CROP PROTECTION PROGRAMME

TECHNICAL SUPPORT FOR SME SUPPLYING PHEROMONE-BASED PEST CONTROL TECHNOLOGIES IN SOUTH ASIA

R8304 (ZA0574)

FINAL TECHNICAL REPORT

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1 - SUMMARY SHEET

Title of project:	Technical support for SME supplying pheromone-based pest control technologies in South Asia
R Number:	R8304
Project leader:	Dr Alan Cork
Institution:	Natural Resources Institute
CPP Production System:	Land-Water Production System
CPP Purpose:	Purpose 2: Productivity and productive potential in production systems increased through removal or amelioration of constraints by crop pre-harvest pests. Output: Promotion of environmentally benign ICM strategies for major insect pests of rice appropriate for use by poor farmers.
Commodity base:	Cereals and vegetables
Beneficiaries:	Resource-poor farmers in South Asia and commercial producers of benign semiochemicals-based pest control technologies.
Target Institutions:	SMEs and policy-makers involved in producing and promoting IPM component technologies and pheromones in particular.
Geographic focus:	South Asia

	Planned	***Actual***
Start date:	1 September 2003	1 September 2003
Finish date:	31 August 2004	30 September 2004
Total cost:	£80,852	£80,852

2 - Contents

3 - ABBREVIATIONS

BARI	Bangladesh Agricultural Research Institute
BCRL	BioControl Research Laboratories Limited, Bangalore, India
CPP	Crop Protection Programme of DFID
DAE	Department of Agricultural Extension
DFID	Department for International Development
IPM	Integrated Pest Management
NGO	Non-Governmental Organisation
NRI	Natural Resources Institute
SE	Standard Error
SME	Small and Medium Enterprise

4 - EXECUTIVE SUMMARY

- The project undertook to identify and resolve technical constraints of SMEs engaged in the manufacture and marketing of pheromone products in South Asia as a means of achieving sustainable promotion of IPM compatible alternatives to insecticides in the region.
- Sixty percent of SMEs producing pheromone products in South Asia actively participated in a project survey and stakeholder workshop to determine the major constraints that affect their ability to successfully produce and market pheromone technology to farming communities.
- Together the companies produce and market 1.6 million pheromone lures per annum for use with thirteen economically important insect pests covering a range of crop types. Nevertheless, cotton pests accounted for 95% of the production with the majority of lures traps and lures being sold through the State Government procurement system.
- Most SMEs were optimistic about the future with 57% expecting sales to increase and 36% believing that sales will stay at similar levels in the near future, broadly in line with the rest of the world where the market for pheromones is growing at about 10% per year.
- SMEs felt that pheromone supply was a major constraint, with most pheromone being imported through one company in a final blended form. Unlike other biopesticides they are subject to an import tax but access to ISO9002 certified material enables the smaller producers to compete with larger companies.
- Most SMEs rely on other product ranges to achieve a financially viable business, typically production and distribution of seeds, viruses, natural enemies.
- An international stakeholders' workshop was conducted involving 50 participants from four countries. The workshop provided a venue for the dissemination of information by invited experts, both national and international, and feed-back from participants on project activities. These activities provided the background information for the development of a pheromone manual that was produced to provide answers to the technical questions raised by SMEs.
- From the nature of some of the questions raised in the discussion sessions it was apparent that there was considerable uncertainty among SMEs and indeed some of the scientists about the scope and limitations of the technology. Indeed the role of major pheromone products for monitoring pests in India is still poorly defined and unless and until SMEs and extension agencies provide farmers with well-defined protocols for using the products they will not be widely adopted on a sustainable basis.
- Solutions to the issues raised by the SMEs are in part the responsibility of Government but Government needs assistance to ensure that the decisions it makes are in the best interests of consumers and the industry itself. The Chief Guest, Dr C. D. Mayee, Agriculture Commissioner to the Government of India, was very supportive of the technology and encouraged SMEs to join together to seek constructive solutions to their problems. By presenting a common face to Government the chances of achieving a consensus to drive the agenda forward will be greatly enhanced. Areas where Government and SMEs could play a role were identified and broadly reflected the recommendations presented by Dr P. S. Chandurkar, Plant Protection Adviser to the Government of India in his lecture to the workshop.
- Workshop participants identified a number of themes that represented the major constraints to the industry they were pheromone – source and cost, quality assurance, registration and markets. Workshop recommendations included, formation of a Society to represent the industry, training package for SME's on 'product' evaluation, identification and promotion of new market opportunities, review of company capacity and direction (SWOT analysis).

5 - BACKGROUND

Considerable advances have been made in recent years to develop IPM-based control strategies for agricultural crops in South Asia that incorporate semiochemicals to control key insect pest species (Cork and Hall, 1998). Much of this work has been funded by DFID through the CPP, notably control of the rice yellow stem borer, *Scirpophaga incertulas*, and brinjal shoot and fruit borer, *Leucinodes orbonalis*, (Cork *et al*., 2001, Cork *et al*., 2003). In addition pheromones for coffee white stem borer, *Xylotrechus quadripes, (Hall et al., 1998)*, groundnut leaf miner, *Apoaerema modicella, (Hall et al., 1993)*, sugarcane borer species such as top borer, *Scirpophaga excerptalis*, internode borer, *Chilo sacchariphagus indicus*, and stalk borer, *Chilo auricilius* and cotton pests, *Helicoverpa armigera*, *Spodoptera littoralis*, *Earias insulana* and *Earias vittella* were identified (Cork and Hall, 1998) using DFID funding. Despite this work only one pheromone has been registered for use in control in South Asia and that is a formulation developed by Shin Etsu for control of the pink bollworm, *Pectinophora gossypiella* in cotton by mating disruption.

There are many reasons for the lack of commercialisation of these pheromone-based systems in South Asia. In India mating disruption was found to be efficacious for control of *S. incertulas* in rice (Cork *et al*., 1998) but not cost-effective (Cork, 1998). Nevertheless, indigenous scientists continued the work and developed mass trapping as an efficacious and cost-effective alternative (Cork and Krishnaiah, 2000). They went further and promoted the technology through extension services, but despite considerable demand from farmers (10,000 lures sold per annum), they were unable to sustain this endeavour because of the lack of active compounds (I. C. Pasalu, Directorate Rice Research, personal communication). Similarly, SPIC Science Foundation developed a method for controlling *C. sacchariphagus indicus* that was effective and well received by sugarcane producers but were unable to secure viable commercial production of the technology because of a lack of interest by the parent company (S. Narasimhan, personal communication).

After a pause in the research, initially funded through the CPP, on the pheromone of *X. quadripes*, this is now continuing with funding from the Common Fund for Commodities. A pheromone-based control technology for this species would complement the odour-baited traps adopted for control of the coffee berry borer, *Hypothenemus hampei* in India. World coffee prices have slumped in recent years and many smallholder coffee producers in India are in considerable financial difficulty (R. Naidu, Coffee Board, personal communication). Adoption of semiochemical-based control strategies for the two most economically important pests would enable smallholders to move to organic coffee production that would provide a significant advantage in this competitive export commodity market.

DFID-funded work on the development of an IPM strategy for control of *L. orbonalis* in Bangladesh, India and Sri Lanka has been found to be effective in significantly reducing fruit damage without the use of synthetic insecticides. Smallholder farmers in Bangladesh typically spend $1,000 per ha per year on insecticides for control of this pest (Rashid *et al*., in press). Negotiations are on-going between Syngenta Bangladesh Limited, the Bangladesh Agricultural Research Institute and other Government Agencies to determine the parameters for registering these products for use in Bangladesh. However, there is no in-country capacity to produce this technology the likelihood is that Syngenta Bangladesh Limited will initially import the products which will have inevitable cost implications for small-holder farmers.

Successful promotion of pheromone-based technologies and their adoption by smallholder farmers is dependent on the availability of quality products at an affordable price and that is only achievable through local production.

6 - INTRODUCTION

Pheromones have a proven track record for use in monitoring and control of economically important insect pests. Currently, the world market for pheromones is claimed to be expanding at about 10% per year from a base of $100 m - $250 m. Their appeal derives from their target specificity, cost-competitiveness with existing control technologies, low application rates, field longevity, environmental acceptability and ease of use. In many ways they provide the ideal tools for resource-poor farmers in developing countries and benefit poor and rich consumers of their produce alike. They have been utilised by advanced countries to enhance export opportunities by eliminating pesticide residues and hold the same potential for developing country producers who seek to enter new markets.

