ICM in cotton: a success story?

WITH the contractions IPM and ICM becoming more and more widely used in public health and crop protection, it was perhaps not surprising that at the Brighton Conference a complete session was devoted to them. Four papers, under the title *ICM in cotton: a success story?*, made up what was a most interesting and informative session.

Cotton IPM in Asia

The first paper was by K.G. Eveleens, of the FAO Regional Office for Asia and the Pacific, and was entitled *The FAO/EU Cotton IPM Programme in Asia: problems and prospects.* This new FAO Programme, funded by the European Union, became operational in late 1999 and covers six countries of which China, India and Pakistan are major cotton producers, accounting for half of the world's production area and about 40% of the global output, Table 1.

Cotton crop protection in the region is, for the most part, still very much chemically dependent, although technologically a reduction of such dependence appears feasible. The problem is that often new IPM methodologies remain stuck in academia or on drawing boards, while farmers continue as before to spray frequently and according to the calendar.

The FAO Programme focuses on season-long participatory field training according to the so-called farmer field school (FFS) model as the best strategy to turn farmers into IPM practitioners. The methodology has been pioneered and brought to fruition in IPM training of rice farmers in Asia and although there are substantial differences between cotton and rice agroecosystems, indications are that this approach is equally suitable to bring cotton farmers' crop protection practices more in line with the tenets of IPM.

The chief features of the FFS system as opposed to the conventional system are:

- *Criteria for Decision Making:* Grow a healthy crop; Conserve natural enemies; Make regular field observations as a basis for management decisions.
- *Technology Packages:* Fixed technology packages are not working so that human resource development is a prerequisite for sustainable agriculture.
- *Role of Pesticides:* May cause problems so that they must be used as a last resort and on the basis of farmers' analysis of the ecosystem.
- *Consideration of Natural Enemies:* Essential for proper decision making and within farmers' capability.
- *Research:* Carried out at all levels – local studies with full farmers' participation and all stakeholders interact in setting agendas.

The author concludes that the starting point for the Programme is a crisis situation brought about by excessive use of chemicals and a sense of urgency to do something about it. This is not the first or only endeavour to this purpose, but what the Programme perhaps sets apart from other efforts is its focus on the farmers as the most direct victims of the malady. As the old saying goes, the best surgeon is he that has been hacked himself, and this applies also to remedial action for the present cotton crop protection predicament.

Table 1. *Cotton production statistics for China, India and Pakistan and the Whole World (1998)**

Country	Production (Metric tons x 1,000 seed cotton)	Area harvested (1,000 hectares)	Yield (kg/hectare)
China	10,665	4,501	2,369
India	5,177	9,290	557
Pakistan	4,686	2,930	1,599
Total of 3 countries	20,528	16,721	4,525
Total World	51,793	33,180	

* compiled from: FAO Selected Indicators of Food and Agriculture Development in Asia-Pacific Region, 1988-1998. RAP Publication 1999/34, October 1999

ICM tools

Global implementation of ICM in cotton was the title of the paper by A. Sagenmuller and R.T. Hewson of Aventis CropScience. They said that through the development of new crop protection products – seeds, biotechnology and agronomic services, such as diagnostic systems and resistance management strategies - Aventis CropScience is providing the farmer with valuable ICM tools for sustainable, safe and economic agricultural production.

ICM, they said, is seen as the successful way forward for farming, and is an integral part of the Company policy of helping the farmer produce reliable supplies of affordable food and fibre with the least impact on the environment. A global network has been established with experienced staff carrying out research work, training farmers and advisors and liaising with the key contacts in each country.

Some of the success stories arising out of projects carried out in cotton in the Republic of Uzbekistan, Greece, India, Colombia and South Africa were then described in the paper. The case studies confirm the results for cotton reported in a paper by one of the authors and others at the 1998 Brighton Conference.

The integrated programmes tended to give improved efficacy and higher crop yields. Since they were often obtained with lower application rates, or fewer treatments, they were more cost effective. There were often considerably higher beneficial insect populations in the integrated programmes compared to the conventional pest control approaches.

Maintaining the population of beneficial insects during the early stages of cotton growth may help not only with managing the main pests but also secondary pests, further reducing the number of treatments required.

Many of the programmes have concentrated on IPM because effective management of insect pests is the main problem facing the cotton grower. However, there is a need to extend these programmes to cover all aspects of ICM, such as seed rates, fertilisers and irrigation, and this is beginning to happen as illustrated by the work in Greece and India.

Key factors in the success of these

projects have been: a) the involvement of all interested parties; b) development of local programmes involving thresholds and 'windows' tailored to suit local needs; c) use of farm-scale demonstrations; d) training and educating farmers in scouting techniques and identification of beneficial arthropods; e) use of economic thresholds to determine optimum timing; and f) development of simple ICM tools for the farmer.

An interesting example of the last is the 'Pix' indicator in Greece. Developed by Aventis CropScience it is placed against the last five nodes of the plant and the colour of the indicator at the position of the youngest leaf denotes whether or not an application of the plant growth regulator mepiquat chloride is necessary and, if so, the dose to be used. It resulted in a lower amount of chemical being used for the integrated compared to the conventional programme.

The authors concluded that the results obtained in cotton show that similar opportunities for reducing costs, whilst maintaining yields, are possible in other crops.

