Helping small companies compete in biopesticide markets

RIU

Validated RNRRS Output.

Small enterprises are now manufacturing and marketing non-toxic environmentally friendly natural compounds to replace harmful pesticides. Although lots of small companies in India already produce biopesticides, they don't have much marketing know-how. Now, a new professional society and a quality manual help them improve their product ranges and take advantage of booming markets—as exports alone are growing at 10% a year because of the demand for organic produce. In South Asia the society and quality manual have already had a profound effect on manufacturing and quality. Policies for registering biopesticides in Bangladesh have been changed. Plus, in India, small companies sell over 200,000 traps a year baited with natural compounds and, in Sri Lanka, biopesticides are sold for fruitfly and palm weevils.

Project Ref: **CPP60:**
Topic: **1. Improving Farmers Livelihoods: Better Crops, Systems & Pest Management**
Lead Organisation: **Natural Resources Institute (NRI), UK**
Source: **Crop Protection Programme**

Document Contents:

Description

CPP60

Research into Use
NR International
Park House
Bradbourne Lane
Aylesford
Kent
ME20 6SN
UK

Geographical regions included:

Asia, Bangladesh, India, Sri Lanka,

Target Audiences for this content:

Crop farmers,

A. Description of the research output(s)

1. Working title of output or cluster of outputs.
In addition, you are free to suggest a shorter more imaginative working title/acronym of 20 words or less.

Support to SMEs supplying pheromone control technologies and promoting policy change for commercial production

Suggested title: SME innovation platform to empower farmers to adopt sustainable organic production technologies (SMEIP)

2. Name of relevant RNRRS Programme(s) commissioning supporting research and also indicate other funding sources, if applicable.

DFID Crop Protection Programme (CPP)
DFID Competitive Research Facility (CRF)
European Union Framework Programme 6

The CPP initiated the series of projects that constitute the cluster arising through contacts made at a programme workshop in Bangladesh in 1999. However, partnerships developed with commercial companies in India were built on earlier contacts derived in part through participation in a British Council funded conference in Chennai in 1995, and partnerships with researchers and research foundations of private companies involved in the development of pheromone systems for control of sugarcane, rice, groundnut and eggplant pests, notably the Hindustan fertiliser Company, Nagarjuna Research and Development Research Institute and the SPIC Science Foundation. Co-participation in the SME cluster at the same time as a competitive research facility funded project to develop and promote an integrated pest management (IPM) system for eggplant in India and Bangladesh created opportunities for synergy by enabling commercial partners to participate in CRF-funded project activities, thereby achieving greater adoption and sustainable impact. Further an EC FP6–funded project, SUSVEG-ASIA (ICA-CT-2002-10018), increased both the breadth of technologies and range of target crops involved in cluster activities, notably outputs from the tomato leaf curl virus control programme in India (R8247) were evaluated and adopted in Bangladesh.

3. Provide relevant R numbers (and/or programme development/dissemination reference numbers covering supporting research) along with the institutional partners (with individual contact persons (if appropriate)) involved in the project activities. As with the question above, this is primarily to allow for the legacy of the RNRRS to be acknowledged during the RIUP activities.

R8026 (September 2001 – August 2003)
R8304 (September 2003 – September 2004))
R8367 (April 2004 – March 2005)
R8413 (February 2005 – December 2005)

Prof. A. Cork, Natural Resources Institute (NRI), University of Greenwich
Central Avenue, Chatham Maritime, Kent ME4 4TB, UK. Tel: 01634 883209, Email: a.cork@gre.ac.uk

Mr Sarwar Ahmed, Managing Director, Syngenta Bangladesh Ltd., House - 2/6, Block E, Lalmatia, Dhaka-1207, Bangladesh. Email: syndhaka@bol-online.com, Tel. 00 880 2 9137030-1, Fax. 00 880 2 9134263.

Dr Nazira Quraishi Kamal, Head Entomology Division, Bangladesh Rice Research Institute (BRRI), Gazipur 1701, Bangladesh. Email: brrihq@bdonline.com, Tel. 00 88 02 9333098, Fax. 00 88 02 9350122.