In common with any crop protection technology, need for and timing of application, application methodology and maintenance are important factors in their use. Importantly farmers have to be able to identify which product to utilise and in general application should be prophylactic. For these reasons most pheromone products that have found utility in developing countries tend to be associated with crop pests that are economically important in all crop seasons. To derive the maximum benefit from pheromone products their utility and limitations should be understood by users, although this is also true of any crop management practice.

While insecticides are produced by large national and international agro-chemical companies in South Asia, pheromones by contrast are produced and sold by small and medium enterprise (SMEs). These companies lack the resources and knowledge to achieve significant impact in the crop protection marketplace in the short term. Nevertheless, with the active support and encouragement of government and other stakeholders they will be better placed to respond to the needs of farmers and can deliver a higher level of sustainable impact than hitherto achieved.

Previous projects funded through the CPP have chosen to partner University and Government researchers and NGOs. While these organisations have useful attributes for developing and testing technologies in close cooperation with farmers they lack the capacity to manufacture and deliver the end products of the research process to farmers. This project has endeavoured to address that issue directly by developing ways and means of interacting with SMEs to enable them to better understand and develop the technology that they are manufacturing and promoting.

7 – PROJECT PURPOSE

Promotion of pro-poor strategies to reduce the impact of key pests and diseases, improve yield and reduce pesticide hazards in production systems.

8 – RESEARCH OUTPUTS

Output 1 – Scope for application of current pheromone technology to crop protection by farmers in South Asia and constraints to commercial development understood and documented.

Survey structure and coverage
In order to better understand the current environment in which SMEs are operating in South Asia to produce and promote IPM component technologies, such as insect pheromones, a questionnaire was developed and sent to the eight major producers and two large agrochemical companies, Syngenta Bangladesh Limited and Biostadt India Limited, who had expressed interest in commercialising pheromones in their indigenous markets. This was followed up by interviews with representatives from the SMEs to ensure that the questions had been correctly interpreted and to provide the SMEs with an opportunity to raise issues that they considered important to their businesses but had not been addressed by the survey. In addition a simplified version of the questionnaire was sent to 30 companies in South Asia that were known to have either produced pheromone or related bio-pesticide products.

The questionnaire was broken down into five sections:

- Organisation Type
- General information on pheromone and bio-pesticide production and sales
- Pheromone products
- Marketing, distribution and promotion
- Trends in pheromone use

In total data was obtained from17 companies, 10 interviewed and 7 postal surveys. Of those that responded 13 SMEs were pheromone product suppliers, one had products under development, two were considering entering the market, one was a distributor of chemicals for preparing lures and one was an R&D company. It was estimated that the survey covered companies that accounted for 60% of the market in South Asia.

The main conclusions arising from the survey are given below and summarised in the proceedings of the workshop (Annex 2).

Market structure
Analysis of vertical market linkage (Figure 1) indicated that while there were 6 companies that produced pheromones worldwide the majority of the chemicals were sold to pheromone product suppliers in South Asia through a single pheromone chemical distributor. Some of the chemicals were supplied directly to pheromone product suppliers and at least one supplier had the capacity to synthesise chemicals in-house but these routes had only limited impact on the market. The restriction on supply was felt by the SMEs to be a major impediment to growth in the indigenous market although the single distributor provided the chemicals in a pre-blended form and the products were ISO9002 certified. This enabled smaller companies to compete in the market without the need for analytical equipment or expertise to produce and quality assure pheromone blends. As the smaller SMEs were less vocal in the Bangalore workshop the impression was given that a single source was an impediment but in reality it prevents larger producers totally dominating the market. A situation highlighted by the call from larger and more vocal producers to retain import tariffs while they develop indigenous synthesis capacity.

Some thirteen companies produced and sold pheromone products to agro-dealers, NGOs, organic farmers and plantations as well as farmers, research institutes and Government

agencies but by far the largest markets for pheromone products were provided by State Government departments through a tendering process. The tendering process was seen by many of the companies to be a very contentious issue. In principle it provided an opportunity for companies to gain an assured market and for their products to be promoted to farmers at no cost to themselves. However, because the tenders were based on price and not quality the products provided to farmers were often sub-standard which reduced rather than encouraged farmers to use them and reduced the profit margins of SMEs to a point where it was not worthwhile applying for the contracts.

