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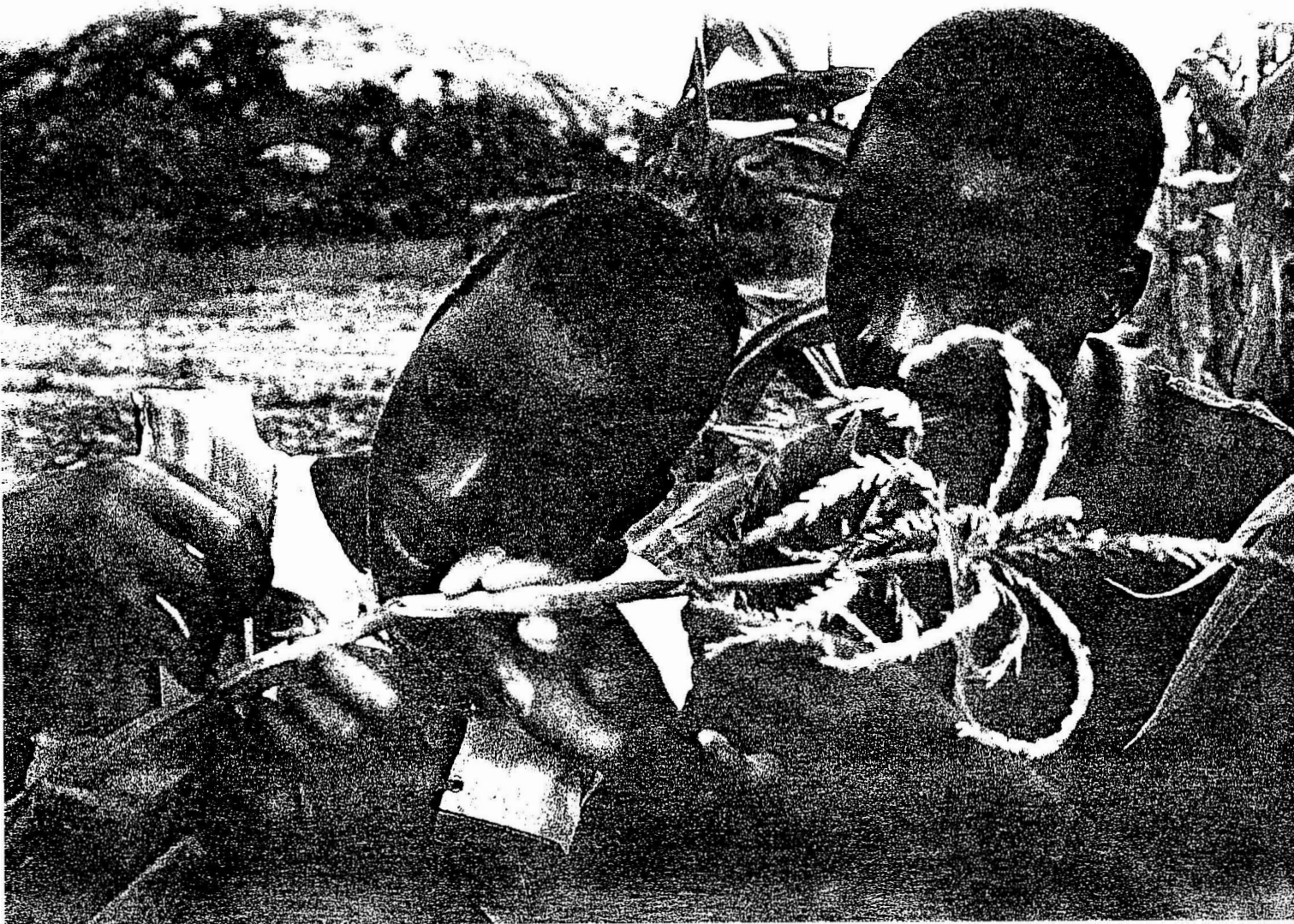
PERSPECTIVES ON PESTS

Achievements of research under the UK Department for International Development's Crop Protection Programme, 1996–2000



Department for International Development

The Department for International Development (DFID) is the UK government department responsible for promoting development and the reduction of poverty. The policy of the Government was set out in the White Paper on International Development published in November 1997. The central focus of the policy is a commitment to the internationally agreed target to halve the proportion of people living in extreme poverty by 2015, together with associated targets including basic healthcare provision and universal access to primary education by the same date.

