# A Market Analysis of Farm Film Plastics

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# 1 Executive Summary

This report is the outcome of a study of agricultural plastic film waste in Scotland – to provide more information on the amount of farm film plastic (such as silage wrap and crop cover) that will require collection and processing now that the Scottish Environment Protection Agency is strictly enforcing waste legislation which bans the burning of agricultural plastic waste. The study has been carried out by ADAS working in partnership with SAC Consulting and comprises (a) a literature review, (b) a mapping study of farm film plastic used within Scotland's agricultural sector each year, and (c) a questionnaire study with suppliers, users and recyclers of farm film plastic suppliers.

The literature review considered schemes from the UK, Europe, Australia, USA and Canada. In many countries, where the value of waste plastics has been favourable, effective business models have been developed for collecting plastics from agricultural operations and recycling the materials. These schemes have developed protocols for segregation, separation, and quality control. However, the main issue with film plastics used on farm for crop cover and feed conservation is contamination and many collection schemes rely on the higher value of packaging plastics to provide the financial incentive to support the less valuable film plastic collection. The review identifies 3 approaches to treating plastic film with a level of contamination - levy support, commercial association of collectors and commercial film manufacturer.

The mapping study has used multiplication factors taken from a previous ADAS study (2007) and applied them to the most recent Scottish Agricultural Census data available to calculate farm film plastic waste by farm type across Scotland's sub-regions. The results are shown in maps and tables. The total farm film waste arising is just under 22,000 tonnes with 9% of this from the horticultural sector and 91% from livestock. In terms of the type of farm film plastic waste, 82% is from silage bale wrap, 9% is from silage clamp cover and is from crop cover. These figures are as expected. As would be expected, analysis by sub-region reflects the distribution of farm types across Scotland, with Grampian showing the highest farm film waste arisings for bale wrap (from the beef farming sector), Dumfries and Galloway for clamp cover (dairy) and Tayside for crop cover (vegetable farming). With regard to the logistical challenge of farm film plastic waste collection, Scotland features two contrasting areas of (a) high agricultural production in the Lowlands, and (b) low agricultural production in the Highlands, with an additional feature of multiple islands.

For the questionnaire study, a non-representative sample of farmers, waste collection/recycling companies and farm film plastic suppliers was selected, ensuring a spread across farm types and sub-regions but focusing on respondents known to be involved in the supply chain. A target figure of 100 interviews as agreed, with about 80% of these being farmers and growers. A response rate of 91% was achieved. The intention was not to collect data which could be scaled up to represent the sector as a whole but to add detail to the mapping study. Some of the key findings were:

- Whilst national collection services appear to be available, some farmers report that there is no service in their area. This could be a marketing issue but is more likely to be due to the high cost of collection in remote locations.
- Agricultural film plastics are typically purchased in Spring and Summer and are supplied both directly to farmers and indirectly through sales to contractors.
- Questionnaire responses from farmers suggests a preference for annual or biannual collection of farm film plastic waste which will require farmers to develop good storage facilities.
- There are opportunities to reuse single use plastic on farms and 23% of farmers in the study find they can re-use some plastics. Reuse on silage clamps was the most popular method.
- A number of silage film brands sold carry the APE UK co-responsibility levy. No independent importing outside these brands was identified. A threat to this will come from imports of non-aligned brand materials that fall within future trade agreements.

# 2 Introduction

Since January 2019, the Scottish Environment Protection Agency (SEPA) has stated that they will strictly enforce the requirements of waste legislation, bringing an end to the common practice for farmers and land managers to burn most types of agricultural waste, including farm film waste, under a waste management exemption. More information is now required on the actual amount of farm film plastic – such as silage wrap, soil cover and crop cover – used in Scotland that will require collection and processing as a result.

In January 2020 Zero Waste Scotland (ZWS) commissioned a study to undertake (a) a literature review, (b) a mapping survey of farm film plastic used within Scotland's agricultural sector each year, and (c) a survey of farmers, waste collection/recycling service providers and farm film plastic suppliers. The work was carried out by ADAS and SAC Consulting. This report is the outcome of the study.

For the purposes of this report, agricultural film plastic includes LDPE/LLDPE (Low Density Polyethylene/Linear Low Density Polyethylene). When referring to product this is clean manufactured plastic film. When referring to agricultural plastic film arisings or waste, this is the used plastic with the addition of contaminants such as organic matter, soil and water.

LDPE crop cover includes both the clear plastic that covers brassicas for example, and the plastic mulch that is in direct contact with the soil below field grown strawberries for example.

# 3 Scope

The study specified that the following outputs should be included:

1. A proposed and final engagement list
2. A proposed and final sampling approach
3. A mapping study (survey) of farm film plastic usage, including quantities, types and uses of farm film plastic, as well as where this plastic is being used
4. A desktop / literature review of international practices
5. A report detailing the findings of the mapping study (survey)
6. A report detailing the findings of the desktop / literature review
7. All raw data collected during the mapping study (survey)
8. Any materials purchased for the desktop / literature review as a direct result of delivering this Contract

Not in scope: the study is not required or expected to consider or identify existing disposal routes or practices for other types of farm plastics.

For clarity, the table below sets out where the specified outputs can be found.

| | Specified output | Location within this report |
|---|---|---|
| 1 | Engagement list | A full list of interviewees is included within the results spreadsheets which will be emailed with the final version of the report. However, as noted in section 3.3.1, ZWS confirmed that they did not need to agree the list of potential survey respondents |
| 2 | Sampling approach | Section 3.3.1 |
| 3 & 5 | Mapping study (survey) report | Sections 5 & 6 |
| 4 & 6 | Literature review report | Section 4 |
| 7 | Raw data | As noted above (Engagement list) |
| 8 | Materials purchased | n/a |

# 4 Methodology

## 4.1 Literature review

A search for information relating to schemes and initiatives in the UK, EU and other countries for collecting plastic film from farms was undertaken. This was undertaken as a desk exercise and included reference to specific sources including international conferences, research papers and web sites. Recycling schemes and technical papers have been identified. Following this initial stage more detailed examination of specific schemes to understand working practices for the collection and recycling infrastructure, quantities, service provider's costs and other incentives. This research has identified the country, the structure of the recycling scheme, and as far as possible in light of the constraints of the search and commercial information, the details of participation. Three models have been identified.

## 4.2 Mapping of farm film plastic waste in Scotland

In 2007, ADAS and Valpak carried out a research trial into the arisings of Agricultural Waste Plastics (AWP) as part of the AWP Collection and Recovery Programme (ADAS, 2007. *Research study into the quantities of UK packaging/non-packaging waste farm plastic arising from farms for AWP Programme Management Board*). The trial aimed to provide an estimate of the flow of agricultural plastics in the UK which was subsequently used to inform the development of Producer Responsibility recommendations made by the Programme and Defra's Advisory Group on Farm Plastics. Using data generated through surveys, the trial established the quantity and flow of AWP from producer/importer through to re-processor and provided estimates of the arisings of AWP, by farm category and region, for the UK. The final report included mapping of AWP arisings, and data from the previous study was used to inform the baseline of the new study for Zero Waste Scotland.

For the mapping study within this report, the mapping data produced in the previous research trial (ADAS 2007), was updated. Farms have been classified according to the following main activities: Fruit, Vegetables, Beef, Dairy and Sheep. This is in order to illustrate the most significant amounts of plastic waste produced by farm type. The quantities of plastic that arise from farms has been

calculated from first principles using Agricultural Census data from 2016 and 2017 (Scottish Government, 2016b, Results from the June 2016 Scottish Agriculture Census, and 2017a, Economic Report On Scottish Agriculture - Section C Time Series. High-resolution GIS maps showing the location and magnitude of LDPE arisings from different types of farming for each of the major types of LDPE usage are then produced.

### *4.2.1 Vegetables & Fruit*

Fruit and Vegetable LDPE arisings were estimated by first establishing the areas, in hectares, of different fruit and vegetable crops by sub region. This was calculated using the area of 'Vegetables for human consumption' and 'Orchards and soft fruit' from the Scottish Government's Agricultural Census data (2016) referenced above.

#### **4.2.1.1 Vegetables**

The areas of vegetables were further broken down into different crop types by multiplying the total area of 'Vegetables for human consumption' for each sub-region by a factor to determine the area of the following crop types for each sub region: peas for canning, freezing or drying, beans for canning, freezing or drying, turnips/swedes, calabrese, cauliflower, carrots and other vegetables. The factor was calculated using values from the Scottish Agriculture Census (2016) which details the percentage area of each crop type for the whole of Scotland.

The calculated areas for each sub-region were then used to estimate areas of crop covered by LDPE plastic film, as well as the weight of plastic film arising from each crop, using estimates of plastic cover for different crop types from the Defra report: '*Horticultural Crops Grown Under Protection - Impact of Use of Temporary Covers and Plastic Mulches on UK Agronomic Practice*' (ADAS, 2011). This was then totalled to give the total LDPE plastic arising from vegetables farming in each Scottish sub region.

### *4.2.2 Livestock*

Livestock LDPE arisings were estimated by first establishing the numbers of different livestock animals by sub region using the Scottish Agriculture Census data (2017) which gives numbers of beef & dairy cattle of different ages and sheep for each sub region. These numbers were then multiplied by estimates of the amount of LDPE plastic arising from different individual dairy & beef cattle age groups and from breeding ewes (from the ADAS 2007 study referenced above) to give an estimate of the total LDPE plastic arising from each farm type. The values used can be seen in Appendix 1.