Dr Syed Nurul Alam, Senior Scientific Officer (retired), Bangladesh Agricultural Research Institute (BARI), Gazipur-1701, Bangladesh. E-mail. entoipm@bdcom.com, Tel. 00 88 02 9257400, 9256404, Fax. 00 88 02 9252713.

Dr. K. P. Jayanth, General Manager, Bio-Control Research Laboratories (BCRL), Bangalore 560 064 INDIA. Email: jayanthk@vsnl.com Tel: 00 91 80 8468839-42, Fax: 00 91 80 8468838.

Dr S. Narasimhan, Director, Asthagiri Herbal Research Foundation (AHRF), Chennai-47. INDIA. Email: asthagiri@vsnl.net, Tel: 00 91 44 22210852, Fax: 00 91 44 22791044.

Dr K. Krishnaiah, Plot No. 96, Road No. 3, Chandrapuri Colony, L. B. Nagar, Hyderabad 500074, INDIA. Email: krishnaiahk@vsnl.net, Tel: 00 91 44 24113127

Dr B. Fakrudin, Institute of Agri-Biotechnology (IABT) Krishinagar Dharwad-580 005, Karnataka , INDIA., Email: bfakrudin@hotmail.com, Tel: 00 91 836 2748624

Associated projects

R7465(C & D) (April 2002 – December 2006)

Dr N. S. Talekar. College of Plant Protection, Yunnan Agricultural University, Kunming, Yunnan 650201, China.

4. Describe the RNRRS output or cluster of outputs being proposed and when was it produced? ***(max. 400 words)****. This requires a clear and concise description of the output(s) and the problem the output(s) aimed to address. Please incorporate and highlight (in bold) key words that would/could be used to select your output when held in a database.*

The RNRRS supported a range of initiatives to develop semiochemical (**pheromone** and **kairomone**) technologies as environmentally benign alternatives to conventional toxic insecticides for use in crop production. Despite developing and validating the technology with researcher, NGO and farmer groups adoption was disappointing in Sub-Saharan Africa and South Asia. In Egypt DFID-funded projects resulted in almost total replacement of insecticides with pheromone to control cotton pink bollworm (300,000 ha) by the early 1990's producing significant **health**, **environment**al and **cost benefits** for **farmers**. However, area-wide adoption was only achieved by the pro-active involvement of SMEs prepared to manufacture and market formulations in Egypt. In South Asia Government researchers do not have the mandate to deliver products to farmers, although the Directorate of Rice Research demonstrated there was significant farmer demand for controlling rice yellow stem borer by **mass trapping** (Pasalu et al., 2004). NGOs, though willing to engage with farmers on technical issues

do not have the wage structures to retain trained personal capable of promoting such products and some are generally reticent to create farmer dependence on external inputs. Despite the large number of SMEs marketing pheromone products in India most are formulators lacking **technical knowledge**, marketing and promotional skills and are highly dependent on state government procurement systems for sales.

The cluster of activities funded through the CPP provided a vehicle for **building capacity** by addressing the technical constraints of the industry and developing means for influencing policy in **South Asia**. Needs assessments were made through questionnaires sent to 30 companies and a follow-up **workshop** in 2004 that involved a range of stakeholders, including SMEs, policy makers and NGOs. The workshop acted to provide technical information to SMEs which was reinforced by the subsequent production and dissemination of a **pheromone manual** for companies. The Chief Guest, Dr C D Mayee, Indian Agriculture Commissioner, highlighted the need for a consistent voice from **SMEs** to articulate the needs of the industry and for them to seek commercial opportunities in crops where they do not compete directly with pesticide producers, such as **rice**, **sugarcane** and **vegetables**. The former issue was addressed by developing an industry-wide **professional society**, South Asian Society for Advancement of Pheromone Technology (SASAPT), which was inaugurated in September 2005. Further cluster activities were facilitated through Society members, such as national trials to resolve issues associated with inconsistent performance of ***Helicoverpa armigera*** pheromone products while separate activities with Syngenta Bangladesh Ltd. led to the development of novel commercial products, a marketing strategy for presenting the products to farmers and **policy change** on **registration** of biopesticides in Bangladesh.

