



Final Report

Off Farm Series | Cotton Research & Development Corporation

Part 1 - Summary Details

CRDC Project Number: **CRDC268**

Project Title: Value of Research Investment Relating to the
Waste Classification of Cotton Gin Trash

Project Commencement Date: **Project Completion Date:** July 2005

CRDC Program: Off-Farm

Part 2 – Contact Details

Administrator: Hassall & Associates
Organisation: Hassall & Associates
Postal Address: PO Box 1052, Dubbo NSW 2830
Ph: 02 6884 6250 **Fax:** 02 6884 6249 **E-mail:**

Principal Researcher: Ingrid Christiansen
Organisation: Hassall & Associates
Postal Address: PO Box 1052, Dubbo NSW 2830
Ph: 02 6884 6250 **Fax:** 02 6884 6249 **E-mail:** ichristiansen@hassall.com.au

Supervisor: (Name & position of senior scientist overseeing the project).
Organisation:

Postal Address:

Ph: **Fax:** **E-mail:**

Signature of Research Provider Representative: _____

Part 3 – Final Report Guide (due 31 October 2008)

Background

Cotton Production in NSW

Cotton in Australia is primarily produced in New South Wales and Queensland, where it is grown as an annual summer crop. In NSW, cotton is grown in the north-west, central west, western NSW and the western Riverina. The bulk of the crop is irrigated and additional areas of dryland production occur when seasons and prices are favourable. Drought over the past four years has seen a reduction in the area of cotton production. The 2000-01 season resulted in 355,600 hectares cropped to cotton in NSW with a total production of 2.5 million bales (Table 1). As this was the last season with close to full production, the 2000-01 figures have been used in all calculations in this report.

Table 1 New South Wales Cotton Production 2000-01

Region	Area (ha)	Production (bales)
Macintyre*	66,933	470,785
Gwydir	105,600	734,800
Upper Namoi	24,833	143,550
Lower Namoi	65,700	438,116
Macquarie	57,000	400,878
Bourke	14,900	114,000
Tandou	6,560	49,600
Southern NSW	15,157	116,709
TOTAL	355,600	2,468,438

* Includes some Queensland production

Prior to harvest the crop is defoliated so that the cotton bolls can be more readily machine harvested. The harvested crop is packed into modules for transport to regional cotton gins.

Cotton gins separate the cotton lint from the seed and any waste matter. This waste, known as 'gin trash', includes leaves, bark, bracts, stems and soil.

The 26 cotton gins in NSW are located close to areas of cotton crop production as follows:

Border Rivers¹

- Boomi – Koramba
- Mungindi – Namoi Cotton
- Mungindi – Twynam

¹ Notes that Border Rivers region is also serviced by gins in Queensland

Gwydir Valley

- Ashley – Namoi Cotton
- Ashley – Auscott
- Moree – Dunavant Enterprises
- Moree – Brighann Ginning
- Moree – North West Ginning
- Moomin – Namoi Cotton
- Wathagar – Namoi Cotton
- Collymongle – Twynam

Namoi Valley

- Narrabri – Auscott
- Myall Vale – Namoi Cotton
- Merah North – Namoi Cotton
- Yarraman- Queensland Cotton
- Carroll – Carroll Cotton
- Boggabri – Namoi Cotton
- Carinda – Namoi Cotton

Bourke

- Darling River Cotton
- North Bourke Ginning

Menindee

- Tandou

Macquarie Valley

- Warren – Auscott
- Warren – Twynam
- Trangie – Namoi Cotton

Southern

- Hillston – Namoi/Twynam

Waste Classification of Cotton Gin Trash

The NSW Environment Protection Agency (EPA) raised concerns about the potential for residues of pesticides used during crop production to persist in the gin trash and suggested that gin trash be classified as a hazardous waste. Such a classification would impact on the disposal and reuse strategies of gin trash.

Cotton ginners were very concerned about both the cost and practicality of a hazardous waste classification. The handling, storage, transport and disposal of this industry by-product would likely have added considerable cost to cotton ginning processes. In response to this concern raised by the Australian Cotton Ginners Association, CRDC invested \$120,000 (which included \$10,000 towards a researcher's salary and \$10,000 in-kind contribution from CRDC) to commission The University of Sydney to undertake a detailed study of the presence, degradation and risk of pesticides in cotton gin trash.

Over a 2 year research period, trash produced during the 2002 season at three cotton gins was studied. In total, 14 pesticide residues were detected and their degradation measured over two years. The residues were risk characterised and found not to pose a hazardous risk due to strong organic binding of the chemicals resulting in high unavailability. It was concluded that the solid waste classification, as defined by the EPA, was an appropriate classification for the trash.