## 4.3 Questionnaire study of farm film plastic waste usage and disposal

### *4.3.1 Sample selection*

Census statistics (from the Economic Report on Scottish Agriculture from the Scottish Government website) were used to inform the sampling of the farms that were contacted for interview. The statistics provide a breakdown of the percentage of farm types and location and based on these statistics, a sample from SAC's own client contact list was selected to match the breakdown of farm characteristics and location. The intention was not to select a representative sample but to choose interviewees who would be likely to participate and who are involved in the agricultural film plastic supply chain. Using SAC's client contact list provided considerable advantage in terms of optimising the response rate to the telephone interviews, because SAC was able to contact farmers and agricultural businesses with whom they have an existing relationship.

Details of waste collection / recycling companies for interview were provided by Zero Waste Scotland. A selection was made from the list to ensure a spread across Scotland by location. Suppliers of farm film plastic contacted were a selection of the ones named in the interviews with farmers. Only two UK farm film reprocessors were identified and these were both interviewed.

A target of 100 interviews was agreed with Zero Waste Scotland, broken down as shown below. In practice, there has been some slight changes to these figures as shown in section 6.1. Once the

sample selection methodology had been agreed, Zero Waste Scotland confirmed that they did not need to agree the list of potential survey respondents (engagement list).

| Interview group | Shetland | Orkney | Eilean Siar | Highland | Grampian | Tayside | Fife | Lothian | Scottish Borders | East Central | Argyll & Bute | Clyde Valley | Ayrshire | Dumfries & Galloway | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Veg & Horticulture** | | | | | 1 | 6 | 1 | 1 | 1 | | | | | | **10** |
| **Dairy** | | | | | 1 | | | | 1 | 1 | 1 | 2 | 3 | 5 | **14** |
| **Beef & Sheep** | 1 | 2 | 1 | 5 | 5 | 4 | 1 | 2 | 5 | 2 | 3 | 3 | 3 | 5 | **42** |
| **Arable / AD** | | | | 1 | 2 | 2 | 1 | 1 | 1 | | | | | | **8** |
| **Contractors** | | | | 1 | 2 | | | | 2 | | | | | 4 | **9** |
| **Waste collectors (HQ)** | | | | 1 | 2 | 3 | | | 1 | | | | 1 | 1 | **Up to 10** |
| **Plastic film suppliers** | | | | | 1 | 1 | | 1 | 1 | 1 | | | | | **Up to 5** |
| **Reprocessors** | | | | | | | | | | | | | | 1* | **Up to 2** |
| **Total** | | | | | | | | | | | | | | | **100** |

* The second reprocessor is based in Wales

**Table 1: Target interview numbers**

### *4.3.2 Study methodology*

The study was carried out using telephone interviews. A standard interview script was written to provide background information for respondents about the study and about the process. The questionnaire included guidance for interviewers to ensure that the surveys were carried out consistently and professionally (see Appendix 2 for sample questionnaire). The methodology agreed was that we would give respondents 2 call back opportunities if they were not free to speak at the time of the first call.

For the 5 interviews with supply companies and the 2 with reprocessing companies, a slightly different methodology was adopted. This was because these interviews were carried out after the farmer and waste collector interviews, during the week commencing 16/03/2020, after tighter Corona virus rules had been introduced. As a result, participating in our survey was not a high priority for the companies

contacted and it was more difficult to speak to the correct contacts. So, for some of these interviews, after the initial telephone contact, a copy of the questionnaire was emailed to the respondent.

### *4.3.3 Questionnaire design (see Appendix 2 for sample questionnaire)*

The survey required the development of 4 separate questionnaires for the following groups:

- Farmers and growers
- Waste collection / recycling companies
- Farm film plastic supply companies
- Plastics reprocessors

The farmer and grower questionnaire was developed by using the questionnaire from the previous study (ADAS 2007) as a template, with additional input from SAC Consulting. This was forwarded to Zero Waste Scotland for review. It was agreed that the questionnaires for the other 3 groups would be based on the farmer and grower questionnaire and that these did not need to be reviewed by Zero Waste Scotland.

### *4.3.4 Data collation and analysis*

Questionnaire responses were handwritten by interviewers and then scanned and emailed for collation. Responses for farmers & growers and waste collectors were collated onto spreadsheets – one for each group of interviewees to facilitate analysis. The results and analysis are shown in section 6.2 and 6.3.

Analysis of farmers & growers responses involved defining the farm type of each respondent based on responses relating to the farm type and the size of each part of a farmers' business indicated by the number of livestock and area of crops the farmer reported. Based on this analysis the following categories were established:

- Arable/Anaerobic Digestion Plant
- Beef & Sheep
- Dairy
- Contractors
- Vegetable/Horticulture

The responses to each question were analysed based on the farm type and location to establish if any notable trends could be found and, where appropriate, the findings are reported broken down into farm type and location if it was thought that this breakdown would be important.

Analysis of the responses from waste collectors was carried out in a similar fashion, although the target numbers of respondents in this section were much lower. As a result, responses were reported alongside the name of the contractor where this was thought to be appropriate. The numbers of respondents in the other sections, Farm film plastic supply companies and plastics reprocessors, were lower still and responses in these sections are reported on a respondent by respondent basis.

# 5 Literature review

## 5.1 Research of agricultural waste plastic collection in other countries

### *5.1.1 Europe-wide: Agriculture, Plastic and Environment (APE)*

APE Europe is a European association, headquarters in Paris, and subject to French law formed to ensure equal and cost-effective access for all agricultural businesses under the principles of an extended producer responsibility (EPR) framework. There is a 10 year plan (2012 to 2022) to raise recycling of agricultural plastics levels from 30% to 70% over the period.

The association has partners involved in agricultural plastics production and sale, with two objectives: innovation in agricultural plastic applications to improve crop yields and environmental protection; and develop national collection schemes across Europe. It has strong partnerships with:

- European Plastics Converters (EuPC)
- Plastics Recyclers Europe (EuPR)
- Comité Español de Plásticos en Agricultura (CEPLA)
- PlasticsEurope
- European Association of Plastics Recycling and Recovery Organizations (EPRO)

APE Europe supports the development and implementation of National Collecting Schemes for used agri-plastics waste in the 5 countries that it operates in (http://apeeurope.eu/operating-schemes/): France, Germany, Norway, Iceland and Ireland.

ECCPA Commitment. All the producers of the scheme have signed the European Commission's Circular Plastics Alliance commitment to incorporate 10 million tonnes of used plastics into new plastic products by 2025.

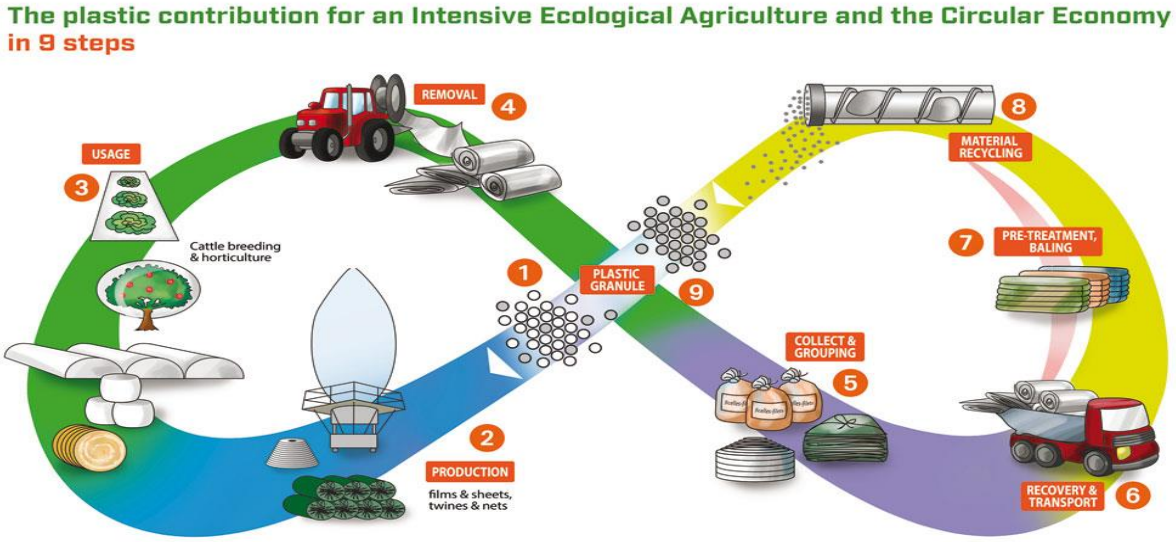


**Figure 1: The plastic contribution for an Intensive Ecological Agriculture and the Circular Economy In 9 steps (ECCPA) (Source http://apeeurope.eu)**

## *5.1.2 UK*

### 5.1.2.1 APE UK

APE UK was launched in the UK in September 2019. It operates under the APE Europe guidelines, as a non-profit, non-legislative compliance scheme designed to help farmers at the lowest possible cost through the shared responsibility of producers, distributors and farmers. It will reduce the need for new Government imposed taxes on farm plastics as have already been introduced elsewhere in Europe. APE UK's scheme claimed to have 80% of major manufacturers of non-packaging manufacturers on board. All existing collectors are invited to join.

In the first year an Environmental Protection Contribution (EPC) will be included in the price of products equal to 2p/kg (£20/t) for all product categories. Thereafter, the EPC will be subject to modification.

The list of collectors is yet to be announced for the UK but is expected soon. All non-packaging agricultural plastics collected will go to reprocessors contracted by the scheme, both here in the UK and elsewhere within Europe.