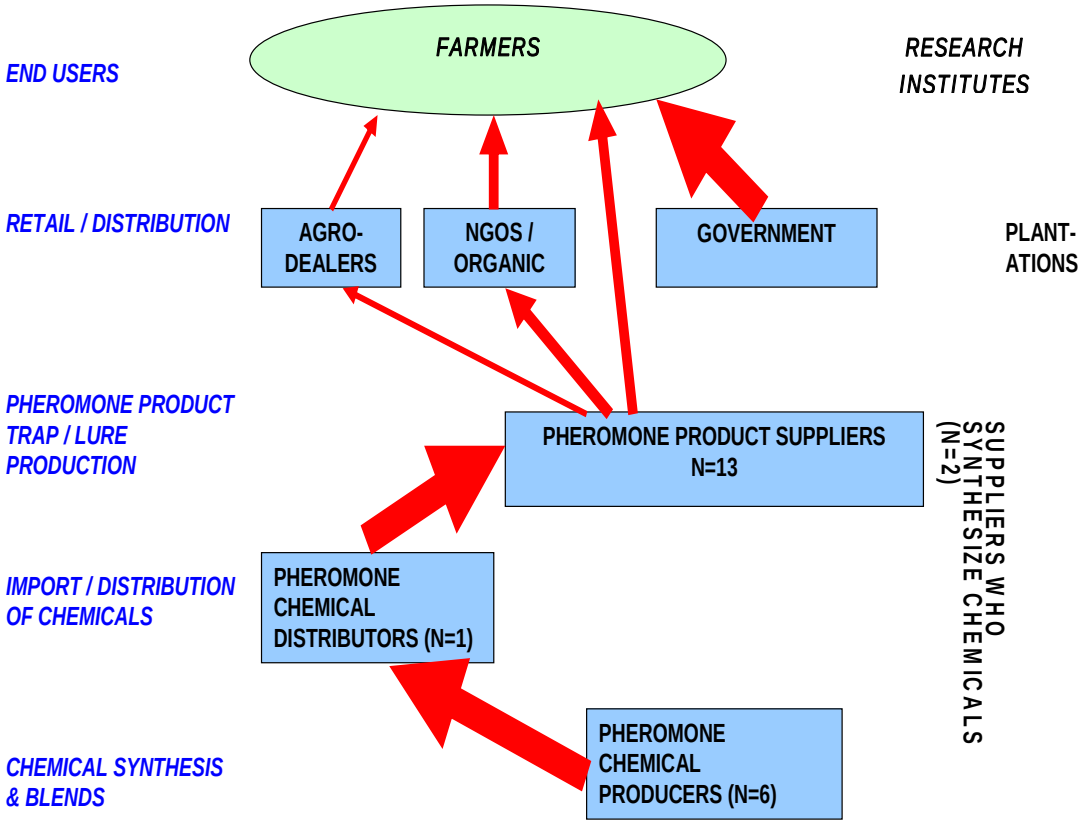


Figure 1 Market structure: Vertical Linkage

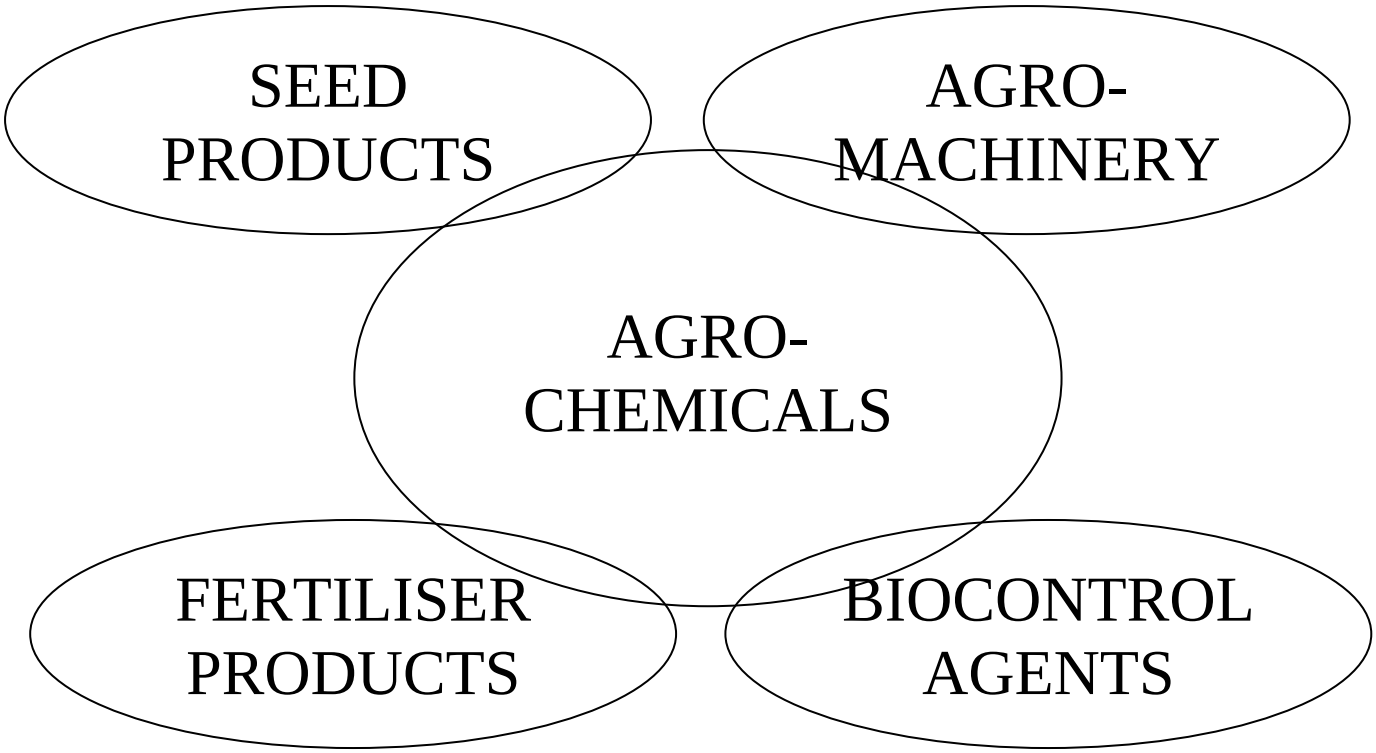


Figure 2Horizontal Linkage

The majority of the companies surveyed were privately owned by people with a science background, environmental focus and IPM approach to farming. Most of the SMEs interviewed produced and distributed a range of products; very few relied on pheromone products as their sole business interest. Some SMEs produced and marketed agrochemicals although they were more likely to be solely involved with bio-control products such as the production of natural enemies, NPV for control of *Helicoverpa armigera* and *Spodoptera litura* and *Trichoderma viride* for control of soil pathogens. Other products included seed distribution and organic fertiliser, the latter derived from seaweed. A number of companies reported considering options for providing co-operative farmers with crop management packages, seed-to-seed technology assistance

Pheromone product range

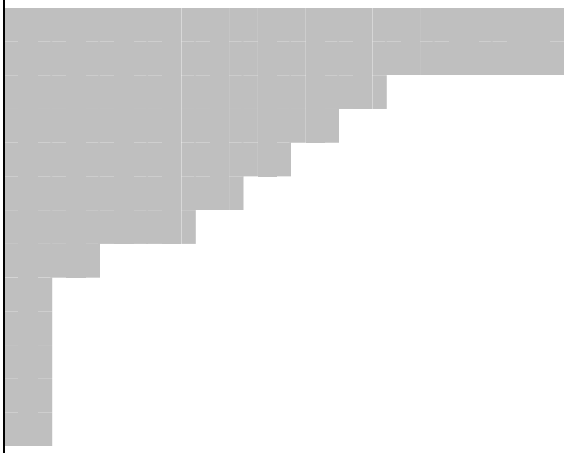
The range of species for which pheromone-based products are marketed in significant numbers by the SMEs interviewed is listed in Table 1. Pheromone trap systems for *H. armigera* and *S. litura* dominatd the market. These products were primarily produced for Government tenders and used by cotton farmers. Indeed, of the pheromones sold the top four products are almost exclusively used in cotton although *H. armigera* and *S. litura* are economically important pests in a wide range of crops. All these products used in cotton are in principle for insect monitoring and not control. Because they are produced in response to State Government tenders they reflect Government priorities rather than market opportunities identified by the SMEs.

Nevertheless, five of the remaining pheromone products are used for control, *S. incertulas, R. ferrugineus, B. cucurbitae, B. dorsalis* and *H. coffearia*. Significantly the pheromone of brinjal fruit and shoot borer, *L. orbonalis*, is a recent product in the market-place. It is now sold by six companies as a result of the successful development of mass trapping for control

of this pest through a DFID-funded collaboration between NRI, AVRDC and a number of Government research organisations in the region.

Table 1 Pheromone products produced and marketed by SMEs in South Asia

Product target species	No. of SMEs producing the pheromone product
	1 2 3 4 5 6 7 8 9 10 11 12
Helicoverpa armigera	
Spodoptera litura	
Earias vittella	
Pectinophora gossypiella	
Leucinodes orbonalis	
Scirpophaga incertulas	
Plutella xylostella	
Rhynchophorus ferrugineus	
Bactorcera cucurbitae	
Bactercera dorsalis	
Odoiporus longicollis	
Homona coffearia	
Spodoptera exigua	



The quantity of pheromone lures sold by SMEs per year is given in Table 2. The table clearly shows the importance of the market for *H. armigera* and *S. litura* and other cotton pest pheromones to the market, accounting for at least 95 % of the production. The figure for *L. orbonalis* is probably an underestimate because NRI alone produces 20,000 lures per year for this pest species and this production is matched by that of the commercial companies.

Table 2 Quantity of pheromone products sold per year by SMEs.

Insect species	Quantity of lures (x1000)
Helicoverpa armigera	830
Spodoptera litura	480
Earias vittella	280
Pectinophora gossypiella	130
Leucinodes orbonalis	10
Scirpophaga incertulas	20
Plutella xylostella	<10
Rhynchophorus ferrugineus	<10
Bactorcera cucurbitae	<10
Bactercera dorsalis	<10
Odoiporus longicollis	<10
Homona coffearia	<10
Spodoptera exigua	<10

Customers

The SMEs were questioned about the relative importance of different customers to their companies, the results are shown in Table 3. Interestingly, 54% of the 13 companies that responded felt that Government tenders provided an important market, only 40% of those that supplied the State Governments felt they were a very important customer. However, this probably reflected the relative ease of winning contracts with State Government agencies. Some SMEs appeared to specialise in this business while others avoided it. A poor financial return was an important factor in SMEs deciding whether to participate in the tendering process or not, but it was also seen as an inequable process and open to abuse.

Table 3. Type of customer and relative importance to SMEs

Customer	Customer type		
	Not important (%)	Important (%)	Very Important (%)
Government	46	32	22
Organic	70	16	14
Dealers	68	16	16
Farmers	66	8	24
Plantations	76	16	8
NGOs	84	7	9
Seed suppliers	100	0	0

Profitability and finance

The relative profitability of different pheromone products was examined by ranking products as profitable, small profit margin and breakeven or loss. Most producers responded in a similar manner, the sex pheromones of *H. armigera*, *S. litura* and *P. gossypiella*, and aggregation pheromone of *R. ferrugineus* were considered to be profitable, *E. vittella* was breakeven and other products were considered to result in a loss. The reasons for the poor return on the *E. vittella* pheromone compared to products for other species probably reflected the high cost of the major component of the pheromone and relatively small market size. Apart from cost, chemical instability of the pheromone was probably an important factor limiting farmer acceptance of the attractant, although in follow-up questioning it was apparent that producers were unaware of the problem and sold the product in the same way that they promoted other pheromones.

The supply of pheromone concentrate was seen by many SMEs as a major constraint to profitability. As mentioned earlier most of the pheromone is blended and imported from Europe for use with specific pest species. This has the effect of raising the cost of the active compounds but does have the advantage of enabling smaller producers to enter the market with products that are efficacious.

The market price for pheromone lures is broadly dictated by the cost of the pheromone concentrate rather than other market forces. Depending on structure and function pheromones of different species are released at different rates and, depending on the synthetic routes available, vary in price. Thus, for example, Lepidopterous pheromones with trans or *E*-isomers are usually more expensive to produce than cis or *Z*-isomers and for many Lepidopterous pheromones loadings of 1mg are used. However, for *L. orbonalis* 3mg is used in the lure and the pheromone is composed of two monounsaturated compounds with an *E* configuration so that it is inevitable that pheromone lures will be more expensive than that of *H. armigera* which is composed to two compounds each with the Z configuration.

Nevertheless, some SMEs were either unaware of this situation or do not want to accept this argument and instead accuse the importing companies of 'hiking' their prices.