Reference

Pasalu, I.C., Varma, N.R.G., Krishnaiah, K. and Katti, G. (2004) Pheromone: its scope in rice IPM. National Symposium on Trends in Pheromone research and technology, NRCG, Junagadh, Gajarat, India. pp. 56-71.

5. What is the type of output(s) being described here?
Please tick one or more of the following options.

Product	***Technology***	***Service***	***Process or Methodology***	***Policy***	***Other Please specify***
X	*X*	*X*	*X*	*X*	

6. What is the main commodity (ies) upon which the output(s) focussed? Could this output be applied to other commodities, if so, please comment

The project cluster was not focussed on a particular commodity rather a generic technology. The technology utilises specific odour and visual cues to influence the behaviour of target pest species in order to control their impact on crops, livestock and disease transmission. A range of techniques has developed around their application notably, mass trapping, lure-and-kill, mating disruption, push-pull and auto-confusion. The technology utilises non-toxic, natural compounds in low dose (auto-confusion employs less than 1g a.i. per ha per season) to control specific pest species with no direct impact on non-target organisms. Ideally suited to form the basis of integrated crop management strategies the world market for semiochemicals is increasing at 10% per annum (£42 million in 2003, increasing to £106 million by 2008) although Asia still only accounts for 13% of the global biocontrol market.

DFID-funded projects have assisted the identification, formulation and field application of pheromones and related semiochemicals, some of which have had significant impact. Notably, on farmer livelihoods in Southern Africa (tsetse, see UniversityUK 'Eureka' publication), Egypt (pink bollworm) and, more recently, in South Asia (fruitfly and brinjal fruit and shoot borer). Nevertheless, independent commercialisation and farmer adoption of other products has been disappointing.

The recognition that SMEs can provide the engine for change has been borne out through this project cluster where, despite their natural reticence to work together, the companies have acted for the common good. Importantly SMEs in South Asia are not wholly dependent on semiochemical products for their livelihoods but actively sell a range of product lines, most commonly seeds, natural enemies and biopesticides. Indeed while pheromones provide a common technology to link the companies together each is aware that in order to build lasting relationships with farming communities they need to offer a comprehensive range of crop management technologies suggesting that cluster outputs could be linked to a wider range of crop management issues. Thus, the companies affiliated to SASAPT could provide the basis of an innovation platform to both build the capacity of SMEs and transfer a range of non-pesticide RNRRS crop production technologies to targeted resource-poor farmer crops in South Asia; with similar models being applicable in other regions.

Apart from limited knowledge of production and field application techniques for the semiochemical products SME's formulate and sell, they have very limited capacity to promote and market other goods and services and, in particular, interact with farming communities. Research conducted through the DFID Competitive Research Facility (R7465(D)) to promote mass trapping in a single commodity, eggplant (brinjal), demonstrated the effect of engaging researchers to work with farming communities and SMEs to promote an output of the RNRRS to farmers. A year after the project finished sales of pheromone lures and traps for control of the key pest, *Leucinodes orbonalis* now exceed 200,000 per annum in the absence of Government subsidies and almost all farmers involved were either small or marginal land holders (<2ha). Other models to promote products to farmers are being trialled by SME's but their impact has yet to be assessed.

7. What production system(s) does/could the output(s) focus upon?
Please tick one or more of the following options. Leave blank if not applicable

Semi-Arid	***High potential***	***Hillsides***	***Forest-Agriculture***	***Peri-urban***	***Land water***	***Tropical moist forest***	***Cross-cutting***
X	*X*	*X*	*X*	*X*	*X*	*X*	*X*

Activities under the project cluster were primarily focused on dissemination of knowledge associated with capacity building and system learning, although field activities were undertaken in rice, tomato, country bean, chickpea, pigeonpea, eggplant and cotton. Semiochemicals have application in all agro-ecological zones in south Asia and a wide range of crops, although experience has shown that impact is best achieved in relatively high value crops where insecticide inputs are high (peri-urban, high potential). The Government of India has embraced organic production as a means to promote production of safe food for domestic consumption and meet increasingly stringent export standards. This thrust area provides considerable opportunities for SMEs engaged in commercialising non-pesticide crop production technologies and perhaps explains why Shri K. S. Money, Chairman of Agricultural Produce Export Development Agency (APEDA), accepted our invitation to act as the

chief guest at the inauguration ceremony of the SASAPT.