#### 5.1.2.2 UK Farm Plastic Responsibility Scheme (UKFPRS)

UKFPRS was formed in November 2019 by farm plastic collection companies across the UK. It is open to all UK farm plastic collectors and will operate on a not-for-profit basis funded by the collectors and with no charge to farmers. Including both packaging and non-packaging plastics, the UKFPRS aims to:

- Provide audited totals of the quantity of farm plastic collected and recycled
- Further increase the volume and quality of plastic recycled
- Educate farmers to reduce contamination within their waste plastic
- Provide the supply chain with corporate responsibility regarding plastics they put into the market
- Assist with exploiting new technology for the reprocessing of farm plastic
- Lobby government and other bodies as required for support to increase plastic recycling facilities within the UK

The signed-up collectors include:

- Farm XS (England)
- Agri-cycle in (England)
- Emerald Isle Recycle (Northern Ireland)
- Birch Plastics (Wales)
- Solway (Scotland)

#### 5.1.2.3 Hub Collection Trial, SASTAK / ADAS trial 2007

As part of the Agricultural Waste Plastics (AWP) Programme, the concept of the Sastak Machinery Ring Trial in Shropshire was to develop a collection infrastructure which would enable farms producing low quantities of AWP, or that are located in isolated / hard to reach locations, to participate in an AWP collection scheme. This was a demonstration trial that showed that locally run, well managed hubs are a cost effective method of collecting in a small period of time.

The study concluded that hubs are simple and easy to run and if utilising an existing business structure in an area, can help to minimise costs, optimise administration and help marketing. The trial found that transport logistics are a high cost but can be optimised where a reprocessor is located in the region.

An average participation of 45 farmers per hub was achieved. Pre-registration was essential to optimise the hubs, and there were just ten no-shows out of 180 registrations. The trial revealed that a hub day may readily cope with 60 visits. The average tonnage delivered per farm was 479 kg but this was estimated to be low because:

- The trial did not collect crop cover
- It operated for only a part of the silage-use season
- It was ahead of spraying and fertiliser usage season
- The burning of containers was still allowed at this time

The majority of farmers travelled up to 15 miles to a hub. Farmers were prepared to source separate plastic waste into use type, which provides both polymer and packaging/non-packaging separation. Key to this success was a strong promotional programme to educate potential participants. Costed findings were produced as part of the study but these have not been included here because they are out of date.

#### 5.1.2.4 Hub and Mini Hub Trial Somerset FWAG / ADAS trial 2007

As part of the Agricultural Waste Plastics programme this was designed to illustrate economic and quality improvements that could be gained from sorting and baling AWP at source (farm) or at collection hubs. Anticipated improvements included increased tonnage capacity and efficiency at collection.

Bagged plastic appeared to be cleaner and drier than loose plastic accepted in previous collections. Feedback from one reprocessor indicated contamination levels of 38% (average generally received at the plant was 60%).

The quantity per farm varied, although the average was 505kg per farmer at main hubs and 400kg at mini hubs of mixed AWP (packaging and non-packaging, excluding rigid containers). This is lower than previous collections in the area and is perhaps due to:

- Reduced levels of contamination
- The timing of the trial including only a part of the silage use season
- Hub collections held ahead of spraying and fertiliser season
- Non-inclusion of rigid AWP containers

Mini-hubs (~ ten farmers) and small-scale hubs (~20 farmers) could be operated with low overhead costs but require self-organisation. Full size hubs (~50 plus farmers) could be operated efficiently using an experienced organising body.

Excluding costs specific to the trial situation, Somerset FWAG forecast the operational cost of commercial hubs to be £130/tonne for main hubs and £158/tonne for mini-hubs (on-farm). Administration costs would be additional to the operational costs.

#### 5.1.2.5 Other UK drivers - farm assurance schemes – e.g. Red Tractor

Farm assurance schemes impose a responsibility on farms to conduct business in a responsible manner, with consideration for the environment. The Red Tractor scheme provides farmer guidance notes by sector. The requirement for chemical containers, referring primarily to agro chemicals is:

- Key Wastes are disposed of in a manner that minimises the risk of contamination / pollution
- Wastes are disposed of by registered waste carriers
- Wastes are not burnt
- Evidence to be provided by Waste Transfer Notes / Receipts

The same principles are likely to apply to all plastic wastes that are produced by the farm, with the general heightened concern of plastics in the environment. Collection schemes such as that offered by Waste collection company 6 offer receipt certification for the plastic they collect.

### *5.1.3 Ireland: Irish Farm Film Producers Group (IFFPG)*

IFFPG is associated with APE and is the sole national farm plastics recycling scheme in Ireland. IFFPG recycles silage wrap, silage covers and netting, and claims to recycle approximately 25,000 tonnes annually, which equates to a >70% national recycling rate. Of this 80% is re processed.

Farmers can recycle farm plastics at one of IFFPG bring-centres advertised on the website or by requesting a farmyard collection. Booking a farmyard collection can be done online with online payment and receipt issued.

The label code is given by retailers when farm film is purchased and has the recycling levy applied. A valid label code entitles the farmer to significantly reduced charges at the collection. Collection of 500kg from bring-centres is €20 with a label code and €85 without, and collections from farmyards are €45 with a label code and €100 without. IIFPG suggests that 500kg equates to approximately 200 - 250 wraps.


Non-silage plastics are also collected (Farm Plastics Recycling Ltd., sister company to IFFPG recycles fertiliser and meal bags and drums). The cost of collection is €10 per 500 kg bag of fertiliser / meal bag & drum and €5 per 500 kg bag of netting.

Farmers must present their silage plastics loose, clean and dry for recycling. Non-silage plastics (fertiliser / meal bags, drums & netting) must be segregated by plastic type, bagged and presented for recycling. Bulk fertiliser bag inner liners must be removed and bagged separately. Drums must be triple rinsed (from https://www.farmplastics.ie/).

### *5.1.4 Spain*

MAPLA is an association of producers of agricultural plastics for agriculture, formed to organise a national system of management of agricultural plastic waste to boost its recycling rates.

Promoted by APE EUROPE (with associated partners), the founding members of MAPLA were established in February 2020 by Spanish manufacturers and importers of agricultural plastics. MAPLA will organise the management of film waste, financing the collection and recovery through an eco-contribution at the purchase point of the products, similar to other models already implemented in Spain such as tyres, containers or electronic equipment. It will also allow the use of waste as resources, in line with the European Plastics Strategy, thus promoting the circular economy of plastic. The first collection operations promoted by MAPLA are planned for 2021.

MAPLA invites farmers, cooperatives, marketers and distributors to join the new national model, in order to better meet farmers' expectations and the needs of the environment.

The headquarters of the Association are in Seville. MAPLA represents 90% of the processors and distributors of agricultural plastic films and is expected to grow progressively incorporating other plastic products (ropes, meshes, irrigation tapes, etc.).

### *5.1.5 France*

Created in 2009 under the APE association (with associated partners), the scheme collects vegetable and animal production films, twines, nets, anti-hail nets, flexible irrigation pipes. In 2018 it claimed to collect 83,000 tonnes (a 61% collection rate) (http://www.plastiques-agricoles.com/agriculture-plastique-et-environnement-ape-commission-ape/ ).

### *5.1.6 Norway : Grønt Punkt Norge*

Grønt Punkt Norge, formed in 1997, with Plastertur representing the plastic industry and five other companies for metal, paper, glass, fibre and newspapers. The scheme claimed collection of 17,800

tonnes in 2018 which was estimated to be 84% of the waste plastic arisings on farms. Collection is paid for by members. Plastics purchased with Green Dot marking indicate participation in the scheme.

The Ministry of the Environment states that the responsibility for recycling used packaging rests with the companies that produce, import or use packaging: the "Polluter Pays Principle". The membership agreements stipulate that each member company must pay a licence fee for the service provided by the material organisations.

The Green Dot links 25 European countries to an international community for the recovery and recycling of used packaging. In Norway, the trademark on a pack is the equivalent of a receipt verifying that the relevant member company has paid the recycling fee. Grønt Punkt Norge ensures that anyone using the trademark on a pack that will be used in Norway has paid the license fee (www.grontpunkt.no/english/).

### *5.1.7 Germany*

#### 5.1.7.1 ERDE (Harvest plastics recycling Germany)

ERDE is funded by manufacturer and industry funded and is supported by APE Europe. In cooperation with RIGK as the system operator, ERDE organises the separate recovery and recycling of used agricultural films made from PE-LD (fraction 1) and PE-LLD (fraction 2) across Germany through collection partners. ERDE offers patron membership in order to further reinforce both the environmental and the economic efficiency of the collection system and to broaden public awareness of this. These memberships are open to all companies with links to crop plastics who want to intensify their commitment in the fields of resource and environmental protection in agriculture.

Agricultural services companies and farmers collect their plastics and take them – swept and cleaned of significant dirt – to a collection point. At the Crop Plastics Recycling Germany (ERDE) collection points, silage sheets, underlayer films, silo tubes, silage stretch film and net replacement films can be handed in free of charge. Separate services are provided by RIGK for crop forcing films, fibrous webs, nets and yarns. On hand-in, it doesn't matter which brand or where the product was purchased. The collection price is set by the collection point directly. Recycling companies then process the collected material into new plastic raw materials. Farmers, can find all collection points and collection dates via Smartphone – with the free ERDE-App.