The report by Crossan and Kennedy-'Waste Classification of Cotton Gin Trash'-was published in 2004 and provided to the EPA. Based on the information gained from this research, the EPA has indicated that gin trash will be classified as a solid waste. Whilst the industry as a whole is yet awaiting confirmation of this, we understand that one gin at least has received a letter stating that gin trash will now be classified as solid waste. To ascertain the value of this research investment, CRDC have requested that the benefit of the solid waste classification of gin) trash for the NSW cotton industry be determined. This report is focused on the NSW industry as the applicable regulatory requirements are administered and enforced on a state-by-state basis.

Methods

The Cost Benefit Analysis Framework

The aim of a benefit cost analysis is to determine the economic benefit of the change in the waste classification of cotton gin trash.

This benefit cost assessment focuses on two levels. Firstly, the impact on cotton ginners in NSW, and secondly the benefit to the broader cotton industry in NSW.

The framework, within which economic costs and benefits are identified, quantified and compared, is referred to as benefit cost analysis.

Benefit cost analysis is accepted by public sector agencies, and funding institutions as a tool to assist decision-making for investments and in policy development. An economic appraisal requires the identification of a set of options or outcomes that may be undertaken. The analysis clearly identifies the additional (marginal) costs and benefits that would arise from implementing each option over a base case.

Since both costs and benefits occur over a period of many years, and can differ between years, they are converted to a 'present value' (W) so that they can be compared on an equivalent basis. The conversion to a PV is undertaken by applying an annual discount rate (r). Mathematically, the use of a discount rate to convert future amounts to a PV is the reverse of applying an interest rate to an amount today to find its future value.

Two measures are commonly used in the benefit cost analyses to assess and compare the economic merits of each option. These are the Net Present Value and the Benefit Cost Ratio.

Net Present Value The Net Present Value (NPV) is measured as the net difference between the current day value of benefits and the current day value of costs. Where the NPV is greater than 0, the benefits are greater than the costs of the option and therefore adopting that option yields an increase in economic benefit.

Benefit Cost Ratio The Benefit Cost Ratio (BCR) is the ratio of the PV of benefits to the PV of costs. For a BCR of greater than 1, the benefits are greater than the costs over time and the research is deemed worthwhile.

For this analysis, the economic appraisal was undertaken over a baseline period of 20 years, using a discount rate of 7 percent.

Sensitivity testing was carried out on the greatest variable cost (number of batches required for chemical analysis), to determine the impacts that changes in this variable may have on the analysis outcome.

The analysis focused on the potential **cost savings** to industry. It did not expand into the social and environmental impacts of the classification, as there is insufficient information available to compare the different impacts under each option accurately.

Identification of Options

Two scenarios have been identified for the purposes of the analysis. These are specified as:

- 1) Hazardous Waste Classification of cotton gin trash; and
- 2) Solid Waste Classification of cotton gin trash.

Both scenarios consider the management of gin trash as a waste as defined by the Protection of the Environment Operations Act 1997, with the ginning process regulated as a premises based activity under Schedule 1 of the Act.

In order to assess the economic benefit, it is essential to determine the disposal mechanisms that may be utilised under each of these waste classification levels. A number of options exist as follows:

Scenario 1: Hazardous Waste Classification of cotton gin trash

Option a. - Disposal of Waste (base case): for this option it is assumed that the gin trash is classified as hazardous and disposed of at a hazardous waste landfill.

Option b. - Treatment of waste: for this option it is also assumed that the gin trash is classified as a hazardous waste and it is treated through a composting process over a 7 year period and then classified as a solid waste for usual disposal.

Scenario 2 - Solid Waste Classification of cotton gin trash

Option a: Disposal of Waste: Under this option, with gin trash classified as a solid waste, it is assumed that the existing practices (stockpiling, composting and field application) will continue.

Option b: Use of gin trash as a by-product: gin trash may be regarded not as a waste but as a by-product that may be value added for alternative uses such as composting or energy generation. These uses are being investigated by industry and some commercial partners but are not currently widely used.

Data Collection

TO gather data for the benefit cost analysis, Hassall & Associates:

- 1) Interviewed 3 gin managers, an agronomist, researchers who conducted the study and EPA representatives;
- 2) Distributed a survey through the Australian Cotton Ginners Association;
- 3) Contacted a number of commercial waste contractors;
- 4) Identified the cost points for gin trash management under each scenario; and
- 5) Estimated the costs associated with gin trash disposal under the two scenarios.