Constraints identified

Constraints identified are listed in Table 4 in order of relative importance. A lack of knowledge on pheromones was cited as the largest constraint with a lack of support from extension services a close second, although the latter was given a higher rating in the 'very important' category. The lack of new chemicals, poor availability of pheromone compounds and quality of those available were perceived to be major constraints by the SMEs questioned. The lack of demand was attributed to a lack of awareness amongst farmers and reflected their collective weakness in marketing. The companies preferred instead to rely on extension and other Government agencies to promote the technology. Given their lack of confidence in the extension agencies this is a surprising result. Ineffectiveness of products and storage were not considered to be major problems although for some companies storage was an issue, particularly for highly volatile compounds such as fruitfly attractants.

Table 4. Type of constraint and relative importance to SMEs

Constraint	Relative importance to SME		
	Not important (%)	Important (%)	Very Important (%)
No knowledge	22	56	22
No extension	34	22	44
New chemicals	34	22	44
No availability	34	6	60
Quality	36	30	32
Old chemicals	28	30	32
No dealers	44	22	34
Registration	44	30	26
No demand	56	6	38
Cost	55	15	30
Ineffective	70	8	22
Storage	78	16	6

View of the Future

Most SMEs were optimistic about the future with 57% expecting sales will increase and 36% believing that sales will stay at similar levels in the near future. This is broadly in line with the rest of the world where the market for pheromones is growing at about 10% per year. All the companies surveyed were thinking about new products and recommended awareness-raising, Government-supported promotion and subsidies on costs as mechanisms for assisting growth.

Few of the SMEs actively undertook research to improve production, cost-effectiveness and develop new products. Most relied on researchers to identify and optimise products and only when the chemical blends became available from distributors did the SMEs actively manufacture trapping systems.

Currently no pheromone products are commercially employed for control of insect pests apart from red palm weeil, *R. ferrugineus*, the recently introduced use of mass trapping for control brinjal fruit and shoot borer, *Leucinodes orbonalis* and fruitflies. Pheromone trap systems for *L. orbonalis* have become commercially available from six companies in the past two years following a large DFID-funded promotion project.

Key Issues

The key issues identified by SMEs were:

- Range of products produced
- Differences between pheromone products and their uses
- Market focus
- Promotion strategies
- Meeting farmers' needs

Range of Products

Many of the companies produce and sell a wide range of biocontrol products that require considerable technical skill and equipment to produce. In order to improve their profitability it is recommended that they should focus on producing fewer products and specialising in those where they have particular competence compared to their competitors.

There is considerable debate within the companies about the desirability of buying in or producing pheromone components. In order to produce pheromones they would need to invest heavily in equipment and also technical knowledge. However, most of the companies are poorly equipped to undertake such a venture given their technical backgrounds and have not been able to link up with suitable custom synthesis companies who could undertake the work for them. This is in part because the amount of pheromone required for lures is small (10 – 500 g per yr) whereas synthesis companies are geared up for production runs of several kg.

Differences between commercial products

Considerable differences in the composition and efficacy of pheromone products was reported as indicated by the *H. armigera* pheromone (Table 5). However, some of the data is probably erroneous because it would be totally impractical to use 2,000 to 4,000 mg of pheromone in a product for monitoring a pest species. Technically, control of *H. armigera* with pheromones has never been demonstrated although attempts have been made using mating disruption. The use of up to 12 traps per ha is inappropriate for monitoring and broadly reflects the current misunderstanding amongst the companies on what constitutes monitoring. The situation is complicated by the insistence of some NGOs and Government agencies that pheromone traps for *H. armigera* should play a part in IPM, even though there is no scientific evidence to support their application in this manner.

Table 5. Range of *H. armigera* products produced by different SMEs and their uses

Dose (mg)	Monitor or Control	Traps/ha	Field life (days)
2	M	10	14 - 21
5	M	5	20
75	M & C	12	21
120	M & C	12	45
2,000 – 4,000	M & C	6	21

Market Focus

The market focus for pheromone products in South Asia is closely allied to the IPM approach to crop pest management with private and public customers, although the role of Government in this process is in many ways counterproductive, as indicated earlier. Niche markets, such as control of pests of gherkins for the export market are beginning to be exploited although a lack of clarity in the registration process continues to frustrate the efforts of the industry.

Promotion Strategies

Most of the SMEs have limited distribution and dissemination pathways from which to achieve significant impact with their products. Sixty nine percent of the companies spent less than 20% of their costs on marketing and distribution and provided no information on product effectiveness and quality. Many of the SMEs felt it was the role of other agencies to promote the technology and were not proactive in developing their own markets.

Meeting farmers' needs

In order to encourage farmers to use their products and meet their needs the SMES need to provide clear messages on the use of their products, farmers' need to know how the products will benefit them, whether they are cost-effective and whether they are reliable in terms of quality and efficacy. These were areas where most of the SMEs were least effective.

Looking to the Future

The SMEs need to work towards developing a sustainable industry. They are currently relying too heavily on the sale of other products to maintain a viable company. In order to achieve this they need to focus on the 'winners' first rather than diversifying into other areas of activity. They need to develop new markets in crops where they do not face so much competition from pesticide companies as they do in cotton for example, and look beyond IPM. There is a strong case for encouraging direct dialogue with farmers and putting as much effort into developing markets as on technical development. Nevertheless, their poor knowledge of both the physicochemical properties of pheromone formulations and the biology that under-pins their application are major impediments to the ability of SMEs to provide farmers with credible products.

Output 2 – Knowledge and advice to solve technical constraints impeding commercialisation of pheromones disseminated.

Three activities were envisaged under this output:

2.1 Knowledge for SMEs to relieve technical constraints disseminated, January 2004.

2.2 Monograph on pheromone technology compiled, April 2004.

2.3 Regional stakeholders' workshop held, April 2004.

Because only one of the SMEs had any capacity in the synthesis of pheromone components and they funded a visit by their senior synthesis chemist to NRI for training the need to provide assistance on pheromone synthesis was not considered a priority. The survey suggested that production and function of formulations of pheromones, their chemical stability, storage, trap design and function and application of pheromones were important issues for SMEs in South Asia. These issues were addressed in part during discussions held with interviewees during the survey process but in order to provide in-depth knowledge on the subjects a pheromone manual was prepared to cover the issues and (Annex 2) lectures presented on some of them at the project workshop (Annex 3)

Pheromone manual

The pheromone manual was designed to address the main technical constraints identified during the survey of SMEs. To ensure that the manual met with the needs of the SMEs an overview of the manual was presented at the pheromone workshop (Annex 2) and was well received by participants. The manual was designed to provide in-depth knowledge on a range of subjects allied to the application of pheromones for pest control. Care was taken to ensure that the examples taken reflected the interests of SMEs in South Asia but also where appropriate examples from outside the region were used both to increase the horizon of SMEs in South Asia but also to make the manual more valuable for producers in other regions of the world. The manual was not meant to be comprehensive in its coverage of the subject and so numerous references to other work and in particular books and web-sites were provided to enable readers to expand their knowledge on the subject. A general outline and structure of the manual is given in Table 6.

Table 6. Structure of the Pheromone Manual

Chapter 1	Introduction
Chapter 2	Semiochemicals
Chapter 3	Pheromone Chemistry
Chapter 4	Stability of pheromones
Chapter 5	Controlled release
Chapter 6	Trap design
Chapter 7	Monitoring
Chapter 8	Attract and Kill
Chapter 9	Mating disruption
Chapter 10	Further Reading
Chapter 11	Pheromone suppliers
	References

It was originally envisaged that the manual would contain chapters provided by SMEs on their experiences of commercialising pheromones. However, in the event the companies concerned presented lectures on this topic at the stakeholders workshop instead (Annex 2).

Regional Stakeholders' Workshop

The objective of the workshop was to promote an awareness of pheromone technologies in South Asia. Sessions were designed to identify opportunities and address constraints to commercialisation of pheromones as perceived by the industry.

The workshop involved 50 invited participants from four countries. Policy makers from India actively participated in the workshop, notably the Chief Guest, Dr C. D. Mayee, Agriculture Commissioner to the Government of India, Dr P. S. Chandurkar, Plant Protection Adviser to the Government of India and Dr Seema Wahab, Adviser, Department of Biotechnology, Ministry of Science & Technology. Other stakeholders such as SMEs and Government researchers were well represented. The intention was that invited NGOs would represent farmer interests however of those invited only representatives from two NGOs were able to participate.

