Report for the Horticultural Development Council

BIO-DEGRADABLE COVERS AND MULCHES - COMPARISON OF FIELD PERFORMANCE AND ECONOMIC EVALUATION

EARLY PRODUCTION OF LETTUCE, CALABRESE, CARROTS AND OVERWINTER FIELD STORAGE OF CARROTS

Initial Report -

The Scope for Bio-degradable Crop Covers in Vegetable Production

April 2006

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The Scope for Bio-degradable Crop Covers in Vegetable Production

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1.0 SUMMARY

The amount of waste plastic created during vegetable production has significantly increased over the last decade. Quantities used as insect barriers could increase the tonnage further, as the availability of approved insecticide products declines, particularly post-2007, when the approval of those products not listed on Annex 1 of the EU Review will be withdrawn.

ADAS estimates of annual waste plastic generated in 2005 are given in Appendix 1 and summarised in the Table below:

Crop	**Waste Plastic uncontaminated (t/annum)**	**Waste Plastic Generated including contamination with soil etc. (t/annum)**
Brassicas	929	2,322
Carrots and Parsnips	1,772	10,021
Lettuce	201	503
Other vegetable crops	575	1,376
Total	**3,477**	**14,222**

Source: ADAS

Agricultural waste (including plastic covers and mulches) is to be controlled by legislation from May 2006 and in most instances this will require removal from the farm site for recycling or disposal.

The cost of disposing of plastic waste will increase significantly in the coming years and is a topic of both industry and public concern. The wide distribution of vegetable businesses using horticultural plastic and the increasing use of rented land adds to the cost of collection for recycling or disposal to landfill.

After its useful life comes to an end, recycling of "clean" plastic through the BPI Agri facility at Dumfries is currently considered the option least damaging to the environment. In the immediate future organising transport from large scale collection points or hubs direct to Dumfries is likely to be the most cost-effective approach.

There are bale wrap collection schemes developing, with a charge of £263/ha (£105/acre) collected.

Producers are developing ways of reducing polythene usage or extending its useful life as a means of reducing waste. Wider (24m) plastic sheets are commonly re-used for 2 seasons and occasionally 3 or more. Machinery to clean plastic used in field crops is likely to be developed to allow increased re-use.

Degradable materials are only likely to be adopted if technically satisfactory and approximately competitive in price and overall cost, **including disposal**. At present the price of bio-polymers is still fairly high compared with plastic (c. 30% more), though this is mainly due to lower volumes being manufactured. In addition, there are currently technical difficulties manufacturing widths greater than 1.5m.

Conventional plastic products with shorter polymer chains, which degrade more quickly, are also being developed. However, these materials may need approval or an exemption licence from the Environment Agency for disposal in the field. These at present offer more competitive pricing, high strength and ease of use in the field, with the possibility of soil incorporation after use. An example is 'Envirocare', developed by Ciba Geigy, a 25 micron film which can be programmed for a useful life of between 21 days to 300 days, after which it degrades in the soil, taking some 10 months.

A list of UK distributors of biodegradable and other advanced crop covers and mulches is presented in Appendix 2.

Chemical inhibitors and triggers are being incorporated into conventional plastic and bio-polymer membranes to enable successful use as crop covers followed by successful disposal in the field. However, these materials are still at an early stage of development.

There are many plastic crop cover and mulch products and systems employed by the UK vegetable industry. Cost comparisons between standard plastic and fleece materials and newer degradable products are presented, inclusive of materials, labour and disposal (Appendices 3 and 4), based on a number of commonly used materials and systems.

Costs currently associated with standard practice, including disposal to landfill or recycling, are about 30% less than the costs associated with bio polymers, due to the high purchase price and narrow width of bio polymer products. However, overall costs associated with some biodegradable plastics appear to be competitive and offer potential for significant savings in disposal and transport costs, providing this material can be successfully incorporated in to the soil without detrimental side effects.

As the costs of disposal and transport rise, the use of degradable materials will increase provided that they are competitive with established products in overall cost terms and they perform to the technical requirements demanded. At present, the higher purchase price of bio-polymers is in part due to the lower volumes being manufactured. However, growing environmental consciousness and the expense of disposing of traditional plastic may alter the balance in the next few years. Significant price changes can be expected within the next two years.

There is a desire by all stakeholders - manufacturers, distributors and growers - to find cost-effective solutions to reduce or avoid disposal costs and to increase reuse and/or recycling.

2.0 OBJECTIVES

The objectives of this initial report are:

1. To outline the current usage of plastic covers and mulches in outdoor vegetable crops.
2. To investigate the availability and costs of bio-degradable covers and mulches for use on carrots, brassicas and lettuce.
3. To compare the costs currently associated with the use of bio-degradable covers and mulches with those in standard industry practice.