Participating manufacturers are: APE Europe, ASPLA SA, Groupe Barbier, bpi agriculture, CLAAS Vertriebsgesellschaft mbH, Coveris Flexibles Austria GmbH, DUOPLAST AG, KARATZIS SA, Manuli Stretch Deutschland GmbH, NOVATEX, Plastika Kritis SA, POLIFILM Extrusion GmbH, Ab Rani Plast Oy, Reyenvas SA, RKW Agri GmbH & Co.KG, Sotrafa SA, TAMA Plastic Industry Israel and TRIOPLAST GmbH. (https://www.rigk.de/en/recovery-systems/recovery-systems-for-producer-and-packaging-companies/detail/crop-plastics-recycling-germany-erde-recycling/)

#### 5.1.7.2 PAMIRA (Packaging Recovery Agriculture system)

PAMIRA is an association to dispose of empty agricultural pesticide packaging with the PAMIRA trademark in a fully secure, controlled and environmentally-friendly manner. 3,000 tonnes of empty agricultural pesticide packaging accumulates in Germany. Farmers collect the accumulated packaging and hand over (emptied, rinsed and dried) at specified times at their local agricultural trade. The participating companies are listed (https://www.pamira.de/en/trademark-users.html).

### *5.1.8 Finland: Tuula Löytty*

The collection and recycling of agriculture plastic waste scheme gathers about 20 % of the annual volume of 12,000 tonnes with bale wrap film the main product at about 7,000 tonnes. The diagram below outlines the roadmap to 2030 aiming at 100% collecting and recycling. This presents a bottom up approach with a strategy of awareness raising, education infrastructure development and digital solutions.

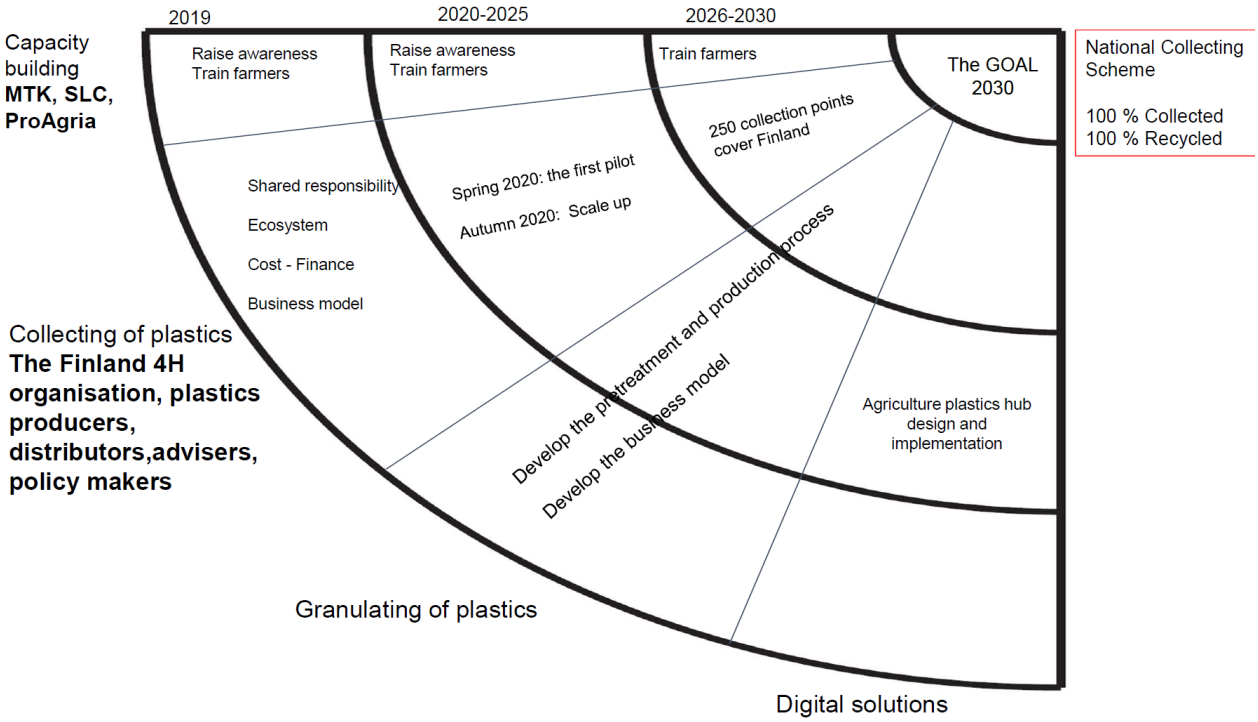


**Figure 2: Tuula Löytty timeframe and actions (from Loytttu T ( 2019) Recycling of Agricultural Plastic waste in Finland ResearchGate)**

### *5.1.9 Australia - drumMUSTER*

drumMUSTER is a scheme in Australia for collecting veterinary and agrochemical containers. It aims to provide a service to all chemical users across Australia and continues to develop services in all areas. Plastic films are not included in the scheme - the reason has not been identified but is presumed to be on economic grounds. Councils and other community organisations provide drumMUSTER services which contribute to:

- an environmental and sustainable solution for agvet container disposal
- the conversion of waste into a valuable resource
- a cleaner environment

The program provides regular training for councils and collection agency staff in the safe handling, cleanliness, inspection and storage of the returned drums. Training also covers the reporting required to track the program's performance at each site (http://www.drummuster.com.au).

### *5.1.10 United States*

#### 5.1.10.1 Cornell Waste Management Institute (CWMI)

CWMI is an initiative of Cornell University and serves the public through research, outreach, training, and technical assistance, with a focus on organic residuals. The initiative was involved in a number studies and pilots in New York State (NYS) termed Recycling Agricultural Plastics Program (RAPP) and ran from 2014 to 2016. (http://cwmi.css.cornell.edu/RAPP-Final-Report-DEC-2016.pdf).

RAPP supported many activities for example coordinating baling and collection on a limited number of farms in 7 counties in Central NYS (Broome, Cayuga, Cortland, Schuyler, Seneca, Tioga and Tompkins). As many markets for recycled agricultural plastics collapsed during the program's operation, agricultural plastic recycling has virtually ceased in all counties post-RAPP (2016). Without

RAPP's funding, counties do not have the time, resources, money, or staff to fund a program. While some counties continue small operations and are searching for markets, they have not found a way to make the practice profitable. Still other counties have the capacity to bale, but the agricultural plastics have nowhere to go. Instead of being recycled, they have been stockpiled awaiting a market. As it stands, most counties are sending agricultural plastics to landfills.

At the program's completion, a total of 910 tonnes of plastic were diverted including 152 tonnes of baled material that were ready for market. Upon conclusion of RAPP, markets for agricultural plastics had dried up. The general consensus is that counties would like a streamlined process at central materials recovery facilities, which are better equipped to handle the mass, mess, and process. Not all counties have access to such a facility, and without a revenue-stream, some have fallen behind.

Cornell Cooperative Extension (CCE) County Associations, continue with outreaching to educate and promote recycling. Delaware and Madison Counties Departments of Solid Waste continue to manage their own collection and recycling programs with support from RAPP for education and are exceeding 50% recycling from a start level of below 10%. St. Lawrence County Solid Waste use transportable compaction containers, Wheelock Disposal use 40-yard roll-off containers and walking floor tractor-trailer are also used. Otsego County Conservation Association operated four collections in the spring and autumn of 2016. Cattaraugus County Solid Waste offer waste sites and had a significant number of farms participating.

#### 5.1.10.2 Revolution Plastics

Revolution Plastics is a plastic product manufacturing and processing company which asks farmers to subscribe to the program, which provides completely free collection for farmers. It is assumed that farmers sign up to purchasing replacement plastic from the company. The company includes Delta Plastic making irrigation pipe and revolution Ag making films. The company provides a wheeled dumpster container used in commercial collections with automatic lift onto lorries. For smaller farmers a dumpy bag is provided. The company runs the collection and recycling services for free and claims to recover 675 tonnes per year. It services more than 4,000 farms in the Midwest, Manitowoc and Wisconsin. (https://revolutionplastics.com/about.php)

### *5.1.11 Canada*

Agricultural Plastics Recycling Group (APRG) is a group made up of over 20 stakeholder organisations from sectors including municipalities, producers, non-profits, recyclers and retailers. The scheme includes a fee on product either included within the product price or applied to products at point of sale. A program led by APRG **is** operated by Cleanfarms (a non-profit industry stewardship organisation). In some provinces Cleanfarms programs are adapted to serve and support provincial regulations. Schemes have a different method of operating in different province across Canada. Examples of schemes that are up and running are in

- Saskatchewan – grain bag recycling
- Manitoba – empty container recycling
- Quebec – empty container recycling

In Alberta this year is the first of a three-year pilot, has 20 collection sites throughout the province. The scheme takes, rolled, tied grain bags of any size, and twine for recycling. Some, however, just take grain bags and a few take only twine. Cleanfarms estimated Alberta farmers generate as much as 2,500 tonnes of low-density polyethylene grain bags and up to 3,000 tonnes of polypropylene twine annually. The full roster of collection locations and what they take can be found on (https://cleanfarms.ca/programs-at-a-glance/).

## 5.2 Summary of findings

In many countries where the value of waste plastics has been favourable, entrepreneurs in the waste industry have developed their own business models and been effective at collecting plastics from agricultural operations and recycling the materials. These schemes have developed protocols for segregation, separation, and quality control. The main issue with film plastics used on farm for crop cover and feed conservation in silage is contamination. Many collection schemes rely on the higher value of packaging plastics, used for chemical containers, providing the financial incentive to support the less valuable film plastic collection.