8. What farming system(s) does the output(s) focus upon?
Please tick one or more of the following options (see Annex B for definitions).
Leave blank if not applicable

Smallholder rainfed humid	***Irrigated***	***Wetland rice based***	***Smallholder rainfed highland***	***Smallholder rainfed dry/cold***	***Dualistic***	***Coastal artisanal fishing***
X	*X*	*X*	*X*	*X*	*X*	

*9. How could value be added to the output, or additional constraints faced by poor people addressed, by clustering this output with research outputs from other sources (RNRRS and non RNRRS)? (**max. 300 words**).*

Please specify what other RNRRS outputs your output(s) could be clustered with. At this point you should make reference to the circulated list of RNRRS outputs for which proformas are currently being prepared.

The initial survey of SMEs showed that 69% of companies spend less than 20% of their costs on marketing and distribution. They had poor access to information on product effectiveness and quality. In order to engage effectively with the farming community SMEs need opportunities to demonstrate the economic benefits of their products and assure farmers of quality and reliability. Their perceived need to engage farmers with packages of technology can provide entry points for a wide range of other RNRRS and related donor-funded research outputs to reach farmers (disease resistant seed (R8425, R8247), crop production techniques (R8412, R8234, R7471), biopesticides (R5540CB, R7821), rodent control (R7372), storage (R6311, R6684, R7486).

There are particularly clear linkages with the RNRRS-funded project to control fruitflies on fruit and cucurbit crops in India using odour-baited wooden blocks (R8089). Indeed Anand Agricultural University was involved in promotion activities associated with both eggplant IPM and the fruitfly project. Other partners associated with the eggplant research, and in particular those with a national mandate such as Indian Institute of Vegetable research (IIVR), Varanasi and BARI, Dhaka could well benefit from experiences derived from the fruitfly project. In addition, some of the SMEs associated with the current project cluster have begun to commercialise fruitfly traps based on odour-baited blocks. These traps are gaining popularity with farmers but in the absence of any scientifically-based study to assess how best to utilise the traps their likely impact on damage levels when used by individual farmers is largely based on potentially misleading anecdotal evidence.

In Bangladesh, outputs associated with an EC-funded project (SUSVEG-Asia) and USAID-funded IPMCRSP on tomato, cucurbits and eggplant are being promoted by BARC, DAE and BARI to high input farmers through a National IPM Project but are not sustainable in the absence of inputs from SME's. The RiU Programme could act to broaden the package of technologies promoted and add value by engaging with resource-poor farming communities.

In Bangladesh commercialisation of pheromone and related biopesticide products was stalled because of a lack of a regulatory framework for biopesticides. Cluster activities assisted the development and adoption of a form of words to enable biopesticides, including semiochemicals, to be registered for sale in Bangladesh and this has

now been gazetted into law. Several companies are in the process of evaluating options for commercialising pheromones, notably Syngenta Bangladesh Ltd. Jubok Agro-Biotech Ltd. recently developed a capacity for rearing natural enemies and is anxious to work with farmers to promote non-pesticide management technologies. To test their approach Jubok recently signed contracts with 150 vegetable farmers whereby they provide all pest management related inputs and purchase the farmers' pesticide-free produce at 10% above market value. The vegetables are in high demand and sold within hours of reaching Dhaka. An Innovation Platform to engage SMEs for development would actively engage with such pro-active entrepreneurs to promote and disseminate RNRRS outputs to directly benefit the rural poor and indirectly benefit the vulnerable urban poor.