This report is the initial stage of a project designed to demonstrate the field performance and effect on crop growth and yield and the economic impact of the use of degradable covers in the above crops.

2.1 Background

UK vegetable production currently creates over 3,477 tonnes of waste plastic per year from crop covers and mulches used in crop production. When contamination with soil and moisture is taken into account, this increases to 14,222 tonnes/year. The principal crops and associated estimates are at Appendix 1. The waste plastic arises from crop covers and mulches used for a variety of purposes:

- To promote early growth
- For field storage
- To exclude insect pests
- For weed control
- To prevent soil contamination.

Plastic mulches, crop cover, fleeces, tunnel films and covers etc. all come under the heading of non-packaging waste and thus subject to the Agricultural Waste Regulations when the holder discards or intends to discard them. The largest amount of waste plastic in agriculture is generated from silage wrap polythene, estimated to be 25,000 t/year, increasing to 50,000 t/year when contaminated following use.

The Environment Agency is also aware of the waste plastic produced in horticulture, which they estimate to be 5,000 t/year across all sectors, increasing to 22,500 t/year with soil etc. contamination.

The disposal methods that have been utilised by vegetable producers vary, the main criterion, unsurprisingly, appearing to be to minimise cost. In the past, some has been disposed of on-farm by either burying or burning (which will no longer be possible after the introduction of the Agricultural Waste Regulations), though the largest proportion has been sent to landfill. To date only small quantities of plastic has been recycled, due mainly to the costs and the extra handling involved.

2.2 Terminology

There is a wide range of terminology and a myriad of commercial plastic products used in the vegetable industry. The industry often uses 'polythene' to describe these products, but in this report the term 'plastic' is used since this relates to the manufacturing source, oil, and to the waste products generated after use.

Crop covers are usually available as:

- Polythene sheets or plastic film, of widths from 1.8m to 24m and thickness from 25 microns to 200 microns, usually used for advancing crop growth. Most are 'ventilated' with 1cm diameter holes, 200 to 500 holes/m^2.
- Spun-bonded polypropylene fibre known as 'fleece', 'floating plastic films' or 'non woven' plastic sheets, from 1m to 24m width and weights from 17g/m^2 to 50g/m^2, usually used for advancing crop growth, pest exclusion, preventing soil contamination and frost protection.
- 'Nets' or 'mesh' of knitted polyethylene tape, usually in sheets 6 to 20m wide, used for wind protection and pest exclusion, with a life expectancy of more than 5 years.

Crop mulches are normally available as:

- Black plastic sheets 1.5m to 18m in width and 25 to 200 microns thick, usually used for weed control but also for preventing crop regrowth during field storage (e.g. carrot and parsnip).
- White or other colour plastic sheets, 1.5m to 18m wide and 25 to 200 microns thick, used for weed control. They may have added properties to advance crop growth or keep crops free of soil contamination.
- Woven plastic permeable to rainfall, used for weed control and with a life expectancy exceeding 5 years e.g. Phormisol and Mypex. Several widths are available, from 1m to 12m. These are not normally used in outdoor vegetable production.

3.0 REVIEW OF PLASTIC CROP COVER AND MULCH USAGE

3.1 Start-up

Clear plastic film was first used to advance the growth of a range of field vegetables in the mid-1970s. By using this technique, growers in traditionally early areas, such as the Vale of Evesham and the Thames Valley, were able to compete with imports from Southern Europe, especially Italy, France and Spain. The economics associated with plastic film covers were fairly straightforward, and the use to promote earliness was profitable. This encouraged the spread of the technique to the cropping areas of Lincolnshire, East Anglia and Scotland. In the 1990s, competitive pressure from EU countries increased and the area of crops covered to promote earliness remained static or declined. However, other benefits of plastic covers, listed earlier, but particularly for field storage of carrots, exclusion of insect and vertebrate pests and the need for soil-free 'clean' crops have developed pushing up the usage of plastic covers and mulches.

3.2 Initial Research and Findings

A summary of the main technical points arising from research and development, which are now common practice in the industry, is as follows:

- Plastic film with 1cm diameter holes, typically with 200 holes/m^2, is the standard product for drilled crops grown on a 1.8m to 2.2m bed system. This remains a 'use once then dispose' system, with virtually all used plastic ultimately going to landfill. Growers are very aware of the cost of disposal and are actively considering and developing their own machinery to allow re-use or recycling of these materials.