The renewable natural resources (RNR) research strategy funded by DFID's Rural Livelihoods Department (RLD) has the primary purpose of generating benefits for poor people by applying new knowledge in natural resources systems. The bilateral component of the strategy is organised as eleven research programmes, the largest of which is the Crop Protection Programme (CPP). The CPP is managed by Natural Resources International Limited (NRIL).

Natural Resources International Limited

NRIL specialises in managing programmes and projects in the natural resources, environmental and rural development sectors, as well as in such cross-cutting areas as institutional development. The company is owned by the University of Greenwich, the University of Edinburgh and Imperial College of Science, Technology and Medicine, University of London (incorporating Wye College), and draws on the expertise of these and other institutions, both in the UK and overseas. In addition to the Crop Protection Programme, NRIL also manages the Crop Post-Harvest, Livestock Production, Forestry and Post-Harvest Fisheries research programmes on behalf of DFID.

SWEETMORE, A., ROTHSCHILD, G. and EDEN-GREEN, S.J. (Eds) (2001) *Perspectives on Pests: Achievements of Research under the UK Department for International Development's Crop Protection Programme, 1996–2000*. Natural Resources International Limited, Chatham Maritime, Chatham, UK.140 pp.

CD-ROM of selected CPP/IPMSA publications, 1989–2001

ISBN 0-9539274-1-5

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Typeset by: Anne Sweetmore Publishing Services, Witney, Oxon, UK

Printed by: Pragati Offset Private Limited (www.pragati.com)

Cover design: Medway Design Team, University of Greenwich

Database software programming: SADs Limited, Maidstone, Kent

Sustainable insect pest management in Indian cotton

R6734, R6760

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October 1996–March 1999

Throughout the cotton-growing areas of India, intensified production, increased use of irrigation and the excessive use of pesticides have led to the major cotton pests evolving resistance to the chemicals used against them: for example, resistance to common pyrethroids used in bollworm control can reach close to 100% by the end of the cotton season in heavily sprayed areas. This resistance encourages the application of more and stronger insecticides, leading to a classic 'pesticide treadmill'. Two related projects, focusing on southern India (R6734) and the irrigated cotton-growing systems of the Punjab (R6760*) have developed and tested integrated pest management (IPM) packages of methods that reduce the need for insecticides. Using the recommended IPM methods, farmers encourage the build-up of the bollworm's natural predators, and target limited sprays of recommended insecticides on the pest only when absolutely necessary. The results have been dramatic. Reduced costs of production and increased yields of cotton resulted in massively increased incomes to farmers. In the last (1998/99) season, farmers using the IPM package in southern India achieved average profits of £176 per ha, compared with £38 per ha for other farmers. Farmers' strong enthusiasm generated by these results attracted widespread coverage by local news media, and this in turn has fuelled strong demands for expansion into other districts. Use of the recommended IPM package has already reduced hazards to the environment and human health, and improved the profitability and reliability of cotton harvests for hundreds of poor rural families dependent on the cotton crop. The future widespread adoption of these methods now seems assured, and will have a major and sustainable impact on improving the livelihoods of small-scale farmers, on human welfare and on the environment.

ISSUES

India produces 2.5 million tons of cotton each year, sustaining the livelihoods of over 17 million people. Most are poor farmers who must support their families on less than 2 ha of land. For these smallholders the cotton crop is often the only source of income for food, medicines, education and shelter. Unfortunately cotton crops have become less and less viable, partly because of the increasing cost of pest control which accounts on average for more than 40% of the cost of growing the crop. Without chemicals, farmers face devastating attacks of pests such as the voracious cotton bollworm caterpillar (*Helicoverpa armigera*), which not only ruins their cotton but also attacks their food crops.

The threat of cotton bollworm has dramatically increased in recent years because of intensified land use. In addition, poor spraying techniques and over-use of chemicals have made the pest resistant to most available insecticides. Seeing their crops devastated by bollworms, and desperate to salvage something from their losses, farmers have continued to buy more toxic (and expensive) chemicals and to spray ever more frequently, but with decreasing effectiveness. The cost of chemicals has pushed farmers into dramatically increasing spirals of debt: in 1986/87 this drove hundreds of farmers to suicide – often by drinking the very pesticide which had brought them to the brink of desperation.