Results

General Overview of EPA Waste Classifications

Waste management in NSW is controlled by regulations that are administered by the NSW Department of Environment and Conservation through the EPA.

The Protection of the Environment Operations Act 1997 (Environmental Guidelines: Assessment, Classification and Management of Liquid and Non-Liquid Wastes) covers the licensing, classification, regulation, and management practices for waste in NSW. Contaminant threshold values are contained in tables A3 and A4 of the Environmental Guidelines, with addenda to both tables published in 2004.

Of particular interest to the cotton industry are the addenda to the 2004 tables including chlorpyrifos, endosulfan and a group of 42 chemicals termed 'moderately harmful pesticides' for which a combined total concentration is used.

Scheduled Chemicals

Tables A3 and A4 of these guidelines refer to Scheduled Chemicals as defined by the Scheduled Chemical Wastes Chemical Control Order 2004, as a part of the Environmentally Hazardous Chemicals Act 1985. The Order regulates activities pertaining to liquid and solid wastes that contain any of the chemicals listed in Schedule A of the Order. A waste is classified as a scheduled chemical waste if the total combined concentration of the chemicals as listed in Schedule A exceeds 1 mg/kg. Of relevance to the cotton industry and taking into account the findings of Crossan and Kennedy (2004), Schedule A includes DDT and its breakdown products.

Waste Classification

Wastes can be classified as inert, solid, industrial or hazardous from minimum to highest contamination levels. Classification depends on the highest level of chemical contamination as determined through either an analysis of the total concentration or a combined assessment of the leachable and total concentrations.

The level of management controls pertaining to each waste classification increases from inert, with minimal restrictions, through to hazardous, which has severe restrictions on management and disposal.

Changes Under the Protection of the Environment Operations (Waste) regulation 2005

The NSW Department of Environment and Conservation is currently seeking community feedback on new provisions made under the revised Protection of the Environment Operations (Waste) Regulation 2005, due to commence in March 2006. This regulation will replace the Protection of the Environment Operations (Waste) Regulation **1996** under the Protection of the Environment Operations Act **1997**, which is still effective in the interim.

The new regulation aims to simplify and clarify the current regulation. Major changes include a new electronic tracking system, changes to the waste levy contributions, waste storage specifications and transport requirements.

It is anticipated that further changes to waste regulation will soon be proposed in relation to licensing thresholds, the waste classification system and the reuse of waste as fertiliser.

Hazardous waste

The hazardous waste classification is the most stringent classification and refers to any material that does not meet the threshold values for industrial waste. With special reference only to the chemicals found by Crossan and Kennedy (2004), cotton gin trash would require the following contamination levels (based on the specific contaminant concentrations without a toxicity characteristics leaching procedure test) in order to be classified as a hazardous waste:

- Greater than 16 mg/kg of chlorpyrifos;
- Greater than 240 mg/kg of endosulfan;
- A combined concentration greater than 50 mg/kg of 'scheduled chemicals' which includes DDT and its breakdown products DDE and DDD; and
- A combined concentration greater than 1000 mg/kg of 'moderately harmful chemicals' which includes bifenthrin, cyfluthrin, cyhalothrin, cypermethrin, deltamethrin, dimethoate, ethion, indoxacarb, parathion methyl, profenofos, propargite and thiodicarb.

Industrial Waste

The industrial waste classification falls between the hazardous and solid classifications. The specific contaminant concentrations without a toxicity characteristics leaching procedure test are:

- Less than 16 mg/kg of chlorpyrifos;
- Less than 240 mg/kg of endosulfan;
- A combined concentration less than 50 mg/kg of 'scheduled chemicals' which includes DDT and its breakdown products DDE and DDD; and
- A combined concentration less than 1000 mg/kg of moderately harmful chemicals' hich includes bifenthrin, cyfluthrin, cyhalothrin, cypermethrin, deltamethrin, dimethoate, ethion, indoxacarb, parathion methyl, profenofos, propargite and thiodicarb.

Solid Waste

The solid waste classification allows a wider choice of disposal options and several of the management regulations required for hazardous waste are no longer applicable at these lower contamination levels.

The above threshold concentrations (based on the specific contaminant concentrations without a toxicity characteristics leaching procedure test) are reduced to:

- Less than **4 mg/kg** of chlorpyrifos;
- Less than **60 mg/kg** of endosulfan;
- A combined concentration less than **50 mg/kg** of 'scheduled chemicals' which includes DDT and its breakdown products DDE and DDD; and
- A combined concentration less than **250 mg/kg** of 'moderately harmful chemicals' which includes bifenthrin, cyfluthrin, cyhalothrin, cypermethrin, deltamethrin, dimethoate, ethion, indoxacarb, parathion methyl, profenofos, propargite and thiodicarb.

