Managing Cotton Stubble/Residues

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Returning cotton stubble to the soil provides a source of energy for the microbial organism, which in turn helps the breakdown of stubble. This maintains the supply of nutrients to the crop. Organic matter enhances the health of the soil, as higher organic matter drives better water infiltration and internal drainage.

An experiment was conducted at Narrabri over three seasons (1992–95) to investigate stubble management systems in relation to cotton growth, lint yield and fertiliser N recovery.

The experiment indicated that removing cotton stubble caused a reduction in lint yield and profitability over time. Compared with the lint yield of the stubble-retained treatment, the yield of the stubble-removed treatment was reduced by 3 and 9% respectively, in the second and third years of the experiment.

The experiment also revealed that the N fertiliser recovery was reduced by 10% where the stubble was removed compared to the retained plots, ie more N fertiliser was lost from the soil where stubble was removed.

A number of growers still pull cotton plants after harvest, but the stalks are then mulched using a conventional mulcher. This process allows the stubble to be returned into the soil profile during cultivation operations

BEST PRACTICE

- Where possible; harvest, in crop operations with heavy machinery and all tillage operations should be performed when soil is dry to reduce compaction risk
- Post-harvest crop management includes the destruction of plants and incorporation of crop residues, generally through performing a root cut and mulch operation followed by tillage to incorporate crop residues.
- Pupae destruction must be performed post-harvest by July 31 in Bollgard II crops and should be performed prior to August 30 in conventional cotton. Tillage is required to a depth of 10cm across the whole bed and furrow.
- The removal of cotton volunteers and ratoon plants from all cropping and non-cropping areas reduces carryover of pests and diseases and is a component of the Bollgard II RMP to reduce resistance risk.

Avoiding soil compaction

Cotton pickers are very heavy, with front axle loads as great as 14 t for conventional pickers and about 40t for round module pickers. However, when the soil profile is dry at harvest, their impact on soil structure is less than when the soil is moist, although wide tyres or dual front wheels will compact loose beds.

It must be remembered, that serious soil compaction may have occurred earlier in the season (due to operations such as fertiliser application and weed control), or remain from previous seasons when the soil has had insufficient time to restore its structure. Soils may take years to recover from structural damage and many wetting and drying cycles assist this process.

A big advantage of a dry harvest is that it gives you the widest possible range of options for preparation and improvement of cracking clay soils, provided that heavy rain does not follow soon afterwards. Cultivation, and particularly deep tillage should only be attempted when the soil is either at plastic limit or drier than plastic limit. Clay soils may be cultivated when dry, however non-swelling soils containing higher amounts of loam or sand can be damaged if cultivated when too dry as the soil structure is more easily broken down.Refer to figure 1 for tillage and rotation options after a dry harvest.

Pupae control

Pupae destruction is a mandatory requirement of the Bollgard II Resistance Management Plan (RMP) and a key recommendation for conventional cotton under the Insecticide Resistance Management Strategy (IRMS). Cultivation of the soil after harvest is an effective way of controlling *Helicoverpa* spp. pupae that may carry resistance to the toxins contained in Bollgard II or to conventional insecticides. In Bollgard II cotton, pupae destruction must be completed prior to July 31 and in conventional cotton it is recommended that the operation be completed prior to the end of August. This ensures that pupae are destroyed prior to the following spring and do not emerge as moths that are potentially carrying resistant genes.

Tillage to a depth of at least 10 cm is needed to kill overwintering *Helicoverpa* pupae, if all of the very large clods (more than 50 mm wide) in the topsoil have been broken down and rearranged. However, care should be taken on silty soil where aggressive dry cultivation will create dust and destroy soil structure.

For further information on pupae control refer to the Stewardship chapter.

'Volunteer' and 'ratoon' cotton

Due to the advent of herbicide tolerant cotton cultivars in the past decade, cotton residue management has become an extremely important consideration for cotton producers utilising the technologies.

'Volunteer' or 'ratoon' cotton provide an excellent host (green bridge) for diseases such as Cotton Bunchy Top

(CBT) and pests such as whitefly, aphids, mites and mealy bugs to survive on-farm from one season to the next. Therefore the need to provide a high level of control has never been more pertinent.