- Wide, 10m up to 24 m, sheets of plastic film with 500 x 1 cm diameter holes/m^2 are usual for widely-spaced transplanted brassica crops. These covers are typically used for 2 seasons and occasionally a third if they are not significantly damaged. Covers are all laid by hand labour and mostly removed by a combination of hand labour and winding machines.

- Use of crop fleece of various thicknesses and widths is increasing, especially on widely-spaced, transplanted lettuce crops. Use has primarily been for early cropping, but they are increasingly employed for pest exclusion, with covers being moved from crop to crop in the same season. There is an increasingly wide range of products available, with a rapidly-growing list of claimed attributes. Quality, weight and durability characteristics of these covers differ and are reflected in the price. Fleeces are usually used for 2 seasons prior to disposal and this is normal practice for lettuce.

- Correct timing of cover removal for all types of plastic film is critical for all vegetable crops. Premature removal results in insufficient yield response, but leaving removal too late leads to retarded crop growth and physiological disorders. This results from a number of factors, including restricted foliage development, with the crop pressing up against the plastic and unable to grow normally.

- Good chemical weed control requires that the soil is moist when residual herbicides are applied. An advantage of wide sheets is that they can be removed for pesticide applications, then replaced.

The technology involved in using crop covers for promoting early growth - the related agronomy, cover application and removal - has changed little in 20 years. Using fleeces for pest exclusion is however relatively new and involves covering crops at or just prior to times of high pest pressure. Industry experience of timing and duration of cover is limited and there are unexpected effects on crop growth, e.g. crop shape and leaf colour.

3.3 Current Use of Plastic Films (including fleece)

An estimate of the current use of plastic covers and mulches in vegetable crops is given below.

Table 3 Estimated Area of Vegetable Crops covered with polythene in England and Wales

Crop	Crop area 1992 (ha)	Area covered 1991 (ha)	Crop area 2005 (ha)	Area Covered 2005 (ha)
Beetroot	2,674	40	1,628	228
Carrot	13,980	2,200	9,833	5,900*
Parsnip	3,061	43	3,060	490*
Turnip and Swede	4,440	62	1,201	1,081**
Onions Salad	1,845	15	2,069	290
Cabbage Spring	3,379	50	2,101	305
Cabbage Summer & Autumn	2,863	200	2,181	327
Cauliflower	17,723	700	9,947	1,492
Calabrese	4,880	600	8,716	1,307
Celery	872	200	825	63
Leeks	2,867	60	1,813	90
Lettuce	6,557	500	5,224	1,097
Others – incl. legumes	12,888	2,850	8,311	1,625
Total	**78,029**	**7,570**	**56,909**	**14,295**

Source: ADAS

** includes crops covered with black polythene for winter storage*
*** includes covers for controlling cabbage root fly in swedes and turnips*

3.4 Use of Covers - Crop Types

Roots – carrots, parsnips

The single most significant area of plastic crop covers used on vegetables is on carrots, where 20% of the UK area is covered with clear plastic or fleece to promote early growth. Typical disposal costs, based on 375 kg/ha of plastic laid, equivalent to 2.5 t/ha at cover removal, amount to some £60/t to transport and dispose of at a landfill site. Because landfill costs are rising, re-use and recycling are being considered, but contamination with soil is a major issue for all mechanised bed systems of production where at least 20% of the polythene is buried in the soil and thus contaminated. Machinery for cleaning recovered polythene is being developed by the larger grower/packer companies, with the aim of recovering plastic for both re-use and recycling.

Flowerhead and Leaf Brassicas – cauliflower, calabrese, cabbage

The normal system is for growers to cover about 15% of the total area being grown to promote growth of early plantings. Wide sheets (up to 18 m, 500 holes/m^2) of plastic or fleece are laid by hand labour. Careful laying and lifting allows more then one crop to be covered in a season and for re-use of the sheets for a second season. Occasionally sheets can be used for a third season, but photo-degradation is often extensive, causing the sheets to disintegrate during windy weather. Use for pest exclusion is currently only in organic systems, although there is interest in using nets or mesh products to exclude pigeons should these materials become cheaper. Some wide sheets are subsequently cut up to make bird scarers, but ultimately these are disposed of in landfill sites.

Salads – lettuce

As with brassicas, wide sheets, usually of fleece, are laid by hand to forward early crops. Some 15% of the lettuce crop is covered. Very early crops can be produced using double covers with polythene laid over fleece; when the spring weather warms up, the polythene is removed, with the fleece cover left until harvest. Some spring crops are covered with lightweight (17g/m^2) fleece to prevent soil contamination due to heavy rain. Covers are used many times over sequential plantings but rarely last more than 2 seasons.