Scheduled Chemical Waste

Any material containing more than a total 2 mg/kg of scheduled chemicals, of which DDT, DDE and DDD are included, is classified as a scheduled chemical waste. Any material classified as a scheduled chemical waste is subject to the *Scheduled Chemical Wastes Chemical Control Order 2004*.

Table 2 Summary of Threshold Concentrations for Waste Classification

Contaminant	Inert Waste SCC ¹ (mg/kg)	Solid Waste SCC ¹ (mg/kg)	Industrial Waste SCC ¹ (mg/kg)	Hazardous Waste SCC ¹ (mg/kg)	Concentrations found by Crossan and Kennedy (2004) ²
Chlorpyrifos	<0.4	<4	<16	>16	0.58 ³
Endosulfan	<6	<60	<240	>240	0.12 ⁴
Scheduled chemicals	<1	<50	<50	>50	0.03
Moderately harmful chemicals	Not detectable	<250	<1000	>1000	4.61 ⁵

¹ SCC is the specific contaminant concentration (total concentration threshold level)

² Average concentrations across the three gins

³ Summed average for chlorpyrifos and chlorpyrifos methyl

⁴ Summed average for endosulfan sulfate and beta -endosulfan

⁵ Summed average for bifenthrin, cyfluthrin, cyhalothrin, cypermethrin, deltamethrin, dimethoate, ethion, indoxacarb, parathion methyl, profenofos, propargite and thiodicarb.

EPA Requirements for Disposal and Management of Wastes

Hazardous Waste

Hazardous Waste Disposal Requirements

Scheduled Chemical Wastes Chemical Control Order 2004 and the Protection of the Environment Operations Act 1997 provides two options for the disposal of hazardous waste:

1. Disposal at hazardous waste landfill; and
2. Treatment of the waste (e.g. to enable reclassification as a solid waste).

There is no potential to re-use hazardous wastes.

Testing of Waste

In situations where the contamination of the waste can be shown to be fairly consistent, regular testing may not be required. However, it has been indicated that the level of chemical contamination and consistency of contamination of gin trash is highly variable. It is therefore likely that each batch of waste would require testing to ensure waste is treated adequately.

Record Keeping and Waste Tracking

Records must be maintained for both licensed and non-licensed hazardous waste activities. Records on waste movements are used to verify correct waste management and for the auditable tracking of wastes. Records must be kept by the waste generator, waste storage facility, transporters and waste receiving facilities. Licensed landfills must report monthly to the EPA. This record keeping is in addition to that required for annual reporting and licence renewal.

Waste separation

Separation of hazardous wastes is encouraged to prevent downgrading of other wastes.

Staff Training

Any staff handling scheduled hazardous wastes must be trained in handling scheduled wastes and methods of containing scheduled waste spills, as required under the Scheduled Chemical Wastes Chemical Control Order 2004 and the Protection of the Environment Operations Act 1997. This is the responsibility of the occupier of the premises.

Protective Equipment

All staff must be provided with suitable personal protective equipment. All equipment used to handle hazardous waste must be either washed according to the Environmental Guidelines: Assessment, Classification and Management of Liquid and Non- Liquid Wastes or used specifically just for the handling of hazardous wastes.

In the event of an accidental spillage, an adequate supply of appropriate personal protective equipment and clean up material must be available in a secure area external to the storage area.

Storage and Containment

Storage of scheduled wastes requires a clearly defined area with conspicuous warning notices located on or adjacent to the storage area. Storage must be sited and constructed to prevent discharge of wastes into the external environment, such as on an impermeable pad with all run-off directed into a holding dam where it can be tested and treated both periodically and following any rainfall events that result in runoff.

Where more than one tonne of scheduled waste is kept, it must be in an approved manner or storage facility and within license conditions.

The Scheduled Chemical Wastes Chemical Control Order 2004 and the Protection of the Environment Operations Act 1997 contains further detail on storage requirements.

Reuse

The reuse of hazardous waste in any manner is prohibited under the Scheduled Chemical Wastes Chemical Control Order 2004, the Protection of the Environment Operations Act 1997 and the Fertilisers Act 1985.

Monitoring

Storage facilities used for hazardous wastes must be inspected at least monthly to ensure no spillages have occurred and an inspection log maintained. Additional inspections would also be required following high risk events such as storm events to ensure containment of the waste.

Disposal at hazardous waste landfill

The EPA regulates both the transport of hazardous waste and disposal at hazardous waste landfill.