Validation

B. Validation of the research output(s)

*10. **How** were the output(s) validated and **who** validated them?*

*Please provide a brief description of method(s) used and consider application, replication, adaptation and/or adoption in the context of any partner organisation and user groups involved. In addressing the "who" component detail which group(s) did the validation e.g. end users, intermediary organisation, government department, aid organisation, private company etc... This section should also be used to detail, if applicable, which social group, gender, income category the validation was applied and any increases in productivity observed during validation **(max. 500 words)**.*

The RNRRS project cluster undertook a wide range of activities from basic science, to understand the molecular basis of pheromone polymorphism and host selection, through the development of commercially-viable products to building the technical capacity of SMEs and the creation of a professional society to represent and promote the fledgling industry's interests in South Asia. In addition the RNRRS project cluster interacted closely with related EC and DFID-funded CRF projects, and built on outputs from a wide range of previous CPP-funded projects that created the basis for the industry. Indeed more than 90% of the semiochemical products sold by SMEs in South Asia for use by farmers are based on attractants identified through DFID-funded projects.

Validation of cluster outputs involved the use of a wide range of measures. Field activities associated with product development (e.g. development of mass trapping technology for control of yellow rice stem borer in Bangladesh) were conducted using standard replicated field trial protocols that allowed testing and hence validation by scientifically valid statistical methods. Some of these outputs will be subjected to further scrutiny by submission for publication in peer-reviewed journals (e.g. development of mass trapping for rice stem borer in Bangladesh and molecular studies on *Helicoverpa armigera*).

Data from comprehensive farmer surveys conducted in Bangladesh to better understand the economics of rice and eggplant production and farmer perceptions of constraints to production were validated using analytical methods suggested by an independent statistician. Outputs from these activities were subsequently used by Syngenta Bangladesh Ltd. to assist in the development of a marketing strategy for commercialising novel semiochemical-based products developed by the project cluster. Related data obtained on vegetable production in India and Bangladesh through activities associated with an EC-funded project (SUSVEG-ASIA) and a DFID

CRF project (R7465(D)) have yet to be fully exploited, although the latter have been published (AVRDC Technical Bulletins 36 and 37).

The cluster survey of market structure, product range, sales, customers, profitability, constraints and opportunities for SMEs marketing semiochemicals in South Asia was conducted to provide baseline data on the industry. The results were used to assess how best to create the conditions for improving product quality, market share and product diversity. The data has not been validated, but provides an effective baseline from which to assess the impact of DFID-funded activities on the industry and indirectly on the farming community and consumers who benefit from availability of these environmentally-benign products in the marketplace.

Cluster activities associated with technical capacity building involved two workshops conducted in Bangalore and Chennai. The Bangalore workshop provided a venue for relating the outputs from industry surveys and present lectures by recognised authorities on the subject. The Chennai workshop concentrated on providing detailed technical assistance designed to improve quality assurance of products. Feedback (from forms distributed to participants) suggested a high level of satisfaction with both activities and provided the framework for the publication of a pheromone manual that covered topics of concern to SMEs. Outputs such as the creation of a society, SASAPT, to represent the SMEs were put forward by the companies at the first workshop and in that case can be validated by the number of companies that subsequently joined. A year after establishment membership represents approximately 60% of the companies producing semiochemical products in South Asia.

11. ***Where and when*** *have the output(s) been validated?*

Please indicate the places(s) and country(ies), any particular social group targeted and also indicate in which production system and farming system, using the options provided in questions 7 and 8 respectively, above ***(max 300 words)****.*

The project cluster was designed to assist the transfer of pheromone and related technologies developed by DFID-funded research to the private sector in order that resource-poor farmers would benefit from improved yields and profits, and consumers would benefit from improved quality and reduced insecticidal residues in agricultural products in South Asia. Project cluster activities had impact across South Asia. Apart from the regional field trials conducted on *H. armigera* validation of outputs is best considered in terms of impact on the SMEs. Thus several companies changed the polymers they used for producing pheromone lures to improve efficacy and investigated new sources of active compounds for their products based on information provided to the project cluster. These companies were located in Gujarat, Andhra Pradesh and Tamil Nadu.

Validation of the changes made to products manufactured by SMEs at the farmer level were not tested, although improvements in product efficiency could in principle be assessed from the results of farmer demonstration plots organised as part of a DFID-funded promotion project (R7465(D)) on eggplant in India and Bangladesh that utilised pheromone-based technology developed by NRI and funded by the RNRRS CPP (R6797, R7071).