Minor Crops – sweetcorn, beans, courgettes

Plastic mulches for earliness and weed control are used widely on a range of minor crops and it is with these vegetables that both photo- and bio-degradable materials have, to date, been most successful. There are management difficulties in some seasons, where the plastic may not last long enough and blows free in a gale. With photo-degradable films, the part buried in the soil may also work loose. However, in most seasons, growers produce successful crops without adverse environmental concerns from litter produced from partially-degraded material.

Summary

- The area of field vegetables covered or mulched with plastic film has increased from 7,570ha in 1992 to 14,295ha in 2005, a rise of 54%, though recent changes in area have been relatively small.
- 60% of carrots are covered with plastic for either early production or field storage over winter.

- The decline in the number of approved insecticides has already seen development of the use of plastic fleeces, meshes and nets to exclude pests and this is likely to increase significantly.
- The ADAS estimate of waste plastic generated from crop covers and mulches in 2005 is 14,222 t/annum (see Appendix 1), with the majority disposed of in landfill sites.
- There is currently very limited use of bio- or photo-degradable materials, but strong interest in developing these, along with novel machinery to re-use and re-cycle plastic covers and mulches.

4.0 REVIEW OF ALTERNATIVE BIO-DEGRADABLE MATERIALS

4.1 Plastic Degradable Materials

Covers and mulches made of plastic 'degradable' materials have been available since around 1990. They are not all strictly 'bio'-degradable and this term is open to various interpretations, but both photo-degradable and bio-degradable plastic films are used commercially to a limited extent.

The main barriers to wider uptake in the past have been cost and technical issues such as crop contamination, litter and less predictable life span. Photo-degradable and bio-degradable products cost 25 to 30% more to purchase than conventional plastic products. A further constraint in the past has been the inability to match the length of life required of plastic film crop covers and mulches with crop needs and the variability of weather conditions. In field scale use they are subject to varying extremes of temperature and sunlight during both winter and summer, differing moisture levels and both aerobic and anaerobic conditions, which can all cause the materials either to fail before their predicted life expectancy or not to degrade as soon as planned.

Photo-degradable materials require ultra violet light (UV) and heat, and biodegradable films need moisture, to activate degradation, with micro-organism activity in the soil completing the process.

Vegetable growers have investigated these materials, but few have felt sufficiently enthusiastic about the results to adopt them. Past experience has often been that materials haven't degraded sufficiently or haven't lasted long enough to be beneficial. Sweetcorn and other minor vegetables are the only crops where clear photo or bio-degradable film is being used to any extent, for soil warming, early germination and weed control.

New Chemistry

Plastic manufacturers are developing new chemistry that allows plastic to degrade in weeks or months rather than hundreds of years. Chemical and biological agents sprayed onto or incorporated into the plastic are being developed, which either trigger or enhance the degradation process at the required stage.

This should offer growers the opportunity to dispose of used crop covers in the soil, or by composting, thus avoiding transport and landfill costs. However, these new products need to perform in the field as effectively as standard materials and be an economic proposition. They may need approval by the Environment Agency prior to soil incorporation**.**

4.2 Materials manufactured from Renewable Sources

4.2.1 Bio-polymers

Bio-polymers are generated from renewable natural biological sources e.g. sugars, starch, natural fats and oils. Many of these are edible and they are all biodegradable. Bio-polymers are an alternative to petroleum-based polymers i.e. traditional plastics.

For horticultural use, materials are available based on the renewable resource of corn (maize) starch. Under suitable environmental conditions, i.e. in contact with moisture and soil micro-organisms, it is completely degraded into water and carbon dioxide.

The material has a life expectancy varying between 6 to 16 weeks, depending on prevailing weather conditions, which will influence degradation. It is available in clear or black and most usually used as a mulch for advancing growth and/or weed control as an alternative to herbicides or in situations where herbicide cannot be used e.g. courgettes, runner beans and various organic crops. After harvest, the remaining mulch can be ploughed back into the soil, where the bio-degradation process is completed. At present, cost is an obstacle as the purchase price is 30 to 40% more than established plastic materials and the maximum extrusion width is limited to 1.5m.

However, price could be reduced if more was used and the lower/nil disposal costs need to be factored into cost calculations. At present, however, interest is mainly from growers of minor and organic crops.

4.2.2 Biofibres

There are paper materials, made from 100% recycled fibres, available for weed suppression. Currently sales are very limited, being almost exclusively to the organic sector where they are used as an alternative to herbicides. In the past, there was interest by a major UK paper manufacturer in developing horticultural uses for paper mulches, but currently the only interest noted is from a distributor. There are some disadvantages in using this type of material including increased weight, less 'stretch' and the possibility of tearing compared with plastic. The material is biodegradable, but may take 3 months to degrade in variable UK weather conditions following incorporation into the soil - rather too long for some cropping situations.

