Feasibility Analysis: Reprocessing Polyethylene Plastic Agricultural Waste Products

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The Bundaberg City Council recently commissioned a feasibility study to identify alternative disposal options to landfill for agricultural plastic waste products. The study was conducted by Central Queensland University over a twelve-month period and comprised a review of existing literature, collection of information from industry and stakeholders, and the preparation of projected financial statements. Several disposal options were identified.

These options were assessed against the needs and objectives of stakeholders to identify the best viable option for the Bundaberg region. This paper provides an overview of the existing problem and a review of the literature that formed the basis of the option identification process. Furthermore, the information obtained from the literature provided direction for the development of survey questionnaires and interviews of stakeholders.

Agricultural plastic mulch is used in conjunction with trickle irrigation tubing to improve crop production and increase yields. The benefits realised through the use of polyethylene plastic products in agricultural practices has resulted in a dramatic increase in their usage since plastic mulch was first used in the 1950's (Granberry n.d.). In crop production plastic mulch is laid on raised soil beds in direct contact with the surface to increase heat and moisture retention. Drip irrigation is generally used with the plastic mulch, as the latter tends to restrict water absorption from above the ground.

Approximately 60100 tonnes of polymer was sold in Australia for use in agricultural plastic applications in 1999 (Plastics and Chemical Industries Association 1999). This represented a 70 percent growth in polymer use for the industry over the six-year period 1994 to 1999 inclusive.

The Shires of the City of Bundaberg, Isis, Burnett and Kolan had a gross value of agricultural production for the year ending March 1998 of $225 million (Queensland Office of the Government Statistician 2000). The estimated area of land under cultivation for horticultural crops using plasticulture was 4794 hectares. Of this area, 2096 hectares was under plastic mulch and 2698 hectares was under drip irrigation[1] (Lovatt 1996).

[1] Based on figures provided by Lovatt (1996) and adjusted for usage growth. Refer to Table 2.

Approximately 590 tonnes of plastic mulch[2] and 270 tonnes of drip irrigation piping[3] are used in the City of Bundaberg and surrounding Shires of Isis, Burnett and Kolan annually. The increased yield and productivity obtained through the use of plastic products has made plasticulture use an important part of local agricultural practices.

The major brands of plastic mulch used locally are made from Linear Low Density Polyethylene (LLDPE). This resin has a flexible consistency permitting it to be used in applications that require a product that can stretch. The most commonly used plastic mulch products in the local region are Black and Black/White.

The increased use of plastic products has led to disposal problems in agricultural regions. Common methods of disposal include:

1. Disposal to council landfills
2. Incineration on farm
3. Ploughing the product into the soil
4. Burying the product on farm
5. Dumping along river banks

(Smart 1997; Clarke 1995)

External costs of the product to the community occur from clean-up costs along roads and waterways, and through the costs of land filling. Some Councils recoup a proportion of costs by charging tipping fees for product disposed of through landfills. However, this has made the landfill option expensive to growers, as tipping fees are incremental to transport costs. Tipping fees at regional landfills are summarised in Table 1.

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[2] Using figures provided by Lovatt (1996) on land usage and 2.5 rolls of mulch per hectare * 75kg per roll, 50% of mulch used once and 50% used twice 485.16 tonnes were used in 1996.This was then indexed at +5% per annum (average annual change per annum of +6.4% for black and black/white mulch).

[3] Using hectare figures provided by Lovatt (1996) and rolls per hectare based on information from Jason Olsen DPI, 3.125 rolls of trickle tubing covers 1 HA. So, 2698 Hectares * 3.125 rolls = 8431.25 rolls * 32kg = 269800 kgs (270 tonnes).