The presence of volunteer and ratoon Bollgard II cotton also poses a resistance risk. It is a requirement of the RMP that all Bollgard II volunteers and ratoon plants are removed as soon as possible from all fields and fallow areas including refuge areas. Refer to Chapter 14.

Good farm hygiene practices of removing all volunteers and ratoon plants in and around cropping areas is not only important in removing disease and pest carryover hosts but also in reducing the resistance risk to BGII technologies.

Effective post-harvest management of crop residues reduces the risk of volunteer and ratoon cotton becoming a problem in the following season. There are several factors which will determine the choice of operation to eliminate the current crop residue effectively (see Residue Management Options below) including equipment availability and the moisture status of the soil.

Post harvest crop residue management

It is a requirement of the Bollgard II RMP that Bollgard II cotton crops must be destroyed by cultivation or herbicide as soon as practical after harvest so that they do not continue to act as hosts for *Helicoverpa* spp. As well as this requirement, there are a number of advantages to effective management of crop residues.

Crop residues can carry disease, clog tail drains, and interfere with herbicide incorporation and with planting operations. Incorporation of stubble will improve these issues and may improve the amount and quality of soil organic matter.

Photo 1 (top) – how a field's trash content should look like after only 2 workings (once mulched they were centre busted and then trace listered). Photo 2 (bottom) – large piles of trash left on the field can causes blockages and other management issues.

Methods for crop residue control have changed greatly since the late 1990's when 'pull, rake & burn' was a common option.

The main processes currently promoted in the industry include:

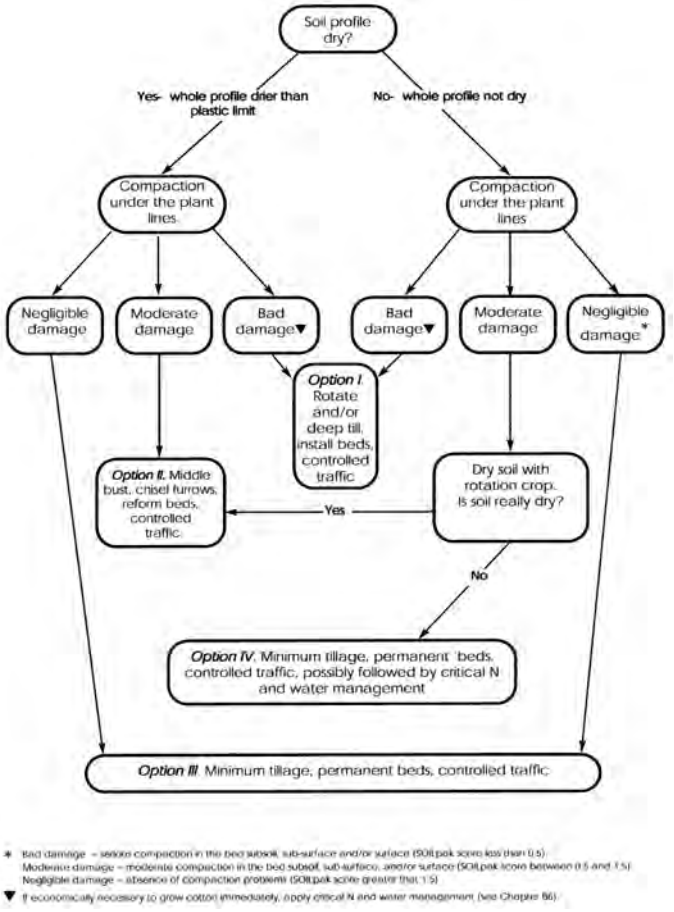
- Mulching of stalk above the ground and cutting the root below cotyledon height (performed in the one operation).
- Incorporating the residues into the surface soil.

Mulching and root cutting

The Australian cotton industry has moved away from the practices of stubble removal and burning, and now promotes the practices of slashing and incorporating stubble. Some of the positives of the mulch and root cut approach are:

- Speedy operation.
- Root and sub section is cut in half reducing cultivation problems.
- System has been widely proven and is available in a variety of configurations.
- Residue is more easily broken down and incorporated than slashing.
- Weather conditions have less of an impact than on rake & burn operations.
- Depending on depth of root cut, some preliminary pupae control is achieved.

FIGURE 1:
Tillage and rotation options after a dry harvest.



- Residues are mulched back into the soil as opposed to being burnt.