Participants discussed a wide range of issues during the course of the two-day workshop. Every effort was made to capture these issues by recording discussions, 'suggestion box' scheme and a Group exercise to encourage interaction between stakeholders. Much of the discussion centred on the presentations with requests for clarification or additional information. However, while not necessarily holding a common view on solutions to issues raised, the SMEs nevertheless had a number of clearly defined themes that they considered to be of major concern in their endeavours to develop the market for pheromones and related biopesticides. These themes can be listed under the headings, pheromone, quality assurance, registration and markets. Some of the issues associated with these themes, and there was considerable overlap between themes, are listed below.

Pheromones - source and cost

- Perceived as expensive by SMEs and end-users
- Limited number of reputable local suppliers
- Import tax is considered to be too high by SMEs
- Conflict between SMEs dependent on indigenous vs imported products
- Competition required to reduce price but need to maintain quality

Quality Assurance

- Major problem for State Government procurement
  - price sensitive but not quality driven
- Problem for end-users, farmers
- Government could provide guidelines for products
  - (1) Pheromone blend
  - (2) Field longevity, release rate (max and min limits)
  - (3) Impurities, specify compounds and limits
  - (4) Trap types
- Analyse samples at point of sale based on label instead of need for registration
- Field efficacy of products
  - (1) Need agreed test protocols
  - (2) Are you testing lures or trap systems?
  - (3) Are low catches compared to 'standard' bad - depends on use
  - (4) Trials need to be adequately replicated at each location

Registration

- Should adopt OECD guidelines
- Not required for monitoring and mass trapping
- Accept case for registration for mating disruption
- Government tool to maintain quality - blunt tool - ineffective
    - Pesticides are registered but QA problems remain
- Questionable ability of laboratories to analyse products effectively
- Can registration assure health and safety concerns of end-users and consumers
- Small market, not worth cost of registration
- Government should undertake toxicology testing of public goods such as pheromones
- Exempt bio-efficacy testing or clearly define a protocol that should be adopted.
    - EAG and wind-tunnel - difficult to quantify and reproduce data.

Market

- Main market, State Government tenders
    - Price and not quality sensitive
    - Creates poor image for products
        - Poor quality of information for end-user
        - Poor quality of support for end-user
        - Low prices undermine local producers
- Pesticide dealers have few incentives to promote biopesticides
    - Licence could be made dependent on promoting biopesticides
    - Alternative outlets needed
    - Market biopesticides/pheromones in separate 'organic' shops
- SMEs weak on marketing/promotion
    - Expensive to invest in product promotion
- Pheromones should be provided as part of IPM package and not instead of one

Solutions to the issues raised by the SMEs are in part the responsibility of Government but Government needs assistance to ensure that the decisions it makes are in the best interests of consumers and the industry itself. The Chief Guest, Dr C. D. Mayee, Agriculture Commissioner to the Government of India, was very supportive of the technology and encouraged SMEs to join together to seek constructive solutions to their problems. By presenting a common face to Government the chances of achieving a consensus to drive the agenda forward would be greatly enhanced. Areas where Government and SMEs could play a role are identified below and broadly reflect the recommendations presented by Dr P. S. Chandurkar, Plant Protection Adviser to the Government. of India in his lecture.

Government

- Higher or lower import tariffs (excise duty)
    - Harmonise taxes with biopesticides, currently 5% tax
- Sales tax, variable, should be exempt
- Work more closely with SMEs
    - Encourage open dialogue with industry leaders
    - Encourage formation of society for industry
- Government R&D funding agencies
    - Projects should not only be driven by researchers agenda but be more responsive to Private Sector and farmer needs
    - Encourage Public Private Partnerships, Joint partnership research R&D
- Pheromones reclassified as biotech products rather than treated as pesticides
- Proactive in developing and testing products
    - Government researchers already undertake field trials
    - could link more closely with industry to save duplication of effort
    - Fund toxicology tests where registration is required
- Include pheromones under IPM programmes e.g. rice stem borers
- Encourage State Agricultural Universities to promote IPM packages

as valid alternatives to pesticides
Relax pollution control on manufacturing, but may be counterproductive for image of industry
Orderly phasing out of pesticides so IPM can be gradually phased in.
Soft loans for manufacturers
Promote biopesticides and pheromones in FFS IPM programmes
Advocate use of pheromones for monitoring and farmer decision making
Promote mass trapping or mating disruption where appropriate

Industry

Need Pheromone Producers Society (National or South Asia?)
Should not compete directly with insecticide companies
Too much focus on cotton pests, very little on other crops
Scope for fruit, vegetable, sugarcane and rice pest control
Major role to play in promotion and adoption
Farmers need good quality information
Society to collaborate with DBT programme for farmers
Need to understand products better, its uses and limitations
Improve understanding of role of products for monitoring
Farmers need clearly defined Action Thresholds
Develop separate trap systems for monitoring and control
Promote use for control
Improve quality of formulation, packaging, transport, product storage
Product labelling and application notes should be mandatory
Society to develop system and put to Government
Review Government standards for lures and traps
If necessary Society revise standards and put to Government for adoption
Develop industry criteria for QA testing lures/traps
Society put to Government for adoption
Caution - Do not involve EAG or wind tunnels

Recommendations & Next Steps

From the nature of some of the questions raised in the discussion sessions it was apparent that there was considerable uncertainty among SMEs and indeed some scientists about the scope and limitations of the technology. Hopefully the workshop and the Pheromone Manual will help to improve that situation. Nevertheless, the role of major pheromone products for monitoring pests in India is still poorly defined and unless and until SMEs and extension agencies provide farmers with well-defined protocols for using the products they will not be widely adopted. Government can play a part in education, but SMEs should not necessarily look to others to solve their problems. They need to work together to move their industry forward.

1) Form Society to represent the industry
Develop constitution, elect committee, chairperson
Define areas of common interest
Engage with Government on issues of common interest
Taxes
Registration
Product quality
Develop links with Researchers
- co-sponsored R&D to fast-track product development
Promotion/marketing
- develop information packs for Government, Extension, End-users
Review status of IPR to identify potential for encouraging industry to invest in R&D

Hold workshop biannually

2) Training package for SME's on 'product' evaluation
- Pheromone blends
  - Blend ratios
  - Importance of impurities
  - Role of antioxidants
- Quantitative Analysis
  - Gas chromatography
  - Mass Spectrometry
- Estimation of field longevity
  - Field vs. simulated field exposure
  - Extraction and residue analysis
- Product testing
  - Field trial designs
  - Replication, position effects, data analysis

3) Identify and promote new market opportunities
- IPM packages for control of 'critical pests' in high value crops e.g.
  - Brinjal
  - Sugarcane
  - Palms
  - Soft fruit and cucurbits (fruitfly)
- Seed to seed - ICM packages
- Pheromones for monitoring
  - Characteristics - low trap catches, few traps
    - Action thresholds
    - Recommendations for control
    - Need high quality pheromone blends
- Pheromones for control - mass trapping
  - Characteristics - low dose, high catches, many traps
    - Need high quality pheromone blend
- Pheromones for control - mating disruption
  - Characteristics - high dose, no catches, no traps
    - technical grade pheromone
    - good for species complex, sugarcane, rice?

4) Review company capacity and direction (SWOT analysis)
- Pheromone synthesis or buy in expertise
- Produce traps or buy in (quality vs price)
- Produce lures or buy in (quality vs price)
- Other products to compliment pheromones
  - Biopesticides
  - Insecticides
  - Seeds
  - Biofertilisers
  - Soil treatments
- Who are your customers?
  - Field crop, forestry and livestock producers
  - Domestic pest control
  - Industrial production units
  - Tourist and leisure industry

What more is needed? Group Exercise

In order to develop an understanding of what further assistance was needed to improve the impact of pheromone technology in South Asia a group exercise was undertaken at the Bangalore workshop in which participants were divided into one of four groups, farmers, government, SME and SME marketing manager. The groups were provided with guidance notes (Annex 2, Session 6) that asked them to put themselves in the role of the stakeholder Group they were assigned to and to identify and prioritise the 10 most important issues that affected their ability to adopt pheromone related technologies. These were posed as specific questions (Table 7).

Table 7. Workshop group exercise.

Group	Question
Farmers	Identify up to ten issues that would affect your decision to adopt these new methods [pheromones for monitoring and control].
Government	encourage adoption of pheromones for fruit and vegetable production while ensuring that the food produced is safe for consumers and yields achieve a good return for farmers
SME	Identify ten steps that you could take to achieve this expansion of your business.
Marketing Manager	What do you need from your technical colleagues and what can you do to increase promotion and uptake of pheromone products.