With the issue of contamination such a high influence on the value of collected film plastics, the success of a scheme is very dependent on having the industry infrastructure to recover and then to treat plastic film with a level of contamination. From the literature review there are three approaches recognised: Levy support, Commercial association of collectors and Commercial film manufacturer.

| Scheme type | Levy support | Commercial association of collectors | Commercial film manufacturer |
|---|---|---|---|
| Example scheme | Ape Europe<br>APE UK (England, Wales)<br>Irish Farm Films Producer Group – IFFPG (Ireland)<br>MAPLA (Spain)<br>APE France<br>Agricultural Plastics Recycling Group (APRG) | UK Farm Plastic Responsibility Scheme – UKFPRS<br>ERDE (Germany) | Grønt Punkt Norge (Norway) |
| Financial support for collection of film plastic | Collection supported by a levy applied to film when purchased | Collection funded by the collector members | Collection funded by the organisation (Government controlled) |
| Level of support | 2p/kg (£20/tonne) added to the sale cost of farm films (UK cost) | Membership subscription to form a fund for collection | Funds raised through variable license fee |
| Advantage | Free to farmers<br>Collection costs are covered, or partly covered | Free to farmers | Collection costs are covered<br>Free to farmers |
| Disadvantage | Requires time to establish true cost / levy requirement (may be underfunded)<br>Administration requirement and cost | Farmers may bear cost of transport to collector<br>Market forces may exclude areas of more difficult collections | License fee set by government. |
| Risks | Variability of cost according to location | Film from areas with high cost of collection could be excluded | |

**Table 2: Worldwide recycling schemes**

## 5.3 References (see also URL's in sections 4.1 and 4.2)


Published References via ResearchGate:

Loytttu T ( 2019) Recycling of Agricultural Plastic waste in Finland ResearchGate

Matthew J Lawrence James W. Garthe Dennis Buckmaste (2010).Producing Solid Fuel from Non-Recyclable Agricultural Plastics

Carmela Sica, Aleksandra Dimitrijević, Giacomo Scarascia-Mugnozza & Pietro PicunoTechnical (2015)Properties of Regenerated Plastic Material Bars Produced from Recycled Agricultural Plastic Film Polymers - Plastics Technology and Engineering .

Demetres Briassoulis Miltiadis Hiskakis H. Karasali Chris Briassoulis (2014)

Design of a European agrochemical plastic packaging waste management scheme—Pilot implementation in Greece Resources conservation and recycling 87 (2014) p72-78

Vox TG, , Viviana L Blanco I., Magnozzo G, Schettinin E, (2015) Mapping of Agricultural Plastic Waste Florence sustainability and wellbeing Forum 2015 Rood for sustainability not just Food

Binhoutal J (2016) Final report RAPP bridge funding New York farm Viability Institute


# 6 Mapping of farm film plastic waste in Scotland

The aim of this work was to establish estimates of LDPE arising from different farming types across different sub regions in Scotland. A map showing the Scottish sub regions is shown in *Figure 3*. Data on the numbers of livestock and number of hectares of different fruit and vegetable crops was acquired for each sub region in Scotland (Scottish Government, 2016a; 2016b; 2017a). This data, along with estimates of the amount of LDPE arising from different livestock types (ADAS, 2007), and amounts of LDPE arising from different fruit and vegetable crops (ADAS, 2011), were used to provide an estimate of LDPE arisings for different farming types for each sub region.

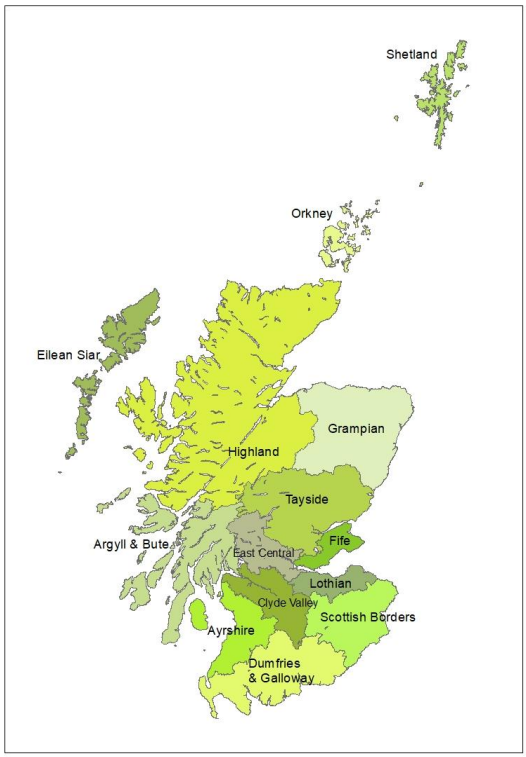


**Figure 3: Map showing Scottish sub-regions**

## 6.1 Vegetables & Fruit

The total LDPE plastic arising from Fruit & Vegetable farming in each Scottish sub region is shown in*Table* **3**. A Map of Scotland showing amounts of LDPE plastic (in kg) arising from Fruit and Vegetable farming for each Scottish sub region is shown in *Figure 4*.

| Region | LDPE plastic waste arising from vegetable farming (Tonnes) | LDPE plastic waste arising from fruit farming (Tonnes) | Fruit & vegetables total (Tonnes) |
|---|---|---|---|
| Shetland Islands | 0.0 | <0.01 | <0.01 |
| Orkney Islands | 0.0 | <0.01 | <0.01 |
| Eilean Siar | 1.2 | <0.1 | 1.3 |
| Highland | 47.0 | 0.8 | 47.8 |
| Grampian | 226.7 | 3.1 | 229.8 |
| Tayside | 863.4 | 25.7 | 889.1 |
| Fife | 304.0 | 5.5 | 309.6 |
| Lothian | 149.3 | 0.3 | 149.6 |
| Scottish Borders | 207.8 | 0.2 | 208.0 |
| East Central | 6.3 | <0.01 | 6.3 |
| Argyll & Bute | 0.4 | <0.1 | 0.5 |
| Clyde Valley | 7.0 | 0.5 | 7.5 |
| Ayrshire | 6.1 | <0.1 | 6.2 |
| Dumfries & Galloway | 4.2 | 0.2 | 4.3 |
| Scotland | 1824.9 | 36.6 | 1861.5 |

**Table 3: Tonnes of LDPE plastic waste arising from fruit and vegetable farming in Scottish Sub regions, calculated using data from (Scottish Government, 2016a; Scottish Government, 2016b)**

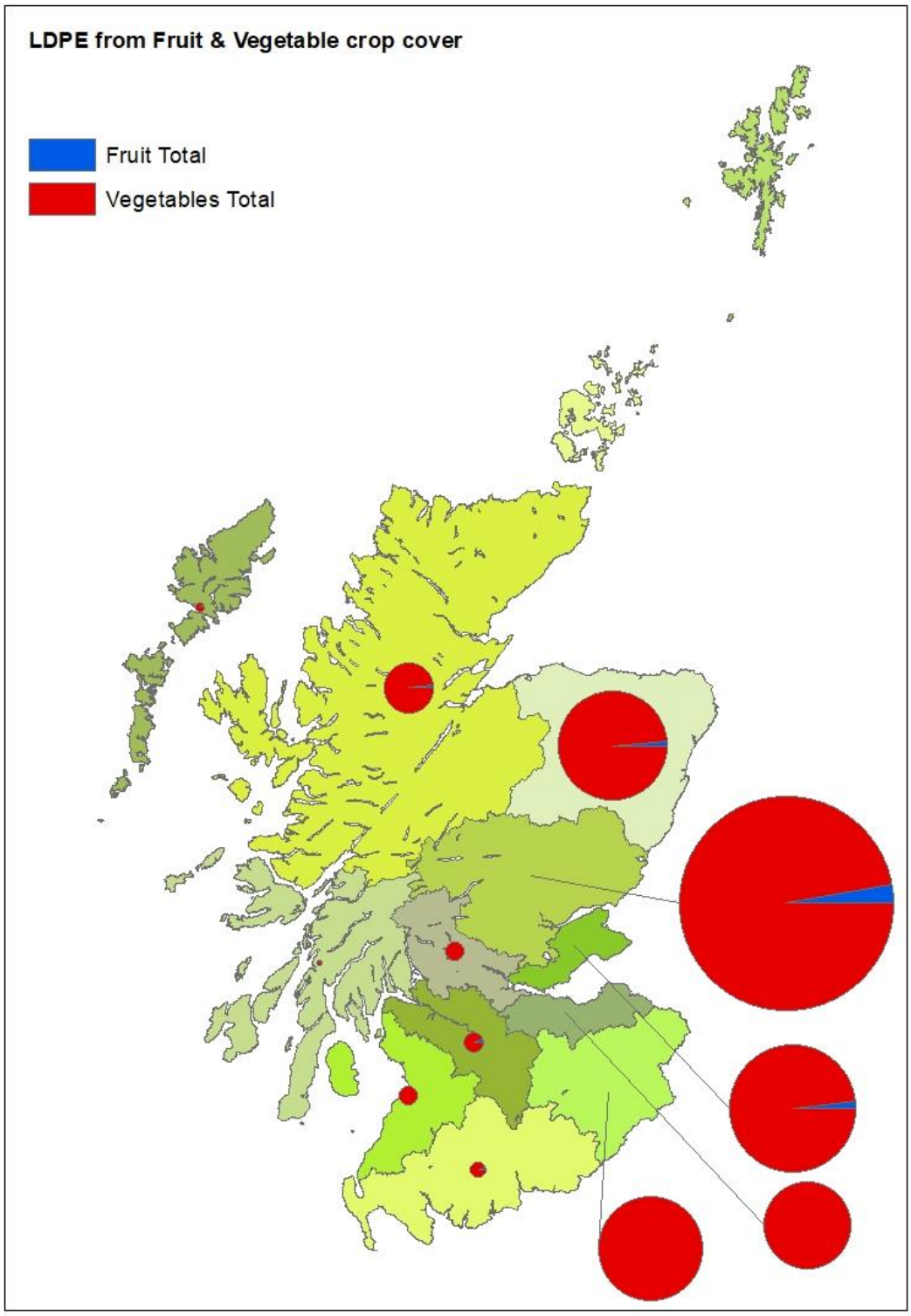


**Figure 4: Map of Scotland showing relative amounts of LDPE plastic arising from Fruit and Vegetable farming for each Scottish sub region.**

Pie charts are sized proportionally to the total arisings from Fruit & Vegetables. Pie charts for Orkney and Shetland are excluded as the areas of fruit & vegetables grown in these regions was negligible. The largest pie chart represents a total of 889.1 tonnes of LDPE arisings in Tayside.

