability of lures and traps

This constraint has previously been repeatedly articulated by farmers and project partner organisations. There are two approaches to solving the lure availability problem. Firstly, strong and durable links are developed between the Europe-based manufacturers and local institutions – probably NGOs – whereby the latter sell lures directly or through farmer organisations to farmers. The selling price of the lure to farmers would be at a cost-recovery price. Eventually, in this scenario, lure distribution is taken over by the private sector. The alternative approach is to try to develop lure production in Ghana, with local sales from there. If a potential private sector supplier can be found, funds would be made available to invest in equipment or initial purchase of materials. To determine the best approach an economic feasibility study could be undertaken at an early stage in the project, looking at possible future demand and likely profit margins. In addition, revolving funds to farm organisations or a rural bank (even IITA) would be made to facilitate purchasing lures by farmers. Certain guarantees would need to be obtained to ensure proper use of such monies. For manufacture of traps, the producers of the plastic cans from which traps are made would be approached with a view to them making the cans already with the side windows already cut-out.
Specific output: sustainable and affordable system of lure and trap production developed.

Labour of botanical production

This is another previously well-articulated constraint: farmers want to be able to buy botanical pesticides off the shelf and not go to the labour of producing them themselves. Previous ideas about the mechanisation of botanical production need to be pursued further:

- Mills have been developed by/with SARI in Tamale;
- GOAN notes that CRIG already have a substantial supply of neem seeds in place for use with their organic cocoa initiative;
- The Songhai (Organic) centre in Cotonou may be able to assist or advise.

These alternatives could be evaluated and a feasibility study conducted if appropriate.
Specific output: local sustainable and affordable system of botanical production developed.

Perception of the benefits of this technology relative to others

Two actions are suggested under this constraint:

- Compare the benefits of pheromone traps relative to other technologies;
- Train farmers so that they can do simple budgeting to allow farmer to make informed decisions about pest control practices.

Both of these could be handled within the framework of farmer training by extension agents – see first output.

Market volume or premium insufficient for ‘biological’ cowpea

Currently the market demand for cowpea produced with reduced-pesticide inputs is effectively non-existent (a small initiative is known from NW Ghana where cowpea is for export use to make baby-food). Farmers themselves are aware of the safety/health/residue issues and will often eat only botanically-sprayed cowpea, whilst sending conventionally-sprayed crops to local markets. Wide-scale promotion of biological cowpea through, for example, developing consumer awareness in partnership with consumer associations may not be within the scope of a new project. However, measures such as contacting TechnoServe again about the organic cowpea farmers in Ghana, exploring the possibility of certification of

biological cowpea (see below) and an ex-ante assessment of the ‘willingness to pay’ by consumers, may help to create a favourable environment for later adoption.
Specific output: market study for biological cowpea, including possibility of official certification to improve market appeal/credibility.

Policy Constraints

Partnerships

- Need for Traceability of Biologically treated products – to develop such a scheme would need the involvement of Public sector organisations – we need to consider what similar schemes already exist for tracing product origins (consider the NRI warehouse receipts idea). *Separate IITA (Coulibaly) project may look at traceability aspects.*
- Strong partnerships between public and private sectors (DIFOV, PPRSD, EPA, MoFA, CNAC, SIR) are needed to inform them of technology availability – activities could include stakeholder workshops to which directors, policy makers would be invited (1-day in each country)
- We need to empower NGOs for diffusion of biologically based pest management technologies – covered under capacity development output above

Competition with pesticides

The output under this heading needs to be framed as improving farmers’ awareness and reducing reliance on chemical pesticides. Comparisons with conventional pesticides, perceptions of traps and botanicals can be activities for the improved extension capacities where the pros and cons of different technologies are explored. We need to be aware of/prepared for possible conflict with the pesticide industry. More generally we can create awareness/information systems for all stakeholders through increased use of the media, talk shows, rural radio, farmer field days and demonstration plots, printed materials (we can use existing posters, leaflets and the training video but need more copies, further translations etc).

Regulations and registrations (quality standards)

We should monitor on-going developments in the regulatory and registration standards at national and regional levels and should aim to register one or more pheromone and botanical products as output of new project as a project output. Some form of regular sampling and analysis for quality control of bio – products would need to accompany this – can we try to encourage a long-term system of such monitoring (perhaps working with GSB, EPA and CEBENOR)? The issue of pesticide residues is a serious one and it is not clear that it is ever checked under existing systems. Could we make some form of analytical comparisons between cowpea produced under the two systems a specific activity of the project?

Mark Downham, January 2006