The process was monitored by two observers (Ms Warburton and Dr Cork) and while overall the participants accepted the terms of the exercise, participation in the Groups was patchy and to some extent dominated by more senior members of the SMEs. Indeed some Managers did not accept the terms of the exercise and blatantly used the opportunity to advance their points of view even when they were not relevant to the stakeholder group they were meant to represent. The issues raised by the Groups are presented in Tables 8 to 11, however, some were not prioritised due to time constraints and this is reflected by the fact that the issues are presented as a numbered list rather than as a prioritised list.

Many of the issues raised supported and extended the views and assumptions made in both the design and approach of the project such as the farmer group suggesting that cost of the new products, ease of application, effectiveness, persistence and availability of products and interaction with extension workers, scientists and marketing executives would be important factors for farmers. Because the Group exercise was intended to identify 'what more is needed' some of the issues raised by the participants such as, 'farmer to farmer communication is the most reliable method of dissemination', while true, were not germane to the exercise. Many of the issues raised by the groups are issues that can be solved with existing knowledge, both held by the SMEs and provided through project activities.

The Farmer Group (Group 1, Table 8) identified issues that were thought to be relevant to farmers but in the absence of farmers in the Groups it is uncertain whether these issues would actually be endorsed by them or whether other factors were more important. Certainly other studies suggest that farmers are price conscious, but that adoption is more likely to be linked to a perceived need for a 'new' technical solution to a problem, the associated expenditure incurred by the farmer on control (money and resources) and the value of the marketable crop. The intrinsic value of a crop is dependent on the timing of production and access to markets. Vegetables produced during the peak season are sometimes not worth picking if prices fall too low and transport costs to markets excessive.

The Government Group (Group 2, Table 9) in particular identified issues beyond the scope of the project but which can have a profound influence on both future scope, direction and hence impact on the livelihoods of farmers supplied by the industry. The issue of importation tax was particularly vexed; even among the SMEs opinions differed depending on whether they were intending to develop a capacity for synthesis or not. Government needs to be pro-active on this issue and developing and supporting inefficient small-scale production facilities is counterproductive to the needs of the industry, especially as they will have to compete in a world market in the near future. More importantly, it would only serve the best interests of those companies with sufficient resources to invest in this area of activity, which will weaken indigenous competition and ultimately provide farmers with less choice and potentially result in higher prices for products.

The SME Group (Group 3, Table 10) identified issues that would most assist promotion of the technology and while not focused on resource-poor farmers would, in the short term, influence crop production practices, accelerating the adoption of IPM and reducing the need for and dependence on synthetic pesticides. In particular, the Group identified the dependence of State Agricultural University crop protection recommendations on pesticides rather than Government recommended IPM as an issue. While the influence of Universities in a farmer context may not be significant they do have a profound effect on the perceptions and thinking of the younger generation of agricultural engineers, educated farmers and scientists associated with crop production. The reasons why Agricultural Universities have not adopted newer technologies in their recommendations to farmers is unclear but probably reflects concerns over availability and efficacy of alternatives to pesticides. NGOs on the other hand have no such constraints and while freely accepting 'newer' technologies often do so in the complete absence of efficacy data but in common with Universities are mindful of the need to promote technologies that are or can be made readily available to farmers.

Interestingly, Group 3 highlighted a number of marketing ploys such as package of practices, demonstration plots, involvement of media to promote products, and were well aware of the importance of making the technology available to farmers promptly and at affordable prices. While dealer acceptance and credit issues are beyond the scope of the project they are nevertheless issues that will influence uptake in the longer term and need to be carefully thought through by the industry. The Chief Guest, Dr C. D. Mayee, suggested that IPM related technologies such as pheromones would be better promoted through shops selling organic products, Ayurvedic and homeopathic medicines. In many ways this untried route might prove more effective than competing directly with pesticides.

The SME marketing Group (Group 4, Table 11) echoed a number of promotion issues raised by Group 3, field days, training and literature but also raised storage, packaging, transport, and QA certification as important issues. The latter group of issues, apart from transport are technical issues that can be resolved with appropriate knowledge, training and equipment. The basis of solutions to these issues will be provided in the manual and workshop proceedings and training is envisaged as part of a follow-on project.

Table 8. Summary of prioritised issues raised by Group 1, Farmers

Number	Issue
1	Farmer to farmer communication is the most reliable method of dissemination (lateral spread).
2	Successful demonstration of the product in a neighbourhood - seeing is believing.
3	Confirmation from the extension worker or call centres/opinion maker
4	Ready availability of new product.
5	Interest of input supply agency/dealer and availability of selected information.
6	Cost of the new product.
7	Possibility of getting the product on credit or availability of credit for buying the product.
8	Ease of application.
9	Effectiveness and persistence.
10	Availability of and interaction with extension workers, scientists and marketing executive.
11	Awareness of the new technology through mass media.
12	Reduction in pesticide use and in harmful effects.

Table 9. Summary of prioritised issues raised by Group 2, Government

Number	Issue
1	Registration - as per OECD guidelines. Monitoring and mass trapping - not required, maintain exemption Mating disruption - registration required.
2	Pheromone technology should be intensively encouraged in all IPM programmes, provide subsides and strengthen extension.
3	Regional centres for quality testing of pheromones.
4	Mating disruption Approved Government laboratories should conduct toxicology studies and the data provided to pheromone producers. The SME's can not afford to undertake the work themselves.
5	There should be a phased withdrawal of unacceptable pesticides to encourage SME's to invest in IPM technology, including pheromones.
6	Registration should be restricted to the chemical composition of formulations and bio-efficacy relaxed for indigenously produced pheromones.
7	Soft loans/grants may be provided to pheromone production units.
8	Exempt pheromones from Central Excise as well as Customs Import tax to encourage adoption of pheromone technology.
9	Exempt pheromones from Sales Tax across the country to reduce purchase price and encourage farmer adoption of technology.
10	Exempt pheromones from pollution control regulations.
11	IPM 'Package of Practices' circulated widely in regional languages. Advice State Governments to Include in the Departmental Package of Practices.

Table 10. Summary of issues raised by Group 3, SME

Number	Issue
1	Reliable, Quality, Economical inputs
2	Create awareness, a) Farmers, b) Dealers, c) Distributors, d) NGO's.
3	Right 'Package of Practices' for farmers' complimenting bio-products.
4	Seek and act on farmers' feedback.
5	Create own Demo-Plots to promote packages of products.
6	Use of local media.
7	Promote adoption of technologies in contract farming / organic farming / high value export market.
8	Change SAU, University recommendations to endorse IPM approach to pest control and promote use of pheromones for monitoring and control where appropriate.
9	Concentrate on both rain-fed and irrigated crops.
10	Synergy with pesticide companies which produce quality molecules that are more IPM compatible than old conventional pesticides.

Table 11. Summary of issues raised by Group 4, SME Marketing

Number	Issue
1	Packaging important
2	QA certification
3	Literature in English and local language.
4	Promotion - provide in-house training
5	Field days - explain life stages
6	Provide free samples
7	Transportation
8	Storage

9 – CONTRIBUTION TO DEVELOPMENTAL IMPACT

The purpose of this project is to promote pro-poor strategies to reduce the impact of key pests and diseases, improve yield and reduce pesticide hazards in production systems. The purpose was to be achieved by undertaking activities that would better enable the private sector to contribute more effectively to the development process by marketing cost-effective and environmentally acceptable alternatives to insecticide-based crop pest control technologies.

Pheromone-related pest control technologies are exclusively manufactured and marketed by SMEs in South Asia. Despite a natural reticence on behalf of the SMEs to collaborate in market oriented endeavours the SMEs producing pheromone products were supportive of project objectives and fully cooperated with planned activities. This reflects their desire to acquire new knowledge and work more effectively to promote the technology.

The project identified the key constraints for SMEs to manufacture and market their products through a survey of SMEs and international stakeholders' workshop involving 50 participants from four countries. The international workshop provided a venue for the dissemination of information by invited experts, both national and international, and feed-back from participants on project activities. These activities provided background information for the development of a pheromone manual that has been developed to provide answers to the technical questions raised by the SMEs.

However, as with any knowledge it remains to be seen have effective the SMEs are at interpreting and utilising the information provided by the project to deliver better products for the key stakeholders, resource-poor farmers.

10 – PROMOTION PATHWAYS

The promotion pathway for project outputs is well defined with the immediate beneficiaries, SMEs being activity involved in the project at all levels. Government and NGO researchers will also benefit from participation in the project through contacts made and information acquired.