Farmer validation of the technology can be gauged indirectly from estimates of pheromone lure production, 193,000 in 2004, although no surveys of farmer satisfaction or long-term adoption rates have yet been conducted. Given the dependence of eggplant farmers on insecticides for control of the key pest, brinjal fruit and shoot borer, and the economic and cultural importance of this crop in South Asia there are still considerable

opportunities to expand these promotional activities for the benefit of resource-poor farmers in other DFID-target states in India, Bangladesh and other countries in the region.

Current Situation

C. Current situation

12. ***How and by whom*** *are the outputs currently being used? Please give a brief description* ***(max. 250 words****).*

Project outputs are available to all SMEs in South Asia and have had a profound affect on the methods and materials used to produce pheromone lures. In particular the outputs have developed an awareness of the need to ensure the use of quality chemicals as the basis of attractant baits. The project has stimulated companies to search for active compounds from a wider range of sources and in particular highlighted the need for quality assurance of finished formulated materials. Many companies have modified their attractant dispensers, and in particular polymers used to make them, although sourcing materials with consistent quality remains problematic for some companies. Considerable work is still needed by the companies to fully understand and implement systems of analysis that will enable them to best utilise the materials they purchase in order to consistently produce high quality products.

Two companies are currently synthesising compounds in South Asia but almost all the production of one is exported for use in the USA and Europe while the other utilises most of its production for its own products. Considerable technical assistance was provided to the SME producing materials that are utilised in-country and this has led to an improvement in quality and range of products produced. Other companies remain reliant on intermediaries to import and supply active compounds and while this assures quality, costs remain high.

Surveys of pheromone-producing SMEs highlighted the extent to which production in India is dominated by sales into the Government procurement system, mainly concerned with the promotion of IPM in cotton. The SMEs believe that the tender system has created a dependency that has distorted prices, compromised quality and stifled development of new products. Nevertheless, a recent FAO publication (www.fao.org/docrep/article/Agrippa/658_en-02.htm) suggests that pesticide consumption in India was reduced from 66,400 tonne in 1994-5 to 43,590 tonne during 2001-02 (27.7% reduction) as a consequence of the adoption of bio-intensive IPM in various crops, most notably cotton, to replace insecticides, which accounts for 76% of the pesticide market in India. Pheromones are seen as a legitimate component of IPM in cotton by Government, SMEs and NGOs and are accepted by farmers. Vegetables still give cause for concern with 55% of samples contaminated with pesticides and 9.5% of samples tested with residues above the MRL, Uttar Pradesh and Kerala being the worst offenders with 49.5 and 52.8% of samples above the MRL (data from IIVR, Varanasi).

13. ***Where*** *are the outputs currently being used? As with Question 11 please indicate place(s) and countries where the outputs are being used* ***(max. 250 words).***

The main outputs of the project cluster have been disseminated to SMEs throughout India and given that semiochemicals are actively sold by at least 30 SMEs they should be readily available to farmers throughout the

country. Nevertheless, this is not the case because of the limited marketing resources of most SMEs with only one company having a national network of distributors (Pest Control India Ltd.). The major suppliers are located in Delhi, Hyderabad, Bangalore and Chennai with major markets in such areas as the cotton belts in Andhra Pradesh and Gujarat. In Bangladesh commercial production of semiochemical products has not yet commenced, although they are being actively promoted by Government agencies in anticipation of an indigenous supply chain developing. There is one active SME in Sri Lanka who has developed markets for control of fruitfly and palm weevils using semiochemicals.

As described earlier a new market opportunity was created by a DFID-funded promotion project that built on earlier DFID-funded strategic research to develop a semiochemical-based pest control technology for the major pest of eggplant. While the technology can now be considered a common good and has potential for commercialisation throughout the region, impact has largely been restricted to those areas where DFID-funded promotional activities were based. There are indications that some SMEs are beginning to commercialise the product in other areas but because of their limited resources SMEs are focusing on relatively wealthy farmers who are thought to be more willing to adopt the technology.

