1. What is Integrated Pest Management?

1.1 Introduction

1.1.1 The definition of Integrated Pest Management?

Integrated Pest Management (IPM) involves using all means of managing pest populations with the aim of reducing insecticide use while maintaining profitability, yield and fibre quality. IPM is a whole year approach to managing pests. This includes management of pests through the cotton growing season, and through the remainder of the year as well. For instance, decisions made in the autumn and winter can have a lasting impact on pest management throughout the year.

An operational definition of IPM developed by the Food and Agriculture Organisation is:

- the presence of pests does not automatically require control measures, as damage may not be significant
- when pest control measures are deemed necessary, a system of non-chemical pest methodologies should be considered before a decision is taken to use pesticides
- a suitable pest control strategy should be used in an integrated manner and pesticides should be used appropriately
- intervention with broad spectrum synthetic pesticides is seen as a last resort when pests exceed thresholds and there are no effective selective management options available.

1.1.2 Why do we need to develop IPM programs?

Cotton crops in Australia are attacked by a wide range of pests, the major ones being *Helicoverpa armigera* (cotton bollworm), *Helicoverpa punctigera* (native budworm), *Creontiades dilutus* (green mirid), *Aphis gossypii* (cotton aphid), *Tetranychus urticae* (two-spotted spider mite) and *Bemisia tabaci* B- Biotype (silverleaf whitefly). Control of these pests has largely relied on the use of synthetic insecticides. Over reliance on synthetic insecticides creates problems, such as insecticide resistance (in *H. armigera*, silverleaf whitefly, aphids and mites), disruption of natural pest enemies, secondary pest outbreaks and environmental consequences. These problems have cast doubt over the long term viability of the traditional insecticide dominated approach to pest management.

In Bollgard II® crops, the need to spray *Helicoverpa* spp. is dramatically reduced. However, these reductions have allowed other pests, formally controlled inadvertently by sprays targeting *Helicoverpa* spp., to emerge as pests. This includes mirids, green vegetable bugs, aphids and jassids. Use of insecticides against these pests may disrupt natural enemies, creating outbreaks of mites, whitefly or aphids. Hence, in both conventional (non-transgenic) and Bollgard II® cotton there remains a strong incentive to use IPM to help reduce reliance on insecticides.

Using a beat sheet to monitor pest and beneficial insect numbers.

A major goal for the cotton industry is to reduce dependence on insecticides while remaining sustainable. This can be achieved by developing an IPM program that minimises insecticide use through integration of a range of pro-active management tactics, especially the conservation and use of natural enemies (predators and parasites) to control pests.

1.1.3 How do we implement IPM?

IPM involves integrating a range of tools and strategies for managing pests. These can be conveniently grouped into seven main objectives which these guidelines are based on:

1. Growing a healthy crop
2. Keeping track of insects and damage
3. Beneficial insects - use them don't abuse them
4. Preventing the development of insecticide resistance
5. Managing crop and weed hosts
6. Using trap crops effectively
7. Supporting IPM through communication and training

It is also important to consider what to do and when, so that these objectives can be planned and achieved. To help this process the year can be divided into five phases that are logical decision points through the year. They are:

Off-season (Winter)	Growing season
1. Post Harvest	3. Planting to 1 flower per metre (first flower)
2. Pre-Planting	4. First flower to 1 open boll per metre
	5. 1 open boll per metre to harvest

These guidelines have a section titled '*Putting IPM into practice*' which lists the actions that require consideration at different times throughout the year. The remainder of the guidelines include more detailed information on the seven main objectives as listed above. This describes the scientific background of each action and the management and planning decisions involved.

1.1.4 Other information about IPM

1.1.4.1 IPM groups/area wide management

IPM groups are a very effective way to help with the uptake of IPM.

Within the cotton industry there are many examples where growers have formed local groups, commonly known as IPM groups or Area Wide Management (AWM) groups. These are generally formed by growers and consultants to help an area progress its IPM program. The groups facilitate this by agreeing on common goals, sharing information and experiences and communicating ideas and solutions to challenges. Groups are an efficient way to share information so that IPM strategies can be implemented on an area wide basis. This approach increases the chances that the actions of growers and their neighbours are complimentary when implementing IPM. In contrast, a grower trying to implement IPM surrounded by neighbours that are not, may have less chance of success because of chemical drift and disruption of beneficial insects. For further information on AWM refer to objective 7 '*Supporting IPM through communication and training*'.

1.1.4.2 IPM and earliness

In conventional cotton IPM aims to optimise earliness through appropriate selection of cotton variety, sowing date, irrigation strategy, nitrogen rate, use of plant growth regulators and sensible pest management. The target of earliness is to reduce the period from sowing to harvest. This may reduce the need for late season control of *Helicoverpa* spp. with expensive, broad spectrum insecticides, thereby reducing the selection pressure for insecticide resistance. Managing for earliness does not imply stringent control of early season pests by excessive use of insecticides. Such an approach may compromise insecticide resistance management and

profitability. Instead, IPM involves preserving and using beneficial insects more effectively, allowing for some compensatory capacity of the crop, monitoring crop damage to ensure that it does not exceed economic levels and managing pests as necessary with appropriate IPM tactics. For further information refer to the section '*Optimising earliness*' in objective 1.

H. armigera larva feeding on a small cotton boll. Resistance to insecticides in this pest threatens the viability of cotton production.

1.1.4.3 IPM and the insecticide resistance management strategy (IRMS)

IPM helps to manage resistance by reducing overall use of synthetic insecticides and hence selection pressure on *H. armigera* and other resistant pests. The insecticide resistance management strategy (IRMS) aims to manage resistance in pests to insecticides. This is critical for conserving the effectiveness of the selective insecticides that are important for IPM. Without the IRMS these insecticides risk being overused, possibly leading to ineffectivness due to resistance. The IRMS sets limits on insecticides use. The IPM guidelines indicate when pest control is needed and which type of control may be most appropriate, within the IRMS.

IPM is also important for the long term viability of Bollgard II® transgenic cotton. Conservation of beneficial insects, through IPM, helps to control important pests such as aphids, whiteflies, mites and mirids. This reduces the need to control these pests with insecticides, which selects for resistance. Furthermore, an IPM approach helps to avoid creating situations that increase the risk of losses due to these pests, for instance by avoiding rotation crops that host pests. For more information refer to objective 4 '*Preventing the development of insecticide resistance*'.

1.1.4.4 IPM, sampling and record keeping

Thorough unbiased sampling is essential for reliable decision making in IPM, whether in conventional or Bollgard II® cotton. The ability to review the season by comparing the costs and profitability of strategies taken on different fields is important for making improvements. The decision support tool, EntomoLOGIC, provides objective sampling systems and also includes the *Helicoverpa* development model, the mite yield loss model, the predator to pest ratios and thresholds for all pests. It also provides excellent record keeping, pest and predator identification and reporting features. For crop nutrition, especially nitrogen, the NutriLOGIC decision support tool provides a rational basis for fertiliser decisions, both pre-planting and through the season. HydroLOGIC provides an irrigation scheduling tool and the capacity to ask 'what if?' questions about irrigation decisions. For a free copy of the CottonLOGIC suite of tools, contact the TRC.

Reliable information on pest numbers is critical for IPM. Checking should start early in the cotton season.

For more information on how to monitor a cotton crop for insects and damage, see objective 2 '*Keeping track of insects and damage*' or refer to the '*Integrated Pest Management Booklet*' in the '*Australian Cotton Industry Best Management Practices Manual*'.