Alternatives to traditional plastic sheets are being developed using fibres such as jute or sisal, and even more innovative sources, such as used coffee bags. These materials are all biodegradable over a period of time (3-4 years). They are likely to be more suitable for uses such as erosion control, soil stabilisation and long term weed control.

A list of suppliers of bio-degradable plastic and other covers and mulches, with contact details, is at Appendix 2.

5.0 DISPOSAL AND RECYCLING OPTIONS

5.1 Re-use

Re-use is the preferred option, but plastic film should be at least 100 microns thick before it is strong enough for repeat usage in field vegetable production. With most current products being only 30-50 microns thick, single use becomes somewhat inevitable and demand for re-usable films will need to increase to bring about change to product specifications. When polythene is re-used, growers have reported relaying taking longer and requiring more labour than using new materials. In general, it is not possible to re-use mulches or covers where the edges have been previously buried mechanically for anchorage. Where they are buried by hand, then re-use may be possible.

The narrow single bed polythene is almost always laid out with a machine which carries out all the necessary operations in one go – the plastic is rolled out, the edges are pressed into the ground and then covered with soil. This process makes it very difficult to remove the sheets without significant damage. However, there is limited reuse of wide plastic sheets.

Fleece is normally rolled out, with the edges covered up using hand labour. This is much gentler than mechanically laying and allows the edges to be uncovered by hand and the fleece rolled up again. Brassica and lettuce growers in particular re-use fleece, but it is so far rare for it to be re-used for more than season.

There are increasing amounts of insect netting covers being used in vegetable production and these have been successfully reused over a 5-year period. New sources and suppliers to this market are promoting materials with a longer life of up to 7 or 8 years, even though this may not be in their immediate commercial interest.

5.2 Disposal

Prior to the introduction of the Agricultural Waste Regulations, burning or burying on the farm where covers and mulches were used was the preferred option for many vegetable growers on cost grounds. Definitive figures for the amount disposed of in this way are difficult to quantify as the amount varies significantly between crops and type of enterprise. Where crops have been grown on rented land, disposal options are often limited and landfill has been the only practical option. It is thought, for example, that carrot growers have disposed of fewer than 10% of covers used by burning or burying.

Unless farms wish to pursue the option of setting up a licensed disposal site, the remaining disposal options are:

- Landfill - either direct or to skips for collection by a specialist waste contractor
- Recycling
- Novel means

Landfill

In the past, most waste plastic that was not burned or buried ended up at landfill sites. Currently landfill continues to be available in most areas of the country, but increasingly sites are being closed, having reached maximum capacity. The location of landfill sites able to accept plastic waste may be obtained via the Environment Agency website. www.wasterecycling.org.uk

Landfill is a relatively expensive option (and likely to become more so), not just due to site charges, typically £30-60/tonne, depending on operator and part of the country, but also because of the costs of collection and transport. A 20t lorry load is estimated at £600 for transport alone.

The Environment Agency recommends sending plastic to landfill where recycling is not practicable.

Recycling

Recycling is of course to be preferred to disposal from the farm and there is agreement from manufacturers, distributors and growers that this is a highly desirable solution if re-use is not an option. Theoretically, all plastic waste could be recycled, but there are a number of constraints at present, such as:

- Lack of suitable recycling sites throughout the country
- Viability of recycling schemes
- Suitability of waste plastic from the vegetable industry
- Economics and logistic factors

In the UK there are currently few formal recycling schemes which are working, the best known being the Bpi Agri facility at Dumfries. Bpi Agri planned other recycling plants, improving access to facilities for most of the UK, but demand to date has not justified investment. With much of the waste plastic from crop covers and mulches being generated in the East and South of England, transport costs to a plant in the South-West of Scotland are obviously appreciable.

A possible way forward is to organise bulk lorry collection of plastic covers from a few large-scale users (perhaps acting as collection hubs) and deliver straight to the Bpi Agri plant. The industry will also need to keep abreast of any other initiatives being developed not restricted to horticulture, which could initiated by local authorities, waste contractors etc.

Plastic film and mulches, which account for the bulk of the material used, is generally too contaminated with soil at the time of removal from the crop to be recycled without further treatment. For example, in carrot production for every 100 kg of film laid, the recovered weight is 450-500 kg., due to soil and water adhering to or trapped in the film.