14. What is the scale of current use? Indicating how quickly use was established and whether usage is still spreading ***(max 250 words).***

There is enormous potential for semiochemical-based pest control technologies worldwide given their specificity of action, low toxicity and ability to complement other IPM component technologies. Recent concerns over pesticide residues and other health related issues associated with agricultural products have given a fillip to the industry and this has been mirrored in South Asia where organic production is rapidly becoming the standard. However, while the market for semiochemicals worldwide is increasing at a rate approaching 10% per year in developed countries, South Asia is seen as a nascent but minor market even by the SMEs themselves. Indeed there are only three examples of successful adoption of semiochemical products for pest control on a large scale and two of them (fruitflies, eggplant borer) where promoted through DFID funded activities. The third, control of red palm weevil, is a relatively small, but growing market. Most sales of pheromones are associated with pest monitoring and not use for control, thus leaving farmers to apply insecticides when pest levels exceed economic thresholds. Unless and until SMEs and extension workers begin to promote semiochemicals as the basis of pest control measures their full potential will not be realised.

15. In your experience what programmes, platforms, policy, institutional structures exist that have assisted with the promotion and/or adoption of the output(s) proposed here and in terms of capacity strengthening what do you see as the key facts of success? ***(max 350 words).***

In South Asia there are numerous researchers actively engaged in conducting research on semiochemicals. Nevertheless, this research effort has not led to the production of any economically-viable products. To fill this vacuum some SMEs are beginning to engage in product development activities of their own, encouraged by the experience gained from working in this project cluster.

The success of the project cluster to engage effectively with SMEs in South Asia is in part based on their perception of the technical competence of project partners and the fact that the activities undertaken were founded on sound scientific principles and highly relevant to their needs.

Successful adoption of semiochemical products has been recently achieved in South Asia but these were dependent on coordinated actions that engaged with a wide range of stakeholders across the production, marketing, media and consumer spectrum.

Surveys suggest that few farmers keep detailed records of the costs of pesticide and other crop production inputs. Their perception of the economic importance of constraints is often based on indirect evidence tempered by local experience. In order for farmers to change crop production practices the product being promoted has to address a constraint that is considered to be of major economic importance. Farmers will try new products promoted by organisations they trust but long-term adoption will depend on availability, price and efficacy. In Bangladesh, for example, there is considerable brand loyalty which has a strong influence on farmers. This is not so pronounced in India where pesticide dealers may have more influence. Many NGOs promoting non-pesticide management (NPM) take a different approach; they compare profits obtained from low input production with those obtained through pesticide-based crop management practices. Farmers accept that, despite lower yields, profits can be higher. Adoption is closely linked with farmer trust of the organisation advocating change and the impact of practical demonstrations. It is more difficult for SMEs to engage with new farmer groups in this manner because their motives will be questioned. Nevertheless, experience suggests that inviting to meetings farmers who have benefited from the products to be promoted can have a profound impact on the views of the inexperienced farmer group.

Successful adoption of one product builds trust, and motivates farmers to seek new products for other economic constraints. Thus, SMEs engaged in promotion activities associated with semiochemical products are well placed to develop markets for other inputs such as seeds, soil amendments and biopesticides.

Ideally innovation platforms involved with dissemination of RNRRS products should engage with as wide a range of stakeholders as possible and provide credible packages of technology that have validated benefits for target farmers. SMEs can be key stakeholders in this process but technology packages are best developed and farmers' needs assessed by independent researchers.

Environmental Impact

H. Environmental impact

24. What are the direct and indirect environmental benefits related to the output(s) and their outcome(s)? ***(max 300 words)***

This could include direct benefits from the application of the technology or policy action with local governments or multinational agencies to create environmentally sound policies or programmes. Any supporting and appropriate evidence can be provided in the form of an annex.

Fruits and vegetables are often subject to high pesticide doses, notably eggplant and country bean where farmers in Bangladesh spray almost daily during the summer season. Unlike cereals, fruits and vegetables are consumed

shortly after harvest so the time available for the synthetic pesticides to decay is insufficient to prevent residues being consumed. India is the second largest vegetable producer, accounting for 13.4% of world production and surveys suggest that 50-70% of this produce is contaminated with insecticide residues (Karanth, 2002).