## 6.2 Livestock

Plastic arisings for each farming type are split into LDPE arising from silage clamp cover and from silage bale wrap, shown in *Table 4*. A map showing the amount of LDPE plastics from silage clamp cover and silage bale wrap by farm type are shown in *Figure 5* and *Figure 6* respectively.

| Tonnes of LDPE (x1000 kg) | Silage Clamp Cover | | | Silage Bale Wrap | | | |
|---|---|---|---|---|---|---|---|
| **Region** | **Dairy Cows** | **Beef Cows** | **Sheep** | **Dairy Cows** | **Beef Cows** | **Sheep** | **Total** |
| **Shetland Islands** | 0 | 2 | 4 | 1 | 59 | 64 | 130 |
| **Orkney Islands** | 5 | 41 | 1 | 28 | 1,099 | 23 | 1,197 |
| **Eilean Siar** | 0 | 3 | 2 | 0 | 93 | 32 | 131 |
| **Highland** | 4 | 66 | 10 | 27 | 1,779 | 190 | 2,077 |
| **Grampian** | 17 | 188 | 7 | 121 | 5,062 | 127 | 5,522 |
| **Scottish Borders** | 11 | 69 | 12 | 84 | 1,850 | 222 | 2,248 |
| **Argyll & Bute** | 15 | 29 | 5 | 92 | 774 | 94 | 1,010 |
| **Tayside** | 10 | 131 | 7 | 37 | 512 | 135 | 833 |
| **Fife** | 12 | 62 | 1 | 47 | 242 | 17 | 381 |
| **Lothian** | 8 | 62 | 2 | 29 | 241 | 41 | 383 |
| **East Central** | 19 | 56 | 3 | 73 | 220 | 58 | 429 |
| **Clyde Valley** | 62 | 131 | 5 | 243 | 510 | 86 | 1,036 |
| **Ayrshire** | 111 | 154 | 5 | 433 | 600 | 92 | 1,396 |
| **Dumfries & Galloway** | 231 | 378 | 12 | 902 | 1,476 | 215 | 3,215 |
| **Scotland** | 506 | 1,372 | 77 | 2,119 | 14,517 | 1,397 | 19,988 |

***Table 4: Tonnes of LDPE plastic waste arising from Dairy, Beef and Sheep Livestock farming in Scottish Sub regions (Scottish Government, 2017a; Scottish Government, 2017b)***

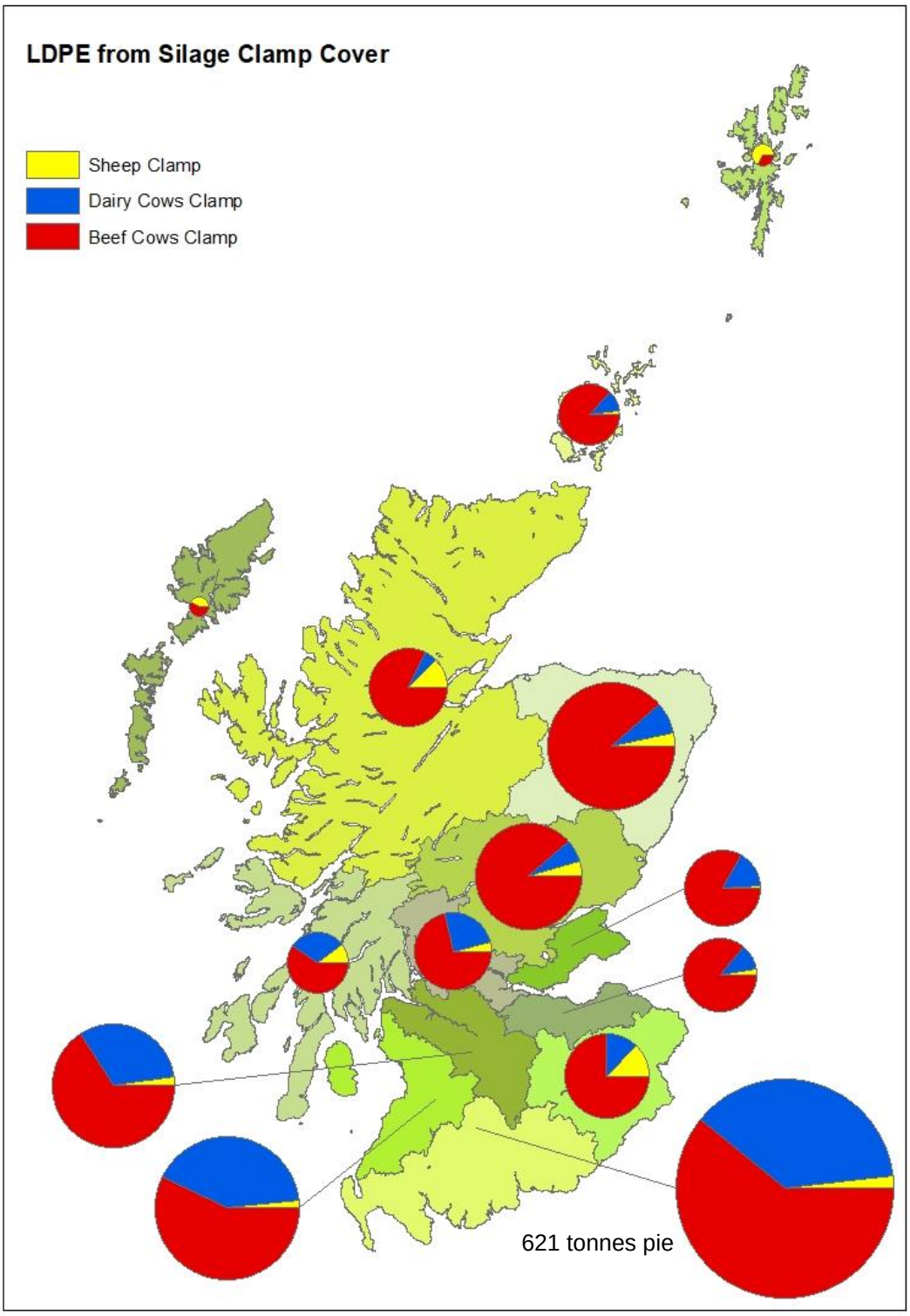


**Figure 5: Map of Scotland showing relative amounts of LDPE plastic arising from Silage Clamp cover for different livestock farm types for each Scottish sub region.**

Pie charts are sized proportionally to the total arisings from silage clamp cover. The largest pie chart represents a total of 621 tonnes.

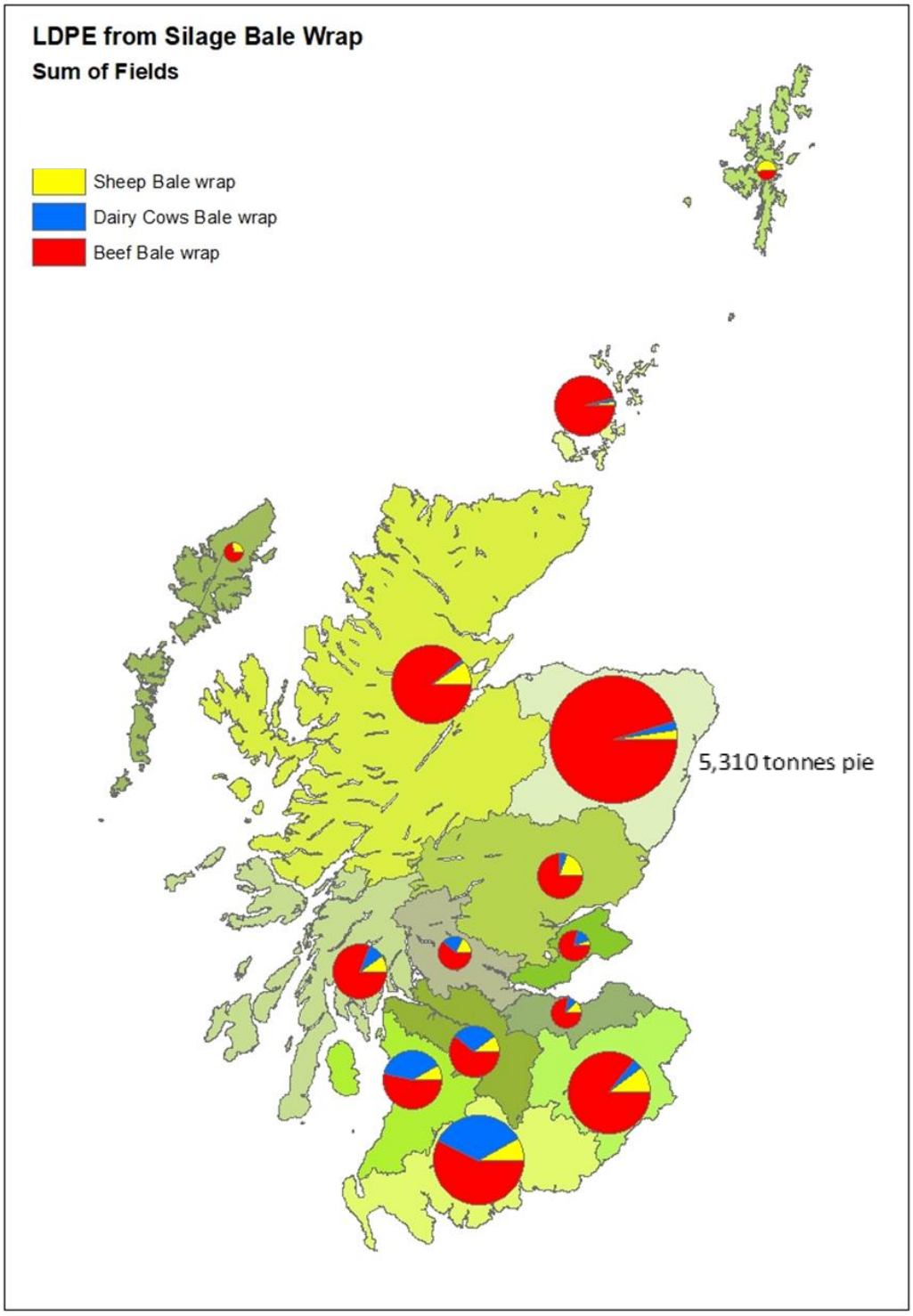


**Figure 6: Map of Scotland showing relative amounts of LDPE plastic arising from Silage Bale wrap for different livestock farm types for each Scottish sub region.**

Pie charts are sized proportionally to the total arisings from silage bale wrap. The largest pie chart represents a total of 5310 tonnes.