Policy makers from India actively participated in the workshop, notably the Chief Guest, Dr C. D. Mayee, Agriculture Commissioner to the Government of India, Dr P. S. Chandurkar, Plant Protection Adviser to Government of India and Dr Seema Wahab, Adviser, Department of Biotechnology, Ministry of Science & Technology. Government policy can have a profound effect on technology development and commercialisation. While the policy makers who attended the workshop expressed their commitment to promoting polices that will enable the technology to compete more effectively with existing insecticide-based crop management tools they are faced with a range of options and pressures that do not necessarily mean they will act in a way that benefits resource-poor farmers. An example of positive action that has had negative consequences is the state Government procurement of pheromone traps for cotton pests. Conceived as a means of promoting the technology in an IPM context and thereby helping hard-pressed farmers the result has been the purchase of poor quality products with little or no information on use, and the result that farmers have been discouraged from adopting the technology because they derive little apparent benefit from it.

The survey of SMEs identified marketing as a major constraint to promoting pheromone technology. The SMEs feel this activity should be undertaken by Government Extension agencies and NGOs. No doubt such bodies have a role to play in disseminating new crop protection technologies but each has their own agenda and the SMEs can not rely on others to promote their products. Not all SMEs are complacent some are actively promoting their products and achieving significant market penetration and importantly developing new products to market. Project outputs will underpin these endeavours and assist the process.

11 – FOLLOW-UP INDICATED/PLANNED

The level of impact that project outputs can deliver will depend crucially on the ability of the SMEs to understand and act on the information provided. The project confirmed that many of the SMEs had a very weak understanding of the function and utility of the products they produced. This was particularly true of companies that were privately owned by entrepreneurs who were attracted by the 'green' credentials of pheromones but had no technical background either in chemistry or biology.

In order to further assist SMEs it is proposed that a second phase of the project is considered by the CPP. This phase of the project will be devoted to building capacity. The mechanisms for achieving this will be the provision of hands-on training for appropriate company personnel in the analysis of pheromones and formulated materials. It is proposed that basic training in gas chromatography will be sub-contracted to a local company in India and that this will be followed up by specific training on pheromones delivered by NRI personnel.

In addition, field work to determine the optimal lure for *H. armigera* will be undertaken as a co-ordinated activity involving at least five of the major SMEs involved in pheromone production. The research is needed because of suggested pheromone polymorphism in the sub-continent. The exercise will build linkages between companies and because the research will be undertaken by a number of companies it is more likely that the final results will be better accepted by the industry and researchers alike.

The project will also help to facilitate the development of an industry society to provide a common platform for dialogue with other stakeholders and policymakers in particular. It is anticipated that this process will involve policy makers and enable further contact in order to lever a pro-poor agenda with Government agencies.

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13 – FINAL LOG FRAME

Abbreviated project title: Enabling SME's promote pheromones

Date of preparation of this logframe: 16 April 2003

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions
Goal			
Productivity and productive potential in production systems increased through removal or amelioration of constraints by crop pre-harvest pest.	To be completed by CPP Programme Manager	To be completed by CPP Programme Manager	To be completed by CPP Programme Manager
Purpose			
Promotion of pro-poor strategies to reduce the impact of key pests and diseases, improve yield and reduce pesticide hazards in production systems	To be completed by CPP Programme Manager	To be completed by CPP Programme Manager	To be completed by CPP Programme Manager
Outputs			
1. Scope for application of current pheromone technology to crop protection by farmers in South Asia and constraints to commercial development understood and documented.	1.1 Knowledge on potential for application of pheromone technology in crop protection in S. Asia compiled. January 2004 1.2 Constraints to commercial development of pheromone technology identified. January 2004	Survey report available to stakeholders.	
2. Knowledge and advice to solve technical constraints impeding commercialisation of pheromones disseminated.	2.1 Knowledge for SMEs to relieve technical constraints disseminated. January 2004. 2.2 Monograph on pheromone technology compiled. April 2004. 2.3 Regional stakeholders' workshop held. April 2004.	Monograph available to stakeholders.	
Activities	**Inputs**	**Means of Verification**	**Important Assumptions**
1.1 Develop questionnaire to assess (a) scope for use of pheromones (target pests, crops, method of use) and (b) constraints to development (sources of material, technical problems, etc.) developed.		Activities 1-2: - Project reports - Quarterly, annual and final technical reports	
1.2 Conduct survey of SME's involved in commercialisation of pheromone in South Asia.			Data collection not adversely affected by reticence of SMEs to provide information.
2.1 Develop solutions to specific technical problems raised by SME's.			

2.2 Write monograph providing technical data on synthesis, formulation, analysis, storage, field application and registration of pheromones.			
2.3 Organise regional workshop on constraints and opportunities for commercialisation of pheromones.			

Note: Outputs should be numbered 1, 2, 3, *etc*. Activities should relate to these outputs and be numbered 1.1, 1.2, ...2.1, 2.2, ...*etc.*

It is expected that most projects will achieve only one or two outputs and a small number of activities.

ANNEX 1 QUESTIONNAIRE

SURVEY OF SUPPLY, PRODUCTION AND DISTRIBUTION OF PHEROMONE PRODUCTS & BIOPESTICIDES

Section A Organisation Type

A1. Organisation Name _____

A2. Contact Name in Organisation _____

Address _____

_____

_____

Tel/Fax _____

Email _____

A3. Type of organisation *[please check]*

☐ Private commercial company

☐ Government Agency or Research ……Institute

☐ Subsidiary or joint venture of ……Multinational company

☐ Non-Governmental Organisation

☐ Other *[please specify]* _____

A4. What is the main business of your organisation?

_____

A5. What is the size of your organisation? Number of staff / employees *[Please check]*

☐ 1 - 10 ☐ 11 – 20 ☐ 21 - 50 ☐ 51 – 100

☐ 101 - 200 ☐ 201 – 300 ☐ 301 - 500 ☐ More than 500

A6. What was the annual turnover in 2002/03 for your organisation? _____ *[specify currency]*

A7. What are the main products sold or produced by the organisation? *Please circle a score for each type of product between 1 (most important / valuable) to 5 (not sold or produced).*

Level of importance (turnover)	*Most important*	*Very important*	*Important*	*Less important*	*Not sold*
Agrochemicals	1	2	3	4	5
Seeds and planting material	1	2	3	4	5
Biopesticides *(Pesticides based on viruses, fungi, bacteria, nematodes and protozoa)*	1	2	3	4	5
Botanical products *(eg. Neem products)*	1	2	3	4	5
Parasites and predators	1	2	3	4	5
Pheromone products	1	2	3	4	5
Organic fertilisers & soil conditioners	1	2	3	4	5
Other products *[please specify]*	1	2	3	4	5

_____

Section B: General Information on Pheromone & Biopesticide Production and Sales

B1. What types of biopesticides does the organisation produce? *[please tick]*

☐ Pheromone products
☐ Bacterial pesticides
☐ Viral pesticides
☐ Fungal pesticides
☐ Nematode entomopathogens
☐ Fungal or bacterial Antagonists
☐ Botanical products
☐ Do not produce biopesticides

B2. What types of biopesticides does the organisation sell or distribute (but ***not*** produce itself)?

☐ Pheromone products
☐ Bacterial pesticides
☐ Viral pesticides
☐ Fungal pesticides
☐ Nematode entomopathogens
☐ Fungal or bacterial Antagonists

☐ Botanical products ☐ Other [please specify] _____

B3. For biopesticides which are sold or distributed, but not produced by the organisation, please list the names of the biopesticides and their source

Biopesticide	Source

B4. In which year did your organisation start producing or selling biopesticides? _____

B5. Why did your organisation decide to produce or sell biopesticides?

_____

_____

_____

B6 Please complete the table for each biopesticide product sold

Product name	Active Ingredient	Target pest(s)	Main Customers *Eg. government, NGO, plantations, seed producers, plantations, fruit farmers, rice farmers*	Profitability of product *1=very profitable 2=profitable 3=breakeven 4=small loss 5=large loss*

PHEROMONE PRODUCTS

B7. What are your main sources of information on pheromone production and use?
[please circle a score between 1 (very important) and 5 (not used)]

	Very Important	*Important*	*Sometimes used*	*Rarely used*	*Not used*
Own scientific staff	1	2	3	4	5
University professors	1	2	3	4	5
Department of Agriculture	1	2	3	4	5
Department of Agricultural Extension	1	2	3	4	5
Parent Company (for Multinationals)	1	2	3	4	5
Pheromone producers who supply your organisation	1	2	3	4	5
National and international journals and books	1	2	3	4	5
Conferences and seminars	1	2	3	4	5
Internet	1	2	3	4	5
Other *[please specify]*	1	2	3	4	5

_____

IF THE ORGANISATION <u>PRODUCES PHEROMONE PRODUCTS</u>, PLEASE ANSWER QUESTIONS <u>B8 – B11</u>

IF THE ORGANISATION <u>DOES NOT</u> PRODUCE PHEROMONE PRODUCTS, PLEASE GO TO <u>SECTION C</u> ON PAGE 6

B8. How many scientific graduates are involved in pheromone product production?