An Innovation Platform to promote non-pesticide production of selected fruits and vegetables in South Asia would generate significant direct environmental and health benefits. The promotion of IPM strategies that incorporated the supply of disease resistant, high-yielding varieties, biorational pest control strategies, commercial soil amendments such as *Trichoderma viride* and advocated use of farm yard manures and wormy compost would result in significantly reduced demand for synthetic pesticides and fertilisers. These actions alone would also reduce the pressure from insecticide resistant secondary pests and encourage the establishment of populations of natural enemies and parasitoids.

Farmers are aware that the use of pesticides has environmental impacts but experience suggests that they will only adopt non-pesticide solutions if they are cost-competitive with pesticides, unless the produce is for home consumption. However, as consumer pressure for pesticide-free produce increases in South Asia, so farmers are becoming more willing to contemplate change.

Reference

Karanth, N.G.K. (2002) Challenges of liming pesticide residues in fresh vegetable: The Indian experience. Eds. E. Hanak, E. Boutrif, O. Fabre, M. Pineiro. Proceedings of the International workshop, CIRAD-FAO, 11-13 December 200, Monpellier France. pp. 1-13.

25. Are there any adverse environmental impacts related to the output(s) and their outcome(s)? ***(max 100 words)***

The only adverse environmental impact that could result from the widespread adoption of semiochemicals for pest management relates to the use of synthetic plastics for both trap and dispenser systems. While these materials are not toxic they do represent an environmental hazard. Nevertheless, research is underway to develop advanced dispenser systems that utilise biodegradable formulations based on natural wax materials. Several of these have been commercialised in developed countries, ‘Splat’ and ‘Exosex’, but they are not yet available to resource poor farmers in developing countries, although NRI is conducting trials of Exosex formulations on rice in India. In addition both systems do not require the use of traps but can be applied directly to the crop although ‘Splat’ formulations do utilise a synthetic insecticide to kill the target pest.

26. Do the outputs increase the capacity of poor people to cope with the effects of climate change, reduce the risks of natural disasters and increase their resilience? ***(max 200 words)***

Farming communities are well aware of the influence weather factors have on crop production at a local level and all have coping systems to accommodate them. Long-term climate change caused by greenhouse gas emissions will inevitably impact more on the vulnerable because they have access to fewer resources to cope with change. Actions undertaken by SMEs could act to mitigate these changes by introducing new technologies, varieties and crops that are better able to cope with changes in climate. The entry point for this cluster concerned pest control with insect semiochemicals and the ability of SMEs to promote such products will be influenced to some extent by climate change given that locations for producing particular crops may change over time. However, in the context of South Asia this is not expected to be a major factor, at least in the short term. However, the ability to produce

healthy crops with improved varieties and management practices will improve the resilience of the poor to cope with the impact of natural disasters and climate.

Annex

R8026
Output 1 – Cost-effective, trapping system suitable for use in mass trapping by smallholder rice cultivators in Bangladesh developed
Output 2 – Social economics of rice cultivation in Bangladesh and effect of ICM strategy on rice cultivation on farmer attitudes understood
Output 3 – Impact on rice crop of incorporating mass trapping, for control of YSB, as a component of the Syngenta ICM programme in Bangladesh assessed

R8304
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
Output 2 – Knowledge and advice to solve technical constraints impeding commercialisation of pheromones disseminated

R8367
Output 1 – Commercial manufacture of pheromone technology for control of rice stem borers and brinjal borer developed and promoted
Output 2 – Tools for training pesticide dealers and rice and brinjal farmers on pheromone and related IPM technologies developed and promoted
Output 3 - Impact of rice stem borer complex on yield of transplanted rice understood
Output 4 - Stakeholder views of pheromone technology understood and strategies for overcoming farmer risk aversion to new technologies developed.

R8413
Output 1 – Biocontrol Producers' Society for South Asia established to provide a common platform for commercial exploitation of pheromone and related products in the region
Output 2 – Analytical personnel from ten SMEs trained to undertake quality assurance of pheromone products to comply with Government legislation
Output 3 - Pheromone monitoring and control systems for key rice stem borer and sugarcane borers commercially developed and promoted by at least two SMEs
Output 4 - Crop management role of *Helicoverpa armigera* pheromone in South Asia, defined and blend composition resolved

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