Table 1: Agricultural Plastic Tipping Fees in the Bundaberg Region

	Bundaberg City Council	Burnett Shire Council	Isis Shire Council	Kolan Shire Council
Small trailer/ute	$ 9.00		No Fee	No Fee
Up to 1 tonne		$11	No Fee	No Fee
Up to 3 tonne	$18.00	$22	No Fee	No Fee
Over 3 tonne	$44	$44	No Fee	No Fee
Semi Trailer	$66		No Fee	No Fee
Special Notes	Charges are proportionate for loads part thereof			No Fee applies to resident ratepayers
Disposal of Plastic Chemical Containers	To Landfill	Free 3 monthly drum muster drop off to tips. Farmer must triple rinse. Product checked and sent for reprocessing.	To Landfill	Farmers triple rinse. Drop off to private firm at cost of 4c/litre. Sent for reprocessing.

In addition to the imposition of tipping fees, the Bowen Shire Council banned the dumping of agricultural plastic waste to council-owned landfills. Growers were required to transport the waste to a disused mine located 80 kilometres from Bowen (Taylor 2000). This resulted in additional time, labour and transport costs for growers. In addition, costs were borne by the mining company as mine staff were required to escort growers to the disposal area.

The *Queensland Environmental Protection Act 1994, Environmental Protection (Waste Management) Policy 2000* was considered in the selection process for the proposed options.

The Act describes the following waste management hierarchy (p8, 2000):

1. Waste avoidance
2. Waste re-use
3. Waste recycling
4. Energy recovery
5. Waste disposal

Waste avoidance supports the use of substitute products or minimising the use of current products. Several alternative products have been investigated as substitutes for plastic mulch. These products are limited by their high cost and low performance value in contrast to polyethylene alternatives.

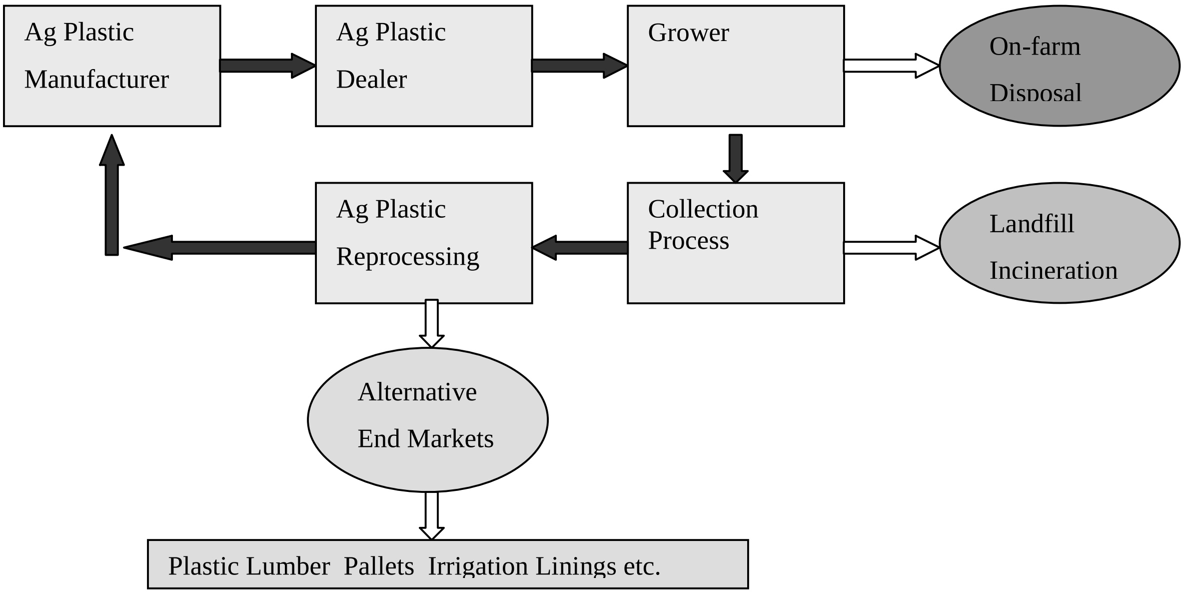
Many growers are currently reusing plastic mulch and trickle irrigation tubing. The mulch has a maximum use limit of two to three applications, whereas tubing can be used up to ten times, depending on handling and preservation practices. Waste recycling and energy recovery are not currently being utilised in the disposal of agricultural plastic products in the region and large quantities of mulch and tubing are disposed to landfills or on-farm.