## 6.3 Total LDPE from Fruit & Vegetables, Bale wrap and Silage Clamp Cover

The total LDPE arisings from the different types of plastic waste for each Scottish sub-region is shown in *Table 5*. A map showing the amount of LDPE plastics from fruit & vegetable farming and from silage clamp cover and silage bale wrap is shown in *Figure 7*. The amounts are also shown in *Figure 8*.

| Region | Fruit & Veg Total | Bale Wrap Total | Clamp Cover Total | Grand Total |
|---|---|---|---|---|
| Shetland Islands | <0.01 | 124 | 6 | 130 |
| Orkney Islands | <0.01 | 1,150 | 47 | 1,197 |
| Eilean Siar | 1 | 125 | 5 | 131 |
| Highland | 48 | 1,996 | 80 | 2,124 |
| Grampian | 230 | 5,310 | 212 | 5,752 |
| Scottish Borders | 208 | 2,156 | 92 | 2,456 |
| Argyll & Bute | 0 | 960 | 49 | 1,009 |
| Tayside | 889 | 684 | 148 | 1,721 |
| Fife | 310 | 306 | 75 | 691 |
| Lothian | 150 | 311 | 72 | 533 |
| East Central | 6 | 351 | 78 | 435 |
| Clyde Valley | 7 | 839 | 198 | 1,044 |
| Ayrshire | 6 | 1,125 | 270 | 1,401 |
| Dumfries & Galloway | 4 | 2,593 | 621 | 3,218 |
| Scotland | 1,861 | 18,033 | 1,955 | 21,849 |

**Table 5: Tonnes of LDPE arisings from Fruit & vegetables plastic film, Silage Bale wrap and Silage clamp cover for Scottish sub-regions.**

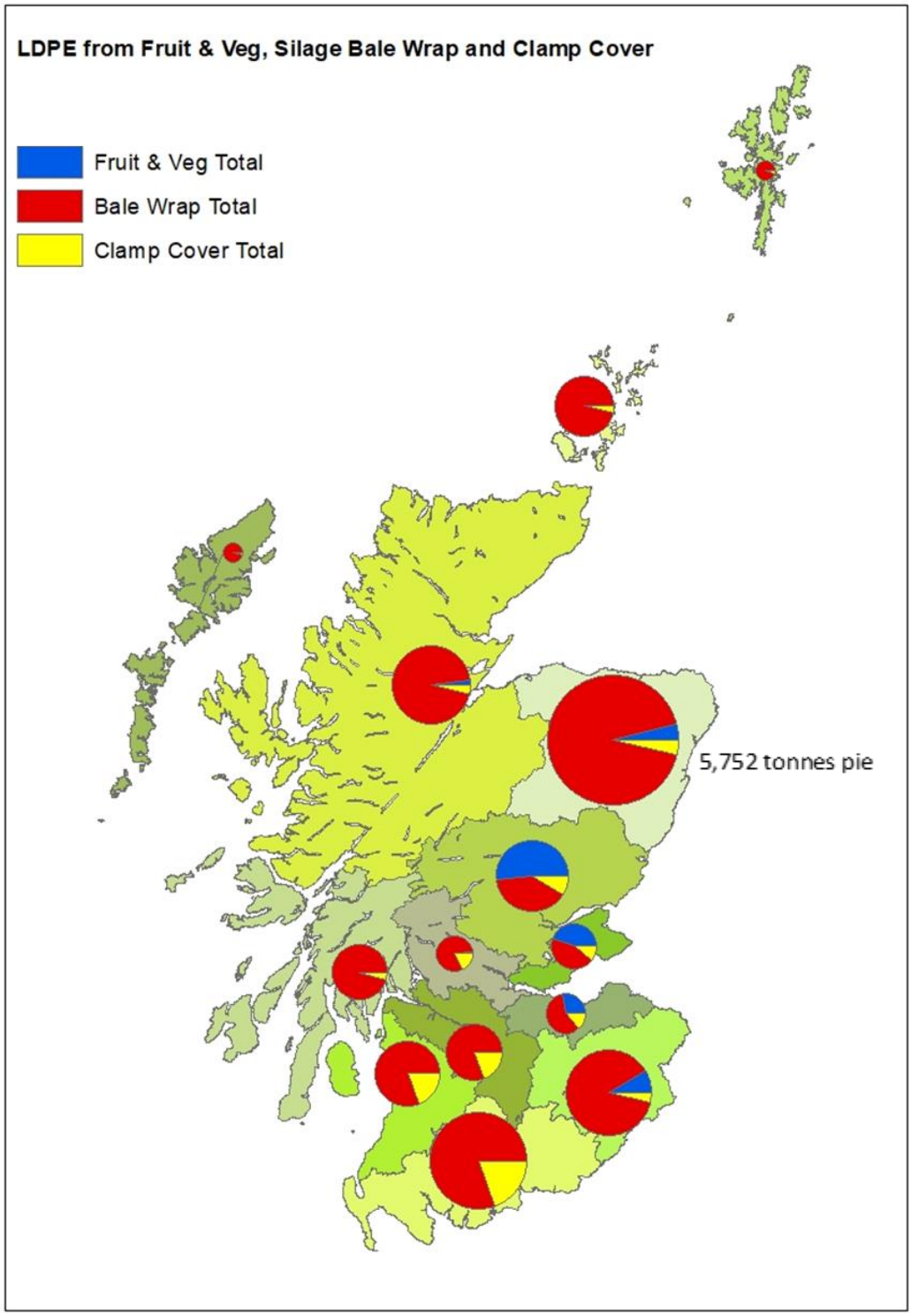


**Figure 7: Map of Scotland showing relative amounts of LDPE arisings from Fruit Vegetables plastic film, Silage Clamp cover and Silage bale wrap for Scottish sub-regions.**

Pie charts are sized proportionally to the Total LDPE arisings from fruit Vegetables plastic film, Silage Clamp cover and Silage bale wrap. The largest pie chart represents a total of 5752 tonnes.