The transport of hazardous waste is restricted to licensed transporters. Licensed transporters are obligated to take the waste to a suitably licensed hazardous waste disposal site. In addition to standard work cover requirements for provision of safety equipment and training, the transporter must be provided with personal protective equipment specific to the contaminant carried, be trained in handling of the contaminated material, carry adequate materials to clean up any accidental spillage of material and be trained in containing any spillages, and complete additional records and paperwork such as Waste Data Forms.

In order to comply with EPA regulations, hazardous waste must be disposed of at a hazardous waste landfill.

Currently there are no landfill sites in NSW licensed to accept hazardous waste. Currently gins would be required to store trash indefinitely on-site until an approved hazardous waste landfill site is established within NSW. Interim on site storage of a hazardous waste requires stringent containment of the contaminant.

The establishment of a hazardous waste landfill specifically for industry use would require construction of containment infrastructures and acceptance of long-term liability.

On the subject of there currently being no hazardous waste landfill facilities in NSW, a waste contractor advised that:

"No one will ever be able to build a Hazardous waste landfill anywhere in Australia. The last one was Castlereagh Landfill which closed about 8 years ago. The NEPM (National Environment, Protection and Management) have ratified this policy Australia wide."

On this basis, there would be no option to dispose of cotton gin trash at landfill if it was classified as a hazardous waste.

Treatment of waste

Industry Can Develop a Treatment Method

The hazardous waste can be treated to remove contaminants or reduce the concentrations of contaminants to facilitate reclassification of the waste in accordance with the threshold levels for industrial or solid waste as stipulated in the Scheduled Chemical Wastes Chemical Control Order 2004. Once the waste is reclassified as an industrial or solid waste it can then be disposed of at suitably licensed landfill.

Industry would be required to develop a waste treatment method to submit to the EPA who would consider it on a case specific basis.

If the contaminant cannot be satisfactorily treated and the waste therefore cannot be re-classified as inert, solid or industrial, it must then be stored until suitable treatment processes are developed and approved through submission to the EPA. Currently no treatment methods have been developed or approved for the removal of contaminants from cotton gin trash.

Solid Waste

Waste Disposal

Solid waste can be directly disposed of at a suitably licensed landfill, of which several already exist. Transportation of solid waste to landfill does not require specialist or licensed transporters and has no training and equipment provisions necessary beyond that required by Workcover.

Reuse

In addition, solid waste may be reused for purposes such as composting, soil incorporation and spreading over agricultural lands.

Record Keeping

The additional tracking requirements for hazardous wastes are not currently required for solid waste. The basic record keeping for the purposes of annual reporting and licensing are still required.

Waste Separation

Wastes would not need to be separated.

Staff Training

There are no staff training requirements to satisfy EPA regulations.

Table 3 Summary of EPA Requirements for Hazardous and Solid Waste

EPA Requirements	Hazardous Waste	Solid Waste
Licensed transport	Required	Not required
Landfill site	Not currently available	Available
Testing	Potentially for each batch	Reduced
Record keeping	Extensive level	Basic level
Waste separation	Recommended	N/A
Waste tracking	Required	N/A
Staff training	Required	Not required
Protective and specific equipment	Required	Not required
Storage and containment	Regulated, required until disposal method approved of	Not necessary
Reuse options	None permitted	Permitted
Monitoring of storage site	Required	Not required

Gin Trash

50-60 kg Gin Trash /bale Cotton

The output of gin trash from each gin varies depending on throughput, weather during harvest, quality of defoliation, crop condition and a range of other factors.

Gin manage6 estimated that 50-60 kg of gin trash is produced for each bale of cotton ginned. This would mean that processing 100,000 bales of cotton leaves around 5,500 tonnes of gin trash.

High Volume

When freshly produced, it is a high volume product and so requires significant area for storage, transport or disposal.

50ha Storage Area

As gin trash stockpiles can "heat up" significantly, there is a risk of causing combustion fires to break out in the gin trash. Burning of gin trash is not allowable under the conditions of a gin's environmental licence. To minimise the fire risk, gin trash is generally stockpiled in heaps of 1-3 m high. As a result, a large area is required to stockpile gin trash. It is estimated that a large gin requires 50 hectares to stockpile two years' worth of gin trash.

Breakdown and Composting

As it is predominantly organic waste, gin trash breaks down with time. When simply stockpiled and turned occasionally, the trash takes 2-3 years to break down. The breakdown may be sped up by active composting. Turning the gin trash in windrows, keeping it wet and in some cases adding microbes may accelerate the composting process.