ICM adoption depends on farmers

In their paper *Prospects for integration of non-chemical and chemical pest management in cotton*, K.A. Jones (Natural Resources Institute), R.H.J. Verkerk (Imperial College) and K. Asanov (Agency for the Cotton Project Implementation, Uzbekistan) pointed out that a large body of work on ICM-compatible technologies, such as the use of baculoviruses, pheromones and augmentative releases of natural enemies, has been carried out in major cotton producing nations. However, little of this work has included research to maximise integration of these technologies as part of an ICM system.

In their paper the authors considered some of the biorational work undertaken in Egypt and Thailand, and then considered in greater detail a current project in Uzbekistan. Side effects of pesticides on beneficials are a key concern in Uzbekistan, the fourth largest cotton producer in the world.

After two decades of successfully replacing intensive insecticide and acaricide use with mass releases of natural enemies, chemical control is now assuming increased importance as the output from the country's several hundred 'Bio-labs' is facing decline due to inadequate funds for operational and maintenance costs.

The authors then outlined the training and research initiatives in Uzbekistan that form part of a current World Bank funded project that aims, among other things, to improve compatibility between insecticide use and existing augumentation programmes for biological control agents. Finally, the applicability of such initiatives to other major cotton growing regions is considered in the paper.

It is apparent, say the authors, that even if a technology has been demonstrated to be scientifically and practically effective, it is not necessarily adopted by farmers and incorporated as part of an IPM or ICM system. Moreover, ICM strategies need to be flexible and continuously reviewed owing to the dynamics within and outside of the cropping system.

Changes in the market availability of pesticides or the deterioration of entomophage production capacity, as experienced recently in Uzbekistan as a result of political and economic flux, can have major effects on the viability of particular approaches.

The work and examples reported by the authors demonstrate that relying on any one technology, either chemical or biological, is ultimately not sustainable. In systems with relatively low insecticide and acaricide inputs, e.g. Uzbekistan and many smallholder cotton farming systems in Sub-Saharan Africa, biological control by wild natural enemy populations should not be underestimated. Hence, it is essential both that the impact of pest management practices on these is well studied and understood, and conservation strategies are developed.

The authors concluded that although adoption of ICM can be limited due to technical, political or economic difficulties, it is ultimately dependent on the willingness of farmers and other stakeholders to adopt less familiar or new technologies which may be perceived as risky, and ICM strategies more generally.

It has been shown with rice and other crops that promotion of ICM through Farmer Field Schools is an effective route to adoption. Similar programmes are presently being promoted in organic cotton in Zimbabwe and other African countries and conventional cotton in Asia. Adaptations of these approaches, backed up by detailed research on technology development and impact is likely to be the key to future adoption of ICM programmes.

Table 2. Outcome for IRM crop management scheme: participating farmers compared with matched control farmers from nearby villages

	Punjab	Tamil Nadu	Andhra Pradesh	Maharashtra
Reduction in pesticide use % (no. spra	-2	46	44	95
Reduction in pesticide use % (a.i/ha)	29	42	69	92
Reduction in plant protection cost %	21	39	55	88
Yield increase (%)	49	17	31	70
Net increase in profitability ($/ha)	40#	93	125	226#
Reduction in health hazard* (%)	48	77	89	92

* Calculated on the basis of human LD_{50} dose reductions from the WHO tables for the particular chemicals involved.

\# Non-participating farmers were operating at a loss.

Implementing IRM practices in cotton ICM

Developing and implementing insecticide resistance management practices in cotton ICM programmes in India was the title of the paper by D.A. Russell, Natural Resources Institute, K.R. Kranthi and T. Surulivelu, Central Institute for Cotton Research, India, D.R. Jadhav, ICRISAT, India, A. Regupathy, Tamil Nadu Agricultural University, India, and J. Singh, Punjab Agricultural University, India. The authors pointed out that pyrethroid, organophosphate, carbamate and cyclodiene resistance levels for the cotton bollworm, *Helicoverpa armigera*, have been monitored routinely at sites throughout India since 1993 using discriminating dose assays. Resistance by *H. armigera* and other pests to commonly used insecticides is a severe constraint to cotton production in India.

Therefore an integrated crop management strategy was developed aimed at maximising profit while minimising insecticide use and the impact of insecticide resistance. Appropriate varieties and agronomy, plus seed treatment where necessary, allow the first foliar insecticides to be delayed until at least 70 days from planting.

Insecticides for fruit and leaf feeders are then rotated, taking account of seasonal shifts in their efficacy and the pest spectrum faced, with endosulfan first, followed by particular organophosphates, leaving one to two pyrethroid sprays until the late season when pink bollworm is also present.

Demonstrations of the system, customised for the different regions of India, were undertaken with 1,650 farmers in one village in Tamil Nadu, three in Andhra Pradesh, nine in Maharashtra and eleven in the Punjab in 1998-99. A summary of the results is presented in Table 2.

H. armigera and *B. tabaci* numbers were devastatingly high across the Punjab in 1998 with numbers above the intervention thresholds for 107 days out of the 140-day season. The number of applications was not reduced but the use of mixtures and of the more toxic materials declined dramatically.

Although they comprised less than 50% of the spray rounds in any given state, organophosphates were responsible for 96% of the human dermal toxicity hazard in the non-project villages. Pyrethroids, which have other problems in IPM programmes, accounted for less than 1% of the overall risk.

The estimated total impact on beneficial arthropods (using the published LD_{50}s) was reduced by 85% for egg parasitoids, 62% for larval ectoparasitoids, 78% for ladybird predators and 63% for lacewing predators.

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When there is more than one author of a paper from the same organisation, only the name of the first is given.

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