Even though recyclers do not make a charge for recycling “clean” plastic, there is the major cost of transport from the holding or collection point to the recycling centre. In reality only a small proportion of plastic crop covers and mulches is actually recycled, this mainly being due to the problems of organising transport, the multiplicity of sites with varying quantities and qualities of material and, in some cases, the high cost of transport.

The sheet plastic which is currently recycled is almost totally silage wrap, much of the used material coming from Ireland, Holland, and Scandinavia where there are both legislation and Government schemes in place. In each of these countries the user pays the costs of recycling, though aid programmes offset some or all of the costs.

Economic drivers are most likely to be the effective means for encouraging recycling. The former Bpi Agri scheme, in conjunction with various farming supply groups, worked well, whilst they were low cost to the farmer. Initially, farmers paid a levy on each roll of silage wrap purchased, which covered the transport cost to the recycling plant. This worked well to start with, but foundered when it was found necessary to introduce additional "gate" charges to sort and clean the plastic because of greater than expected contamination. The rising costs of landfill should however trigger a re-appraisal as to the economics of such schemes.

In Wales and the Peak National Park recycling groups still function, largely because in Wales farmers are supported by Objective 5b funding and in the Peak National Park, the costs are funded by the National Park Authority.

At least one supplier has a desire to implement a scheme whereby growers are offered a rebate for recycling in an acceptable way at the end of the material's useful life, provided of course he show that it was purchased from that supplier.

Novel means

- In suburban areas, some fleece is cut up and 'given away' to gardeners. However, although free, the quality could be variable, which may not be acceptable to the general public, used to consistent quality across virtually every product range on offer. There are also examples of plastic being given away to garden centres to be used as frost protection for flowers and plants awaiting sale.

  Disposal by these avenues will be minimal and only viable where the source of the waste plastic is close to a large conurbation.

- Energy recovery. Incinerators are able to take plastic by arrangement, but loads have to be regulated because the material has to be mixed with other types of waste to enable the incinerator to work efficiently. Soil contamination on the plastic should not be an issue as the incinerator can cope but the charges can be high, plus the cost of transport to the incinerator. In contrast to other countries on the continent, the number of incinerators in the UK is relatively few and their use is seen as contentious. In the short-to medium term at least, their potential as a disposal route is likely to be small, unless close to a site of waste plastic production.

Strategies

Manufacturers are developing and introducing plastic films that have a longer life expectancy and, in addition, film that is thinner but as strong as current materials, in order to reduce the amount for annual disposal.

There are constraints on how thin the material can be. For example, black plastic film for carrot storage of 30 micron thickness has been used instead of the more normal 38 micron, but was ineffective in keeping the light out, leading to early re-growth of the carrots and loss of quality.

Insect netting materials can now be expected to have a life of 7 to 8 years rather than 5. This will reduce the need for disposal for the immediate future as these materials are only now being widely used, particularly for turnips and swedes where there are no pesticide alternatives.

6.0 INDUSTRY FEEDBACK

Current problems and opportunities

- The greatest concern for industry is the ever-increasing cost of purchase and disposal of plastic, which is not seen as sustainable in the long-term.
- Large-scale use of plastic, which is mostly unsuitable for recycling, has a poor environmental image with consumers and multiple retailers.
- Increasingly there is a lack of options for disposal. Introduction of the Agricultural Waste Regulations has closed off on-farm disposal in most cases; landfill sites are becoming full and distant from areas of production.
- A high level of cost is incurred to transport waste plastic off-farm to collection sites or recyclers.
- There is minimal use of degradable materials, even though these have the advantage of break down taking place in the field. A lack of confidence in their performance plus the extra purchase cost have acted as dis-incentives.
- Increasingly vegetable production is on rented land and bio-degradable materials offer a significant opportunity to save costs – potentially avoiding the need for recovery, transport and disposal.

7.0 COST COMPARISON - BIODEGRADABLE v. STANDARD PLASTIC

Introduction

Vegetable producers operate with slim profit margins and adopting new technology has to be cost effective in the short term. Costings of some of the most popular current systems and alternative bio-degradable systems are presented at Appendix 3 and 4. These include the costs of purchase, laying, recovery and disposal options and allow full comparison of the 2 groups to be made.

Carrots – Early Production

Early carrots are produced using plastic on the basis of 'use once then dispose' on bed systems from 1.8m to 2.2m and production is efficiently mechanised. The cost for purchasing, laying, removing and disposing of plastic is estimated at £628 to £770/ha.

Switching to bio-degradable materials made from starch (bio-polymers) is likely to cost significantly more, say £1174 to £1200/ha. This is due to the limited width available, 1.5m, which increases the number of beds/ha and increases the laying costs and the higher material purchase price.