The aim of this work was to develop and demonstrate alternatives to the current over-reliance on conventional pesticides without compromising cotton production, through the development of Integrated Pest Management (IPM) methods for an area-wide approach to cotton pest management.

ACHIEVEMENTS

R6734

Effective components of IPM in cotton, explored on a small scale under a preceding project (R5745), were refined and developed into a package. The use of appropriate agronomy and resistant cotton varieties and seed treatments to protect against sucking pests allowed the use of pesticides to be delayed as long as possible, taking

*Project R6760 was jointly funded by the DFID Natural Resources Systems Programme.

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Table 1. Results of trials by 1600 farmers in 23 villages in four states.

	Tamil Nadu	Andhra Pradesh	Maharashtra	Punjab
Reduction in pesticide use (%)	46	69	92	29
Reduction in health hazard* (%)	77	89	92	48
Yield increase (%)	17	25	70	49

maximum benefit from beneficial insects. When insecticides were necessary, the results of the resistance monitoring programme and the study of mechanisms of resistance and of field efficacy against the different insect pests provided the rationale for the choice of materials and the timing and sequences of chemical applications. Simple pest management guides were developed for the states of Maharashta, Andhra Pradesh and Tamil Nadu.

Extension of the work of the International Crops Research Insitute for the Semi-Arid Tropics (ICRISAT) laboratory to cover whitefly (*Bemisia tabaci*) showed, for the first time in India, that whitefly had developed resistance to the bollworm chemicals chlorpyrifos and acephate (organophosphates) and cypermethrin (pyrethroid) chemicals, but that whitefly were still susceptible to the widely used sucking pest products. These results were incorporated into the control programme.

Making full use of farmer and village participatory methods, these management schedules were extended into single villages in the three states in 1997. These resulted in an average of 40% reduction in insecticide use and a 20–40% increase in the value of the yield, turning a marginal crop into a profitable one. Following end-of-season farmers' field days and excellent media coverage, in the 1998 season this work was expanded to 13 villages and over 600 farmers. Utilizing local people as effective extension agents, insecticide use was reduced by over 92% in Maharashtra, 69% in Andhra Pradesh and 42% in Tamil Nadu, with equal or enhanced yields.

These very positive results were supported by the provision of advanced equipment to detect mechanisms of nerve insensitivity to the Central Institute of Cotton Research (CICR) Nagpur which, with the ICRISAT and Tamil Nadu Agricultural University (TNAU) laboratories, undertook the regular weekly resistance (and thus insecticide efficacy) monitoring on which the pest management programme was built. Nerve insensitivity has now been demonstrated to be a major mechanism of resistance in India. A technical bulletin produced by the project, the *Podborer Newsletter*, has chronicled these advances and raised awareness and understanding of the problems and their solution amongst India's scientific community. A practical training workshop in insecticide resistance monitoring and management was run at CICR on semi-commercial lines. The production of two fast-selling editions of a detailed cotton IPM brochure aimed at farmers in Hindi, Marati, Tamil and now Punjabi has helped to implant the messages.

The project has unequivocally demonstrated that, with careful design supplemented by a detailed understanding of insecticide resistance patterns, effective and economic IPM programmes can be developed and extended. Insecticide use can be delayed, with consequent environmental and biodiversity benefits. Scouting for pest infestations can form an effective basis for decisions on interventions, and the resulting pattern of insecticide use can be much less environmentally damaging and can minimize the risk of developing further insecticide resistance. This represents a considerable step forward in the provision of much more economically acceptable cotton pest control which also addresses environmental and human health concerns.