During recent years recycling of other plastic products has steadily increased. This increase has followed improvements in technology and the development of end-markets for recycled products. During 1997 approximately 9% of high-density polyethylene (HDPE), low-density polyethylene (LDPE) and LLDPE resin used in Australia was reprocessed (Plastics & Chemical Industries 1999; Strategic Industry & Analysis 1999). However, many processors have avoided the recycling of agricultural waste products.

There are several problems that are specific to agricultural film reprocessing. These include difficulties in keeping the film clean on farm, damage caused by ultraviolet exposure, collection problems due to the geographical spread of farms, sorting problems and resin identification (Clarke 1995).

The agricultural plastic recycling loop is displayed in Exhibit 1. The loop is complete when the product is recycled back to its original form. That is, agricultural mulch film would be recycled back into a mulch film product. However, due to the problems outlined above, recycling waste agricultural plastic has not been considered a feasible option. Therefore, the product may be diverted from the loop at three main points.

Exhibit 1 Agricultural Plastic Recycling Loop

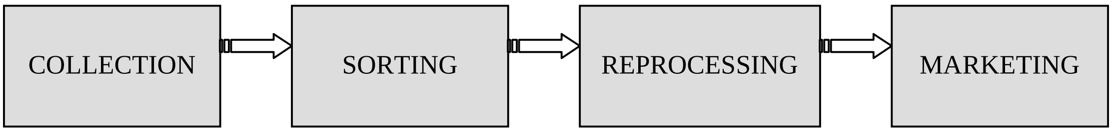


(Source: Cornell Co-operative Extension Service 1996, p4)

Exhibit 1 illustrates the critical stage of the loop where the grower determines the fate of the product. The grower may either dispose of the product on farm through burial, incineration or stockpiling, or can allow the product to continue on to the collection process where three more options become available. The first of these options is disposal to a landfill or incineration with or without energy recovery. The second option reprocesses the product into a different form (secondary recycling). Secondary recycling is the most common form of recycling and along with primary recycling (recycling back to the original product), successfully displaces the use of virgin materials (Curlee 1996). If primary recycling is undertaken the product remains within the original loop.

~~means~~Recycling ideally results in a reduction in the consumption of scarce resources used in energy generation and savings in emissions caused as a direct result of the extraction of those resources. The United States Environmental Protection Agency (1998, p66) declared, “Recycling has lower greenhouse gas emissions than all other waste management options except for source reduction”. Results for LDPE alone showed that recycling of this product had lower net greenhouse gas emissions than producing products from virgin materials.

Exhibit 2 Agricultural Plastics Recycling Process



Source: Clarke 1995

The basic components of an agricultural film recycling system are displayed in Exhibit 2. The collection stage is critical to obtaining the product for further reprocessing. There are two preferred methods for collecting agricultural waste plastics. Firstly, an on-farm collection process can be implemented. This process requires the waste management company or recycling facility to travel to targeted farms for product collection. The second method is a drop-off system that requires the grower to transport the waste product to the facility. The product should be inspected for contaminants before acceptance under both methods.

The sorting stage removes any product unsuitable for processing that may have inadvertently been accepted during the collection stage. Material must be examined to determine the level of contamination from dirt, sand, stones, grease, vegetation, water, other plastics, glue, tape and ultraviolet light degradation. The product may also be sorted into specific plastic types. A multi-purpose facility may also sort the product according to its quality or grade as determined by its contamination levels. Grading allows product to be diverted for several processing options including primary or secondary recycling, or incineration for energy recovery.

The reprocessing stage converts the original waste product into a new product. As discussed above, primary recycling processes successfully convert the original product back into the same form but are dependent on materials with minimal levels of contamination. Due to the high levels of contamination on the agricultural waste products and the potential reduction in resin quality, secondary recycling is more suitable.