Current Practice for Gin Trash Management/Disposal

Variable Management Strategies

The current practices for managing cotton gin trash vary greatly across the industry. Since the practice of burning trash has ceased, many gins are still evolving their suitable management practices. For many cotton gins, trash management and disposal is an area of concern for which they are currently seeking better options. The development of some options has been somewhat stalled by the questions over the waste classification.

The major current methods for disposal / management are:

- Dumped on-site;
- Dumped on-site and ploughed in;
- Landfill on nearby properties where requested;
- Spread on fields;
- Actively composted to spread on fields;
- Collected and composted by a commercial contractor (contractor pays all costs and gins provide trash free); or
- Spread around uncropped land to be later planted to trees.

Land Restrictions

For gins with sufficient space, dumping on site is feasible. However, several gins do not have the available land area to stockpile their seasonal output of trash. At least 5 gins in NSW do not have sufficient space for trash disposal.

Some of these gins currently transport trash up to 25 km to other sites that they own or landfill on nearby properties. This transport has been estimated to cost \$1/bale of ginned cotton. Transport is commonly carried out by contractors. In some cases these contractors have nearby farms on which they spread the trash.

Domestic & Stock Use

Following the "helix incident", gins no longer supply gin trash as an emergency stock feed. Some gins have stopped all movement of gin trash off-site as a result. There remains some concern that the trash still used for stock feed, particularly during drought, with some ginners reporting cut fences surrounding gin trash storage areas, resulting in stock entry.

Some gins allow trash to be collected for use as a mulch and compost in home gardens.

Scoping of Alternative Uses for Gin Trash

A number of gins have trialled or held discussions with potential partners (e.g. Yates) to explore alternative uses and markets for gin trash. These uses include composting for garden mixes, agricultural uses or alternatively combustion for energy generation.

Some cotton gins are intending to actively compost gin trash and incorporate the residues into fields that they own. One gin has purchased windrowing equipment but is not currently composting due to the time and labour costs.

There is some concern about the potential spread of Fusarium Wilt spores and other diseases through the gin trash. For this reason, one farm has constructed a levee bank to contain water run-off in one field where gin trash will be spread.

Disposal of Gin Trash as a Hazardous Waste

Landfill option

Disposal of Hazardous waste not viable

The disposal of hazardous waste at a landfill is not considered to be a viable option as:

- No hazardous waste landfill site currently exists; and
- Construction of a specific hazardous waste landfill site for the industry may not be approved and if one was, construction, maintenance and transport costs would be high.

Based on these considerations, we have assumed that the treatment of waste is a more viable strategy for the industry.

Suggested treatment method

There is no treatment method currently approved by the EPA for hazardous cotton gin trash. For the purposes of this analysis we have proposed a potential method for treatment of gin trash. It should be stressed however that this is a suggested measure only and that further research and development would be required by industry to develop and assess this method and seek EPA approval. We have suggested a treatment method that involves composting the gin trash until the chemical residues degrade in accordance with their half-lives. The concentration of chemicals within the gin trash would eventually reduce to a level below the solid waste threshold levels, and therefore permit disposal of the waste as a solid waste. Further research would be required to determine the time required for the material to compost, its mass to stabilise and the contaminant concentrations to reduce in accordance with chemical half-lives.

Any treatment method for hazardous wastes determined by 1 industry must meet other EPA requirements (as detailed in the Protection of the Environment Operations Act 1997).

Rationale

Organic chemicals are known to break down at rates quantified in terms of a half-life. The half life for each chemical is dependant on a variety of factors including the chemical matrix within which the chemical is held, the stability of the environment the chemical is in, exposure to UV light and interaction with micro-organisms. It should be noted that there is little published scientific literature pertaining to the half-life of organic chemicals within composting materials or the chemical interactions that occur during composting.

It is proposed that the gin trash is composted and stored until such time as the chemical concentrations fall, through breakdown in accordance with half-lives, to below the threshold values for solid waste. Once the gin trash can be classified as solid waste, there are a number of disposal options including disposal at a solid waste) landfill or spreading the compost back on-farm. Solid waste landfills are the most common type of landfill and are readily available throughout cotton growing regions. In comparison, treatment of the waste to comply with industrial waste thresholds would only allow the disposal of the waste at an industrial landfill. Currently, this would mean disposal of the waste at a Kemps Creek site, near Sydney.

Composting

The composting process can be considered as actively or inactively promoted. Active composting refers to the creation of conditions to promote composting such as the addition of water and microbes, and regular turning of the gin trash to create aerobic conditions. Inactive composting is a slower process of natural decay that occurs when the gin trash is simply stockpiled. The proposed treatment method assumes active composting is used.