Switching to bio-degradable plastic (made from oil, e.g. Envirocare) is however competitive, costing £732 to £753/ha. This cost includes £20 to £41.15/ha removal cost, as with standard practice (e.g. as would be the case for composting), but this would not be incurred if soil incorporation can be successfully developed.

Carrots – Field Storage

The standard approach for over-wintered field stored carrots is to use black plastic (made from recycled plastic) under the straw insulation, which is recovered and disposed of to landfill after use. The total cost of materials and labour is estimated at £712/ha.

Switching to a black bio-degradable material such as Mater bi (bio polymer) eliminates disposal costs, but the initial purchase price is relatively high and the equivalent total cost is estimated at £1080/ha. However, sales of bio-polymers for carrot storage are currently low and increased sales are likely to reduce the purchase price.

Switching to paper is also more expensive, estimated to be £1995/ha in total, and there is a requirement to adapt machinery to lay paper, which is heavier, with shorter rolls, than plastic.

Lettuce – transplanted for early production

The current industry practice is to use fleece of various thickness and widths. The cost of the current system is estimated to be £347/ha/annum and assumes 2 seasons use, then disposal. There is no bio-degradable fleece available yet. A wide bio-degradable plastic made from oil (e.g. Envirocare) is available in limited quantities, with a single use cost estimated at £759/ha.

Brassicas – Transplanted for early production

Most growers use wide (12 to 18 m) plastic and re-use for a second or more seasons. The cost of the current system is therefore estimated at £466/ha/annum, based on 2 seasons use, then disposal. A wide bio-degradable plastic made from oil e.g. Envirocare is available in limited quantities with a single use cost estimated at £750/ha assuming use for one season only.

8.0 FUTURE OPTIONS

In addition to the moves described earlier to introduce new plastic film products which have a longer life (i.e. to enable more re-use), are thinner yet with good strength characteristics (reducing waste) or have bio-degradable properties (avoiding landfill), some other initiatives to facilitate re-use or more recycling are under way. These include:

- Several machines retrieve, brush clean and rewind polythene sheets. Thus reducing the weight (and recycling/landfill gate charge) for transport and increasing the potential for recycling.

- Additional equipment is becoming available to wash recovered plastic making it acceptable for recycling. To justify the cost of the development work, this service will be offered as a contract service to growers.

APPENDIX 1

ESTIMATE OF ANNUAL COVERS & MULCH WASTE PLASTIC FROM VEGETABLE CROPS, 2005

Crop	Type of plastic		Area (ha)	Weight new (t/ha)	Total wt. (t)	Life expect-ancy (yrs)	Annual waste (t)	Contam-ination factor (% of new)	Annual total disposal weight (t)
Beetroot	Fleece		228	0.17	38.8	1	38.8	250	97.0
Carrot	2m beds	early	2,012	0.24	482.9	1	482.9	700	3,380.3
	2m beds	storage	3,888	0.3	1,166.4	1	1,166.4	500	5,832.0
Parsnip	2m beds	early	411	0.24	98.6	1	98.6	700	690.2
	2m beds	storage	79	0.3	23.7	1	23.7	500	118.5
Turnip and Swede	Fleece		200	0.17	34.0	1	34.0	250	85.0
	insect netting		881	0.3	264.3	6	44.1	110	48.5
Cabbage, spring	10m plastic		205	0.63	129.2	2	64.6	250	161.5
	Fleece		100	0.17	17.0	1	17.0	250	42.5
Cabbage, summer and autumn	10m plastic		248	0.63	156.2	2	78.1	250	195.3
	Fleece		79	0.17	13.4	1	13.4	250	33.5
Cauliflower	10m plastic		1000	0.63	630.0	2	315.0	250	787.5
	Fleece		492	0.17	83.6	1	83.6	250	209.0
Calabrese	10m plastic		900	0.64	576.0	2	288.0	250	720.0
	Fleece		407	0.17	69.2	1	69.2	250	173.0
Celery	10m plastic		10	0.65	6.5	2	3.3	250	8.3
	Fleece		53	0.17	9.0	1	9.0	250	22.5
Leeks	Fleece		90	0.17	15.3	1	15.3	250	38.3
Lettuce	10m plastic		100	0.63	63.0	2	31.5	250	78.8
	Fleece		997	0.17	169.5	1	169.5	250	423.8
Onion Salad	Fleece		290	0.17	49.3	1	49.3	250	123.3
Others	10m plastic		786	0.63	495.2	2	247.6	250	619.0
	Fleece		786	0.17	133.6	1	133.6	250	334.0
TOTALS	**(t)**						**3,477**		**14,222**

