

Executive Summary

In this document, we review the research that has been undertaken on beneficial organisms (predators, parasites and pathogens) affecting pests in cotton systems over the last 30 years. We estimate that \$A20-25 million has been spent on over 100 research projects over the last 10 years, by rural Research and Development Corporations, Co-operative Research Centres, CSIRO, State Agriculture Departments, and Universities. This research has resulted in a broad understanding of the role beneficials play in the population dynamics of pests, and of their potential contribution to pest management. While it is clear that beneficials, on their own, are unlikely to limit populations of *Helicoverpa* spp. to levels below current economic thresholds, it is also clear that they can have a major impact as part of an integrated pest management system. We show that even limited current guidelines for integrated pest management, which incorporate the effects of beneficials, have the potential to save growers almost \$A1 billion, if implemented over the next 10 years. On this basis, the benefit:cost ratio for research on beneficials could be about 40:1, which compares well with benefit:cost ratios for biological control around the world.

We also show that there has been a major effort to extend information about beneficials to the growers, through printed material and decision support systems such as CottonLOGIC. Recent information on the economic benefits of conserving beneficials provides an excellent platform to reinforce the messages contained in this material, and facilitate the adoption of integrated pest management throughout the cotton industry. This is one part of the challenge for future research and development on the role of beneficials in cotton pest management. The second part of the challenge is to develop techniques that allow explicit manipulation and exploitation of beneficial insects in cotton systems, not just their conservation through the use of soft insecticides. Much remains to be done to achieve this goal. The abundance of beneficials within Australian agro-ecosystems is dynamic and population levels fluctuate at a number of temporal and spatial scales. The unpredictability of beneficials limits their use in pest management programs at present, and there are significant problems in developing research methods that will generate the understanding required to overcome this unpredictability. The research required falls into the following categories:

1. *Basic biological and ecological knowledge.* Beneficial insects have frequently been studied at the community level, with their impacts on pest populations being assessed through comparisons of yield and pest control costs in different management regimes. Consequently, we know little about the ecological requirements, and in some cases even the basic biology, of some of our most common predators and parasites. There is a need for autecological studies which focus on one, or a limited number, of beneficials and which investigate their life cycles, prey, habitat requirements and other basic aspects of their ecology.
2. *Knowledge of distribution and movement in and between cotton, other crops, and natural vegetation.* A greater understanding of variation in the within field distribution of beneficials is required to develop accurate beneficial sampling schemes. The development of novel techniques for quantifying predator movement between and within fields and non-crop vegetation requires greater attention. Correlative studies alone do not provide enough evidence for the movement of beneficials between adjacent and non-adjacent fields within a region.
3. *Understanding the impact of beneficial insects on pest populations.* Abundance of a

beneficial by itself does not necessarily mean that it is having a significant impact on the survival and abundance of a pest. We need to develop techniques for measuring prey consumption, and relating it to the population dynamics of pests. At present we can only assess the impact of a predator through prey consumption studies in the laboratory or in field cages. Both these techniques have significant limitations. Recent developments in the use of egg cards to assess both predation and parasitism may help in field assessments, but also have limitations. Serological methods show promise but require further development. Visual observations are laborious but essential. Combinations of all these methods are required, but these are often beyond the resources of current research projects. The development of novel experimental methods for measuring impact should be a priority. For parasitoids, percentage parasitism methods are widely used but need to be placed in the context of host phenology and abundance.

4. *Further understanding of the effects of pesticides on beneficials.* Laboratory studies of pesticide effects may be experimentally and statistically valid but not biologically meaningful and field applicable. While crude ratings of “hardness” currently exist, better experimental techniques for assessing impacts in the field are required. Current methods are confounded by factors in the environment and methodology, and may fail to account for indirect effects. The lack of standardised assessment protocols makes comparison of results between studies difficult, thus generalised statements regarding the toxicity of a pesticide group to a predatory group are impossible to formulate. An initial and residual toxicity rating is required by farmers to plan strategic pesticide applications. This information would be best presented on the pesticide label.

5. *Improved decision support tools for using beneficial insects.* These include simpler and less time consuming sampling methods that are likely to be widely adopted by consultants. For parasitoids and diseases, diagnostic kits which can measure the incidence of affected larvae in the field are required. We also need more sophisticated means of incorporating beneficial counts into decision making beyond the simple predator:prey ratios now available.

In summary, we believe that extensive research over many years has placed the cotton industry in a position where growers now have sufficient confidence in beneficial insects to allow the widespread adoption of integrated pest management. Conservation of beneficials through the use of selective pesticides is a key element. This alone will reap significant financial benefits for growers, as well as indirect benefits to the wider community through the reduction of pesticide use. However, much remains to be done to achieve the next step: a framework for manipulating agricultural systems in a deliberate and planned fashion, in order to maximise the effectiveness of biological control of cotton pests.