Some of the negatives of the mulch and root cut approach are:

- Unless the machine is set up properly 'ratoon' plants can become an issue if roots are not cut below cotyledon level. GPS systems have helped to reduce this.
- With moist conditions trash and soil surface can build up and hamper following fertiliser applications.
- Machines are generally heavy and horsepower intensive.
- There can be more expense with maintaining machinery due to the extra components.
- Generally speaking, the cutting operation requires a much greater speed to achieve maximum efficiency.

Soon after harvest the stalks should be cut finely enough to avoid immediate management problems such as implement blockage. However if the trash is broken down too finely, decomposition and nutrient release may occur too quickly – this can lead to loss of nutrients such as nitrogen.

If the cotton disease Fusarium wilt is known to be present, it may be necessary to at least partially, disinfect the stalks by leaving them exposed to UV light on the soil surface for several weeks – immediate stubble incorporation is likely to aggravate the fusarium problem. Refer to Chapter 16.

It is important that mulchers and slashers are working effectively. With high yielding varieties, good water availability and stable cotton prices, a large percentage of the Australian cotton crop over the last 3 years has been planted on back to back fields rather than fallow. Good cotton stalk management on these back to back fields is important to ensure a suitable seedbed to optimise germination and establishment.

Systems that work very well include mulchers operated at a slower speed with extra flails added (used in photo 1) and the use of rotary hoe machines either before centre/side busting operations or after the fertiliser operations have been completed. This has been shown to further increase the soil tilth and ensure a good seed bed prior to planting.

Standard slashing

This operation focuses on slashing of the crop residue and allowing other operations to take care of the cotton stub and root system below the ground. This practice is no longer common within the industry due to the issues associated with 'ratoon' cotton.

Pull, rake and burn

The pull, rake and burn process is rarely used throughout the industry as a mainstay for crop residue control. This option is only generally used when growers are looking to re-laser fields and due to minimal cuts are seeking to avoid stubble becoming an issue with the laser buckets. Burning of cotton stalks should be avoided as nutrients will be lost and soil carbon levels will decline quickly.

Management of compacted soils

Compaction in clay soils may be remediated by subsequent crops. Cycles of wetting and drying during the growing period and deep drying by the crop after the last irrigation can crack the soil and improve structure to a point where deep tillage may not be necessary. However, residual compaction may remain; and cracking by rotation crops, and/or deep tillage, may be required to improve yields and profits of subsequent crops.

Full land preparation (ploughing the old hills and forming new ones) gives you the opportunity to 'tidy up' a field: removing hollows, straightening crooked rows, adjusting guess row spacing, and controlling weeds.

After examining the soil structure, assess soil moisture to determine to what depth tillage would be beneficial. The soil profile may not be at a uniform moisture content. It may be possible to till the upper, dry part of a compacted layer and leave the deeper, moist soil untouched (and unsmeared).

For more information the following resources and tools are available at https://www.mybmp.com.au/auth_user/grower_tools_and_resources.aspx

- **SOILpak**
- **Cotton Pest Management Guide**

Reasons why ratoon and volunteer cotton must go

- Mealybugs survive from one season to the next on these food sources, infesting crops earlier in the following season.
- Cotton aphids with resistance to neonicotinoids survive between seasons on these plants, reducing insecticide effectiveness.
- Bunchy top disease can be transmitted by cotton aphids from infected ratoons to new cotton crops.
- Silverleaf whitefly survive between seasons on these plants, resulting in earlier infestation in the following season.
- They provide a winter host for pale cotton stainers and solenopsis mealybugs.
- Inoculum of soil-borne diseases such as black root rot, Fusarium and Verticillium builds up in ratoons.
- Ratoon plants place extra selection pressure on Bt
- Ratoon cotton can be used as a host by the earliest and latest *Helicoverpa* generations.
- Ratoon plants may only express sub-lethal doses of the Bt proteins, therefore increasing resistance selection pressure.
- Fields with ratoons from Bt cotton are unsuitable for planting refuge crops, as the refuges cannot be effective if contaminated with Bt cotton plants.
- Removing ratoons may be a costly exercise, but it is cheaper than the costs of dealing with the problems resulting from not removing them.
- They are a biosecurity risk. Ratoons harbour pests and are a potential point of establishment for exotic pests.