Source: ADAS estimate

APPENDIX 2

SUPPLIERS OF BIODEGRADABLE PLASTIC COVERS AND MULCHES

Company	Contact Details	Product	Colour, Dimensions, Cost (if available)
Capatex 127 Northgate New Basford Nottingham NG7 7FZ	Tel 01159 786111 Info@capatex.com Agro-textiles@capatex.com www.capatex-agro-textiles,com	Mater-Bi, Bio Telo	Black, £119 to 125/roll, various widths, 18 to 20 microns thick, 1,500m/roll 15 to 25 week life. Also clear bio-degradable, 1.5m wide.
Capatex 127 Northgate New Basford Nottingham NG7 7FZ	Tel 01159 786111 Info@capatex.com Agro-textiles@capatex.com www.capatex-agro-textiles,com	Ecopac, bio-degradable paper	1.4m wide and 300m rolls, £115/roll
Ilex Organics Ltd PO Box 158 West Barkwith Market Rasen Lincs. LN8 5WB	Murray Smedley Tel 01673 885138 Office 01673 885163 01673 857627 office@ilexorganics.co.uk	Biolene	Black or Brown, various thickness 18 to 25microns 1500m/roll
Miles Crop Covers Ltd The Beeches 1 Swallow Drive Cedars Park Stowmarket Suffolk IP14 5BY	Tel 01449 614970 Mobile Jill Miles 0797 9800553 jmiles@cropcover.freeserve.co.uk	No bio-degradable material yet; in development.	2m wide roll, and 10?m wide. 30-40% more expensive.

APPENDIX 2 (contd.)

Company	Contact Details	Product	Colour, Dimensions, Cost
J&K Polyculture (IOW) Ltd	Kevin Tel 01983 741444 Jkpoly@aol.com	Envirocare, bio-degradable made from oil, degradability can be programmed 72 days to 365 before break down starts	1.85 m to 6m wide, 40 micron, 400 holes/m2.
Terraseed Unit 2 Hamilton Close Basingstoke RG21 6YT	Tel 01256 843073	Photo and bio-degradable layer with paper	Developed for seeded crops of trees and ornamentals.
Tildenet Hartcliffe Way Bristol BS3 5RJ	Tel 01179 669684 Enquiries@tildenet.co.uk www.tildenet.co.uk	Biotelo/Mater-Bi	Mulch, weed control, from Maize starch. Black, 20micron and 30 micron, 1,500m rolls, various widths.

APPENDIX 3

COSTS ASSOCIATED WITH 'STANDARD' PLASTIC CROP COVERS

Crops	Cover type	System	Rolls/ ha	Material cost/ha(£)	Laying cost/ha (£)	Removal cost/ha (£)	Disposal cost/ha (£)	Total cost/ha (£)
Early Carrots	Plastic	Bed system 1.8 - 2.2 m	8 - 11	437.50 - 550	61.72 (7.5 hrs@£8.23)	41.15 (5 staff hrs)	87.5 - 117.5	628 - 770
	Fleece	Bed system	18 - 22	685 - 753	61.72 (7.5 hrs)	41.15	31.25 - 42	819 - 898
Field Stored Carrots	Black plastic	Bed system	14	362.5	Nil – part of straw laying	200	150 (landfill)	712.5
Lettuce	Fleece	Wide sheets up to 24m; sheets used for 2 seasons	1.7 - 3.4	370	142.70 (6 person team + tractor)	34 (2 person team + tractor)	75 (landfill)	437
Brassicas	Plastic	Wide sheets up to 12m	3.4	308 over 2 years	125	125	62	466

APPENDIX 4

COSTS ASSOCIATED WITH BIO-DEGRADABLE CROP COVERS

Crop	Cover type	System	Rolls/ha	Material cost/ha(£)	Laying cost/ha (£)	Removal cost/ha (£)	Disposal cost/ha (£)	Total cost/ha (£)
Early Carrots	Bio polymer	1.5m bed system	14	1050	98.76 (12hrs@ £8.23)	25 - 51	Nil	1174 - 1200
Early Carrots	Bio-degradable plastic	2m bed system	8	650	61.72 (7.5 hrs@ £8.23)	20 - 41.15	Nil	732 - 753
Field Stored Carrots	Bio polymer	2.2 m bed system	9	1080	Nil - part of straw laying	Nil	Nil	1080
Field Stored Carrots	Paper	2.2 m bed system	15 to 17	1955	Nil - part of straw laying	Nil	Nil	1955
Brassicas	Bio-degradable plastic	Wide sheets up to 12m	3.4	650?	125	125?	?	725