The final stage is the marketing of the product. For many recyclers a major constraint to viability is a lack of confidence in the end product. Some processors prefer to buy virgin resin because of its higher quality than the recycled resin. However, virgin resin may be mixed proportionately to improve the quality of the recycled product. Many products are now made successfully with recycled and recycled/virgin resins. Successful marketing of the product has occurred through promoting the green image of recycling to consumers and the savings in costs associated with the extraction and consumption of raw materials.

Agricultural plastic waste reprocessing programs operating overseas have shown some success. This has been due to commitments from all stakeholders, subsidisation from government authorities and careful coordination of program activities.

In overseas operations[4], the transportation of the product is now generally the responsibility of the individual grower with most facilities having a drop-off area for the plastic waste. Thus the additional cost is borne by the farmer in their day-to-day operations. Again, the geographic spread of farms can place many farmers at a significant distance from the recycling facility imposing fuel costs as well as time and labour costs for the transportation of the product. As the viability of farming requires the minimisation of operating costs many growers continue to use the disposal methods traditionally used – on-farm burial, ploughing in, incineration or dumping. Therefore, it is essential that growers accept waste management as a cost to be internalised in their operations.

The project review identified several possible options for handling the waste products. The options are presented in accordance with the waste management hierarchy preferred by the Queensland Environmental Protection Agency. All options except Option 5 require inspection of the product prior to acceptance to ensure quality control is maintained.

Each option differs on the level of processing to be completed at the facility and the level of capital investment, operating costs and sale price receivable. However, all options can reduce the impact of the problems currently caused by the products going to landfill and being disposed of through methods that degrade the region's land and water quality.

The options considered for the study included:

1. Recycling to an end product
2. Reprocessing to an intermediate product
3. Collection, cleaning and compaction of the collected product
4. Collection and compaction only
5. Collection for energy recovery

In order to assess the viability of the proposed options, a survey of key stakeholders was undertaken. Questionnaires were forwarded to growers located in the Bundaberg, Burnett, Kolan and Isis shires, and large retailers and Councils located on the east coast between the Burdekin and Brisbane inclusive. The extended area was selected for Councils and retailers to determine the availability of product from other regions and potential Council cooperation from those areas. Respondents were asked to provide details on usage and disposal, and willingness to undertake activities in a reprocessing program.

Face-to-face interviews were undertaken with existing processors in southeast Queensland to determine industry interest and develop an understanding of general processing requirements. This was followed by financial analysis of the options using net present value calculations.

Option 2 "Reprocessing to an intermediate product" was identified as the most viable option for the region. This option comprises the following:

- Collection areas at various Council waste management facilities
- Annual on-farm collection for large users

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[4] For instance see the Farm Film Recovery Project in the United Kingdom, now operating in Ireland

§ Centrally located reprocessing facility

⇒ Quality inspection area

⇒ Washing equipment

⇒ Extrusion and Pelletisation equipment

⇒ Storage area for saleable product

The viability of the program is dependent on minimum reclamation rates of product sold in the region annually and commitments from all stakeholders. That is, regional growers, environmental protection authorities, local government authorities and reprocessors.

In conclusion, growth in the use of polyethylene products has increased over the past decade. In particular, the agricultural industry in Australia has adopted polyethylene products in agricultural practices, increasing polymer usage in the sector.

While many reprocessors are currently converting waste stretch and shrink films from commercial/retail operations, recycling/reprocessing agricultural waste is an infant industry with increased expenditure necessary to remove contaminants from the waste. The industry is not only constrained by the level of contamination on the product but also requires education of growers and program coordination to be successful. Growers are often dispersed over large geographical areas and additional transport costs are incurred. Collection, storage, handling and transportation are activities that must be undertaken on farm by growers with limited human and economic resources available to ensure commercial viability of reprocessing/recycling alternatives.

The development of a reprocessing program in the Bundaberg area is a potentially viable business enterprise. However, the success of the program would be dependent on the cooperation of all stakeholders including the local government authorities, growers, reprocessors and environmental protection agencies. Ongoing commitments from all parties will help ensure that improvements to agricultural sustainability are realised.

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