Concentration Increases as Volume Increases

The composting process reduces the volume of gin trash, thus increasing the concentrations of chemical contaminants in the short term. Based on the increasing concentrations of DDE reported by Crossan and Kennedy (2004), it is assumed that the weight of gin trash is reduced by approximately 90% in the first year. As a result, it is assumed that when the volume of cotton gin trash has stabilised due to the composting process, the concentration of contaminants increases by an approximate factor of 10.

Active composting in the initial year would speed up breakdown of gin trash, potentially reducing the volume. After this, the material would need to be stored to allow contaminant breakdown.

Chlorpyrifos

Chlorpyrifos is considered the most likely contaminant to cause the gin trash to be classified as hazardous, on an industry wide level. This is based on the negligible concentrations of other chemical contaminants and the limited regional distribution of DDD.

The half-life of chlorpyrifos is reported to range between 2 weeks and over a year. Available scientific literature indicates that the half-life of chlorpyrifos is likely to be about 1 year. The maximum concentration of chlorpyrifos found by Crossan and Kennedy (2004) was just

under 4 mg/kg. In order to classify the waste as hazardous, the gin trash would need a 4 times greater concentration of chlorpyrifos (i.e. 16 mg/kg).

For this analysis it is assumed that 7 years is required to reduce the concentration of chlorpyrifos to allow reclassification as solid waste. This is based on an initial concentration of 17 mg/kg of chlorpyrifos which increases to 170 mg/kg following stabilisation of the compost volume, a half-life of 1 year and includes a composting period of 1 year.

Endosulfan and Moderately harmful Pesticides

Both endosulfan and the moderately harmful pesticides concentrations have been disregarded in this analysis. The findings of Crossan and Kennedy (2004) show extremely low concentrations of both these contaminants and it is considered highly unlikely that these contaminants would ever cause the waste to be classified as hazardous under the current regulations. Endosulfan concentrations would need to be about 800 times higher than that found and the concentration of moderately harmful pesticides would have to be about 100 times that found.

DDT, DDE and DDD Half-life

DDT breaks down to form DDE and DDD, of which DDE is known to have the longest half-life. These chemicals are only found in the cotton trash within the Namoi Valley and are derived from the historical use of DDT and therefore are only expected in regions that have used DDT in the past.

The maximum concentration of DDE found by Crossan and Kennedy (2004) was 0.5 mg/kg. In order to classify the waste as hazardous the concentration would need to be 100 times greater than this. DDE has been considered in this analysis due to its extended half-life, and therefore represents a worse case scenario.

The half-life of DDE is reported to range from 6 months to over 20 years. Based on available scientific literature pertaining to the half-life of DDE in soils, a probable half-life would be 2 to 4 years. This has been confirmed through consultation with Crossan, who suggests a half-life of 3 years for DDE within cotton gin trash. A hazardous waste classification for the gin trash requires a concentration of greater than 50 mg/kg of scheduled chemicals, which includes the sum total of DDT, DDE and DDD. This concentration would need to reduce to below 50 mg/kg in order to reclassify the waste as solid. However above 2 mg/kg of the sum total of DDT, DDE and DDD, the gin trash would still be classified as a scheduled chemical waste, prohibiting the on-site disposal of waste.

Where DDT, DDE and DDD are present, a longer period of treatment will be required. For example, if the initial concentration was 51mg/kg, this would become 510 mg/kg after the volume of composted cotton gin trash has stabilised in the first year. Based on a half-life of 3 years, 12 years would be required to reduce the concentration to enable the waste to be classified as solid. On this basis, it would take 13 years for the sum total of DDT, DDE and DDD to break down to acceptable levels for solid waste classification.

As these residues were only a concern in a small area, this has not been catered for in the analysis. However, it should be noted that these samples would likely require different treatment methods.

It is considered that at a minimum the compost is sampled and tested in the first and seventh years. Chemical analysis in the first year would enable more accurate forecasting of the chemical contamination concentrations and the length of time required for the treatment of each batch. Analysis would then be required in the seventh year to confirm that contamination within the waste has fallen below the thresholds for solid waste and disposal is permitted.

Scenario Analysis

Scenarios

The costs associated with gin trash disposal under each scenario have been estimated as follows:

1. Hazardous Waste Classification - costs based on the hypothetical treatment method; and
2. Solid Waste Classification - costs based on dumping method (on-site or nearby) used by the majority of gins.

A number of assumptions were essential in estimating these costs; these are detailed in Appendix 1.