Number	Scientific subject

B9. How many other staff are involved in pheromone product production? ____

B10. How many staff have received training in pheromone product production from outside organisations?

Number _____ Name of organisation providing training _____

B11. Where did the funds for the equipment, research and development come from? *[please check]*

- ☐ Government funding, grant or subsidy
- ☐ Parent company
- ☐ Private savings and loans
- ☐ Non-Governmental Organisation
- ☐ Venture capital
- ☐ Other *[please specify]* _____

Section C: Information on each pheromone product

[PLEASE COMPLETE A SEPARATE SECTION C FOR EACH PHEROMONE PRODUCT]

C1. Product Name _____

C2. Chemical ingredients _____

C3. Do you synthesise the chemicals or buy in from another source?

☐ Synthesise chemicals in-house ☐ Buy in individual chemicals

☐ Blend chemicals in-house ☐ Buy in blended chemicals

C4. If you buy in chemicals, please specify source

Chemical	Source

C5. Do you produce the lures or buy from another source?

☐ Produce lures in-house ☐ Buy in lures

C4. If you buy in lures, please specify source

Lure	Source

C5. What is the formulation type of the lure? *[please check]*:

☐ Rubber ☐ Polyethylene ☐ Other [please specify] _____

☐ Closed system (Vial) ☐ Open system (rubber links, septum)

C6. Do you produce the traps or buy from another source?

☐ Produce traps in-house ☐ Buy in traps

C4. If you buy in traps, please specify source

Trap	Source

C5. Please describe the traps

_____

_____

_____

C6. What methods are used to store the pheromones?

☐ Sealed containers Please specify type of seal _____

☐ Temperature-controlled environment Please specify temperature _____

C7. What is the amount of active ingredients in one trap? _____

C8. What is the retail price per trap? _____

C9. What is the wholesale price per trap? _____

C10. What pests is the pheromone product targeted at?

_____

C11. Is the trap used to monitor or control the pests?

☐ Monitor ☐ Control ☐ Both

C12. What crops is the pheromone product targeted at?

_____

C13. How many traps recommended per hectare? _____

C14. What is the recommended field life of the pheromone? _____

C15. Who are the main customers for this pheromone product?

_____

C16. What quantity of the pheromone product did you sell last year (2002/03)?

_____

C17. What was the turnover for this pheromone product last year? _____

C18. Does this product currently make a profit for the company? *[please circle a score between 1 (very profitable and 5 (makes a large loss)]*

	Very profitable	*Profitable*	*Breakeven*	*Small loss*	*Large loss*
Profits from pheromone product	1	2	3	4	5

C19. What is the maximum quantity that can be produced in one batch? _____

C20. What is the cost of production per batch? _____
[or cost of production per trap if information is available]

C21. How is the concentration of the active ingredients measured? *[please check]*:

☐ Gas chromatography ☐ Mass spectrometer

☐ Other method *[please specify]* _____

C22. What methods are used to ensure that the product is not contaminated during production?

_____

_____

C23. What checks are undertaken to ensure that the product is effective in the field?

_____

_____

C24. How many years did it take to develop this product? _____

C25. What are the major production constraints (if any)?

_____

_____

_____

Section D: Marketing, Distribution and Promotion

D1. Who do you sell pheromone products to? *[please circle a score between 1 (almost all sales) and 5 (no sales)]*

Sales to:	*Almost all*	*Most*	*Some*	*Small amount*	*None*
Government agencies	1	2	3	4	5
Non-Governmental Organisations	1	2	3	4	5
Specialised biocontrol or organic farming dealers	1	2	3	4	5
General agrochemical dealers	1	2	3	4	5
Commercial Seed Producers	1	2	3	4	5
Plantations	1	2	3	4	5
Direct to farmers	1	2	3	4	5
Other *[please specify]*	1	2	3	4	5

_____

D2. Do you have your own distribution outlets? How many? _____

D3. In how many locations are your products available for sale?

☐ One only ☐ Less than 5

☐ National network of outlets ☐ Network of outlets in the State or Province

☐ Mail Order ☐ via Internet

☐ Other *[please specify]* _____

D4. Do you have your own extension agents? How many? _____

D5. What extension methods do you use to promote pheromone products? *[please check]*

☐ Advice to dealers ☐ Information leaflets on ……biopesticides

☐ Farmer Demonstration days ☐ Extension visits to farmers

☐ Farmer Field Trials

☐ Other *[please specify]* _____

D6. Do you advertise your products? If so, how and where?

_____

_____

_____

D7. Do you carry out market research for your pheromone products? Please describe.

_____

_____

_____

D8. In your opinion, what description(s) best fit the type of farms and farmers who use your pheromone products? *[please check]*

Size of farm

☐ Very small, marginal ☐ Small ☐ Medium ☐ Large

Crops grown

☐ Staple foods ☐ Vegetables ☐ Legumes & oil seeds ☐ Sugarcane

☐ Cotton ☐ Tree crops ☐ High value export crops ☐ Other *[please specify]*_____

Farmer's education

☐ Little education ☐ Some education ☐ Medium education ☐ Highly educated

Farmer's attitude to environmental issues

☐ Interested in organic farming ☐ Interested in IPM ☐ Concerned about the environment ☐ Concerned about health and safety

☐ No major concerns about the environment ☐ More concerned about farm profits.than the environment

D9. What are the main constraints in marketing and promoting uptake of pheromone products?

Constraints	*Very important*	**Important**	*Some importance*	*Little importance*	*Not important*
Lack of demand by farmers	1	2	3	4	5
Lack of knowledge by farmers of how to use phermones correctly	1	2	3	4	5
Lack of extension support by Government agencies	1	2	3	4	5
Cost of pheromones	1	2	3	4	5
Technical production & quality problems with pheromones	1	2	3	4	5
Ineffectiveness of pheromones as pest control method	1	2	3	4	5
Storage or short shelf life of pheromones	1	2	3	4	5
Competition from old chemical pesticides	1	2	3	4	5
Competition from new chemical pesticides	1	2	3	4	5
Unwillingness of pesticide dealers to sell pheromones	1	2	3	4	5
Lack of widespread availability of pheromones	1	2	3	4	5
Registration costs	1	2	3	4	5
Other *[please specify]*	1	2	3	4	5

_____

D10. What proportion of your total pheromone product costs are spent on distribution, marketing and promotion of uptake of pheromones? *[please check]*

☐ less than 10% ☐ 10 – 20% ☐ 20 – 30% ☐ 30 – 40%

☐ 40 – 50% ☐ 50 - 60% ☐ 60 - 70% ☐ 70 – 80%

☐ more than 80%

Section E: Trends in pheromone use

E1. How have your sales of pheromone products changed over the last 3 years? *[Please circle a score between 1 (large increase) and 5 (large decrease)]*

	Large increase (>100%)	*Increase*	*About the same*	*Decrease*	*Large decrease*
Change in sales of pheromone products over 3 years	1	2	3	4	5

E2. What was your total annual turnover for all pheromones in 2002/03? _____

E3. Have you discontinued the sale of any pheromone products? _____

If yes, which product _____

Why did you stop selling it? _____

_____

E4. Have you plans to sell new pheromone products?

If so, what? _____

E5. Do you plan to change your product range, methods of production or marketing in the future? If so, how? _____

_____

_____

E6. How do you think the market for pheromones will change over the next 10 years in your country?

	Large increase (>100%)	*Increase*	*About the same*	*Decrease*	*Large decrease*
Change in market for pheromone products over the next 10 years	1	2	3	4	5

E7. In your opinion, which type of pheromone product will be the most successful in the future?

_____

_____

_____

Please explain why _____

E8. In your opinion, what do you think the main market and customers for pheromones will be in the future?

_____

_____

E9. What recommendations would you suggest that the government or NGOs should do to promote uptake of pheromone products?

_____

_____

_____

Thank You