R6760

Studies of 260 farm households in 13 villages within the Punjab cotton belt showed that cotton yields and gross revenues per hectare have been declining across the belt since at least 1994. Over the same period, insecticide use has increased by 22% and the costs of spraying by 50%. As a result most farmers are making a loss on cotton. There are biological reasons for this – unseasonal rains and exceptionally high outbreaks of cotton bollworm and whitefly have contributed. There are also social reasons: the intensification of production, the move to irrigation, and the use of input levels that damage both groundwater and the viability of the agricultural system. Although farmers' educational background was correlated with improved yields, the clearest correlation was with the quantity of insecticide used. The yield increase with increased insecticide use did not, however, translate into higher profit margins because of the costs of inputs. Agricultural advice is strongly concentrated with the commission agents, who are also the vendors of insecticide, which is often poorly formulated and usually sold on credit. Increasing insecticide use is selecting strongly for evolved resistance to the main chemicals used against both bollworm (cypermethrin, fenvalerate, quinalphos and endosulfan) and whitefly (cypermethrin, acephate and chlorpyrifos). This was well documented through the measurements made in the project-supported laboratories at Punjab Agricultural University (PAU), with resistance to common pyrethroids used in bollworm control rising to close to 100% by the end of the cotton season. This resistance encourages the application of more and stronger insecticides and their

mixtures to control the resistant pests.

This situation is exacerbated by the fact that whitefly are the vectors for the debilitating cotton leaf curl virus disease (CLCuV). Epidemiological studies demonstrated the range of crop and weed alternative hosts for CLCuV and identified a number of tolerant cotton varieties, of which LH 1556, F 846 and LHH 144 appeared to have the other agronomic characters suited to conditions in the Punjab.

The project used the knowledge gained from these studies to construct a 'best-bet' package of practices for the cotton farmer. This strategy included the use of appropriate short-stature, sucking pest- and CLCuV-tolerant varieties at appropriate spacings; the use of insecticides only when specific pest thresholds were exceeded; and a sequence of single insecticide active ingredients which maximized efficacy against the pest complex and minimized further resistance development. The materials to be used and their sequence depended on the severity and nature of the pest complex at the time.

Farmers in Tamil Nadu discuss IPM with extension workers

This strategy was demonstrated in the 1997 season in farmer-participatory work in two villages. Insecticide use was reduced by 40% and yields increased by 38% in a season otherwise disastrous in the surrounding areas due to unseasonal heavy rains and very high bollworm attack. The Punjab government partially adopted these practices in five villages and achieved 10–20% yield improvements. The work stimulated great interest in the region.

In the 1998 season an attempt was made to implement all aspects of the cotton management plan to over 1000 farmers in 10 contiguous villages of the Lumbi block in the cotton belt, as an initiative of the Chief Minister of Punjab. Good seeds, fertilizer, good pesticides and timely irrigation were promised in addition to field support and mobility. For a variety of reasons, these non-project inputs either did not materialize or were partially provided in this, the worst year on record for high pest levels and low cotton production across the Punjab. Farmers were demoralized and spraying rose amongst the participants despite a determined effort by PAU and project staff. However, the use of undesirable pesticide mixtures and pyrethroids was reduced by half and the yields were 49% higher than that of non-participants. As a result this provided marginal profitability rather than significant loss to the participators. The need for careful insecticide use and active management of resistance is now appreciated by all stakeholders.

The project has successfully identified the pest management issues within the Punjab that are contributing to the decline of cotton production, and has found ways to tackle these production constraints. Pest management decision recommendations have been developed and demonstrated that are based on better understanding of both biological and socio-economic factors. These recommendations have been shown to greatly reduce the costs and environmental impact of control, and to increase cotton yields by over 50% for participating farmers, even in the two worst pest attack years on record. The PAU now has the proven capacity to monitor insecticide resistance in the two most important species of cotton pest.

FUTURE

In 1999, the CPP promoted these positive results in India by helping to train industry and government agri-business stakeholders in the principles and practices of appropriate cotton IPM. Recognising the potential of these improved pest control methods, the Indian Ministry of Agriculture is now funding promotion of IPM in 500 villages in the 20 major cotton districts which account for 80% of the total insecticide used on cotton in India. The Government of India has agreed to provide 30 million rupees (about £450□000) over 3 years Significant inputs are being provided from the pesticide, fertilizer and seed industries. The value of this work has been recognised in a major collaborative project funded by the Common Fund for Commodities (CFC), DFID CPP and the governments of China, Pakistan and India (2000–2004) and the insecticide industry's Resistance Action Committee. This new work will deepen our understanding of the technical constraints to the best use of insecticides for cotton pest control, and will make the benefits of the earlier work available to many millions of cotton growers across Asia. The findings of the projects from 1993 onwards are being used to inform the curriculum-building exercises of the European Community's Asian Cotton Farmer Field School project which is active in Bangladesh, China, India, Pakistan, Vietnam and the Philippines.