CRDC Investment

CRDC indicated that the investment in the research project was \$120,000. This figure has been used as the basis for analysis.

Avoided Costs of \$1.23billion over 20 years

With trash classified as solid waste and dumped in stockpiles, the estimated annual cost for gin trash disposal across the 26 NSW gins is \$3.40 million per year. This estimate is based on information received from cotton ginners and calculations by Hassall & Associates.

If gin trash classification was changed to hazardous waste, the annual costs would rise to **\$64.55** million per year for the whole NSW industry, plus an additional set-up cost of \$8.68 million in year one.

The costs avoided (or benefit) are therefore estimated at \$61.14 million per year, plus avoiding the initial set-up cost of \$8.68 million in the first year.

When considered over a 20 year period, the Net Present Value for this research is estimated at \$1.23 billion, using a discount rate of 7 percent²

This means that the NSW cotton ginning sector is better off by \$1.23 billion over a 20 year period.

Reducing Number of Batches Significantly reduces costs but maintains large benefit

The largest single cost in the treatment of hazardous waste is the chemical analysis of each 'batch' of gin trash. Therefore the NPV varies with the number of batches that need to be

² The benefit has been attributed 100% to the research work, as this seems to have played the critical role in achieving the solid waste classification. It was not possible to define more precisely the relative Importance of the research, as the EPA staff Involved could not be contacted. It is recognised that other work may have contributed to the outcome. A proportion of the 'success' could be assigned to t& research work (say 40%) and the NW for the industry would still be large.

tested. Drawing from the input of ginner, we have assumed 1000 batches per gin per season, which clearly has significant impact on the calculations.

If the number of 'batches' tested may be reduced to 10 through negotiation with EPA, then the cost will be substantially reduced to yield an NPV of \$79.02 million.

Initial Waste Analysis

In the first year of wmposting, limiting sampling to one sample per batch will provide an adequate indication of the chemical concentrations within the batch.

No significant numbers of initial waste analysis results prompt further testing either through uncharacteristic concentrations or unexpected contaminants.

Final Waste Analysis

Each batch of waste requires 10 composite samples to be analysed in the seventh year. Sampling ten composite samples each consisting of ten samples is adequate.

Runoff Analysis

There are 8 rainfall events each year resulting in required analysis of collected runoff. Additionally, it is assumed that the EPA approves a minimal testing regime for runoff of only one sample required due to the low leachability of contaminants as found by Crossan and Kennedy (2004).

Opportunity Cost of Land

The cost of foregoing cotton production is at a gross margin of \$870/ha based on the NSW DPI GM budget for the Northern Region in 2004-05.

Land Purchase

The purchase of additional land is not required.

Assumptions under Scenario 2 (Solid Waste)

No Regular Analysis

Each batch of waste does not require regular testing to confirm chemical contaminants are under solid waste threshold levels.

Random Analysis

Random testing of five batches per year to confirm chemical contamination levels are below the solid waste thresholds is adequate.

Solid Waste Landfill Location

All gins have access to a landfill site within 25 km of the site.

Chemical Concentration

The concentrations of chemical contaminants mirror that found by Crossan and Kennedy (2004) and fall below the solid waste thresholds and scheduled chemical waste thresholds.

Part 4 – Final Report Executive Summary

Cotton gin trash comprises of leaf matter, bark, soils and other matter that has been collected during cotton harvest and is removed from the cotton lint during the ginning process.

The NSW Environment Protection Agency (EPA) raised concerns about the pesticide residues that may be contained in gin trash and has suggested that it may be classified as a hazardous waste.

Cotton ginners were highly concerned about the potential costs and practical implications of such a classification of this high volume waste. In response, the Cotton Research and Development Corporation commissioned a research project, costed at \$120,000, to assess the pesticide levels in gin trash. The research found that pesticide residue levels were generally below that of the hazardous waste thresholds. As a result of this and negotiation by industry, gin trash is now expected to be classified as a solid waste.

This analysis was commissioned in order to compare the benefits and costs to industry of the change in classification of cotton gin trash. In order to undertake an economic assessment of this research, it was necessary to first develop a credible potential treatment method for gin trash as a hazardous waste. If the reclassification had been approved by the EPA, development and implementation of a treatment method would have been the responsibility of the cotton industry.

A Net Present Value of \$1,232 million is estimated for the economic assessment. The calculated benefit is large and demonstrates the high value of the research to industry. The research was considered to have played the critical role in obtaining the solid waste classification of cotton gin trash. The majority of the benefit can be attributed to the avoidance of costs to industry, in particular the much higher trash sample testing costs under the hazardous waste classification.