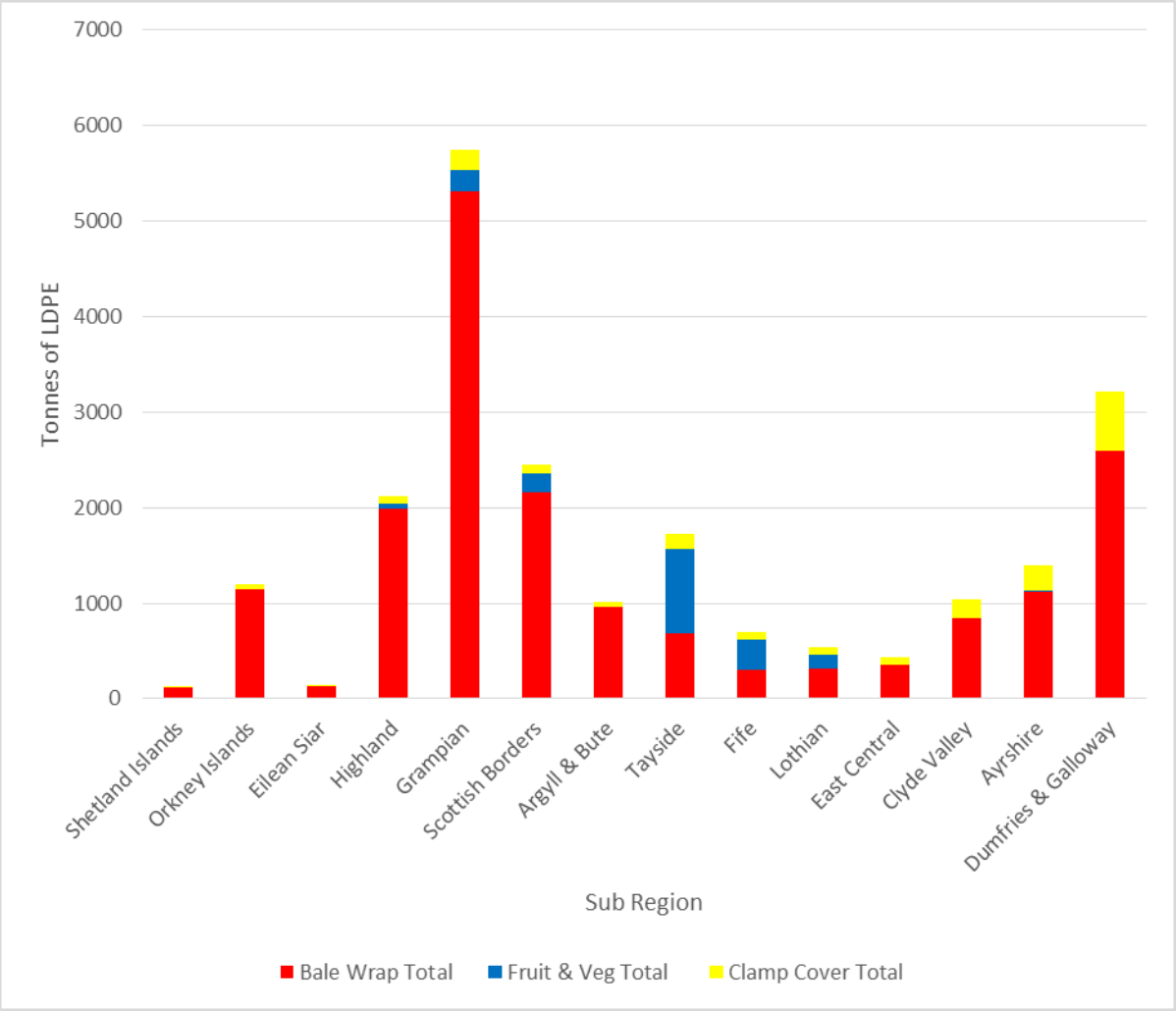


**Figure 8. Amounts of LDPE arisings from Fruit Vegetables plastic film, Silage Clamp cover and Silage bale wrap for Scottish sub-regions**

## 6.4 References


Scottish Government, 2016a. *Economic Report On Scottish Agriculture - Section C Time Series*. [online] Www2.gov.scot. Available at: https://www2.gov.scot/Topics/Statistics/Browse/Agriculture-Fisheries/PubEconomicReport/TimeSeries

Scottish Government, 2016b. *Results from the June 2016 Scottish Agriculture Census.* Available at: https://www.gov.scot/publications/results-june-2016-scottish-agriculture-census/pages/1/

Scottish Government, 2017a. *Economic Report On Scottish Agriculture - Section C Time Series*. [online] Www2.gov.scot. Available at: https://www2.gov.scot/Topics/Statistics/Browse/Agriculture-Fisheries/PubEconomicReport/TimeSeries

ADAS, 2007. *Research study into the quantities of UK packaging/non-packaging waste farm plastic arising from farms*. AWP Programme Management Board.

ADAS, 2011. *Horticultural Crops Grown Under Protection - Impact of Use of Temporary Covers and Plastic Mulches on UK Agronomic Practice*. Defra.

# 7 Questionnaire Study results

## 7.1 Summary of responses

The total number of interviews successfully completed was 91 out of a target of 100 – giving a 91 % response rate. This is shown in the table below. The variance was due to the interviewer failing to get agreement to carry out the interview after 2 call backs.

| | Target number of interviews | Actual number of interviews | Variance |
|---|---|---|---|
| Veg & Horticulture | 10 | 8 | -2 |
| Dairy | 14 | 13 | -1 |
| Beef & Sheep | 42 | 43 | +1 |
| Arable / AD | 8 | 7 | -1 |
| Contractors | 9 | 4 | -5* |
| Waste collectors | 10 | 9 | -1 |
| Plastic film suppliers | Up to 5 | 5 | 0 |
| Reprocessors | Up to 2 | 2 | 0 |
| **Total** | **100** | **91** | |

* In addition to the 4 respondents recorded as contractors, there were 4 more who were both farmers and contractors. These have been recorded within the appropriate farm type category

**Table 6: Summary of questionnaire response numbers**

## 7.2 Farmers & growers

### *7.2.1 Location of respondents*

The breakdown by interviews by location for farmers and growers is shown in the table below. This is very close to the target figures set out in *Table1*.

| Survey Responses | Argyll & Bute | Ayrshire | Clyde Valley | Dumfries & Galloway | Fife | Grampian | Highland | Lothian | Eilean Siar | Orkney | Scottish Borders | Shetland | Tayside | No location given | Grand Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Arable & AD | | | | | 1 | 2 | 1 | 1 | | | | | 2 | | **7** |
| Beef & sheep | 3 | 3 | 4 | 9 | | 4 | 6 | | 1 | 2 | 4 | 1 | 4 | 2 | **43** |
| Dairy | 1 | 3 | 2 | 6 | | 1 | | | | | | | | | **13** |
| Veg/horticulture | | | | | 2 | 1 | | | | | 1 | | 3 | 1 | **8** |
| Contractors | | | | | | 1 | | | | | 1 | | | 2 | **4** |
| **Total farmer & growers** | **4** | **6** | **6** | **15** | **3** | **9** | **7** | **1** | **1** | **2** | **6** | **1** | **9** | **5** | **75** |

**Table 7: Breakdown of farmers and growers interviewed by location**

### 7.2.2 Uses of LDPE by farm type

Farmers were asked about their use of film plastic on their farms. Their responses relating to the function for which LDPE is used on the farm is summarised, for each different farm type, in *Table 8* and *Table 9*.

| Q2. Uses of LDPE by Farm Category (Yes / No) | Arable; Anaerobic digestion plants | Beef & Sheep | Dairy | Vegetable growers / horticulture | Contractors |
|---|---|---|---|---|---|
| LDPE soil cover | Y | N | N | Y | N |
| LDPE silage cover | Y | Y | Y | N | N |
| LDPE bale wrap | Y | Y | Y | Y | Y |
| LDPE bale bags | N | Y | N | N | N |
| LDPE ag bags | Y | Y | N | N | N |

**Table 8: Summary of LDPE film plastic used by different farming types**

| Q2. Uses of LDPE (count of responses) | Arable; Anaerobic digestion plants | Beef & Sheep | Dairy | Contractors | Vegetable growers/ horticulture | Grand Total |
|---|---|---|---|---|---|---|
| LDPE ag bags; LDPE silage cover | 1 | 1 | | | | **2** |
| LDPE bale wrap | 1 | 25 | | 3 | 2 | **31** |
| LDPE bale wrap; LDPE bale bags | | 1 | | | | **1** |
| LDPE bale wrap; LDPE silage cover | | 12 | 10 | | | **22** |
| LDPE bale wrap; LDPE silage cover; LDPE soil cover | | | | | 1 | **1** |
| LDPE silage cover | 3 | 3 | 3 | | | **9** |
| LDPE silage cover; LDPE bale wrap | | 1 | | | | **1** |
| LDPE silage cover; LDPE bale wrap; LDPE silage cover | 1 | | | | | **1** |
| LDPE soil cover | 1 | | | | 4 | **5** |
| N/A | | | | 1 | 1 | **2** |

**Table 9: Responses relating to uses of LDPE film plastic for different farming types**

The dairy farmers were predominantly using LDPE plastic to cover silage clamps, which demonstrates the requirement for a higher quantity and quality of silage to be stored on individual dairy farms. None rely totally on wrapped bales, but of those responding 75%, also used LDPE bale wrap on baled silage to supplement the clamp silage.

The beef and sheep farmers predominantly use LDPE bale wrap, which accounted for 58% of the farmers surveyed. 28% reported using both bale wrap and clamp cover film, while a smaller number (7%) reported using LDPE silage clamp cover only. Part of this may be a practice to cover wrapped bale stacks with a film plastic for weather and animal/bird damage protection.

As would be expected most of the crop cover plastic film is used by the vegetable growers, but one of the five respondents was an arable and AD farm, and may have been a farm also growing field scale vegetables. This may be an anomaly of the small number of the study. 25% of the vegetable growers and horticulture responded that they use bale wrap. It is not clear from the study but it may be that the

respondent was thinking that wrap plastic is used to wrap produce, and palleted produce. It is also possible, that some of the farmers in the vegetable growers /horticulture category also keep some livestock.

It is interesting to observe that five out of seven of the arable and AD farmers responding had silage cover plastic. Two of the seven respondents also had some bale wrap plastic. These farms reported that they have large quantities of silage in clamps, with some reporting that they have some livestock. Many arable farms will have some livestock although classed themselves as mainly arable, and it is known that three of the seven interviewed had an AD plant.

Ag bag plastic is used but this method of silage conservation appears not to be widely practiced, with only 2 (5%) farmers using this method. One farmer has arable and AD and this may be that some AD feedstock, possibly from neighbours' farms with no clamp silage facility, is conserved in this way.

There is very little use of bags for conserving baled silage, and the majority of plastic used on baled silage is wrap film. These findings support the concentration on silage bale wrap, silage film and plastic crop cover in the LDPE mapping section as they are the major uses of LDPE in agriculture in Scotland.

### *7.2.3 What quantities of film plastic is collected from farms in Scotland?*

The farmers were asked about how much Farm film plastic they purchase per year. Farmers' responses relating to how much produce they use plastic film for and how much farm film plastic they purchase each year are summarised in *Table 10* and *Table 11* respectively.

These tables indicate the range of amounts of LDPE that farms purchase. There is considerable range in farm size and the questionnaire study was undertaken on a small number of farms, and so the range of quantity of plastic purchased and used by each farm will be quite variable. It should also be noted that figures reported by farmers are a reflection of their 'on-the-spot' knowledge when interviewed of amounts of LDPE they purchase and may not be a truly accurate representation of the actual amounts.

*Table 10* reports the range of tonnage of silage and area of crop from the farmers responding. The average weight of individual bales that are wrapped varies and could indicate that some farms, notably dairy farms would conserve silage in square bales which are denser than the round bales that are mostly used in the beef and sheep industry.

Only two farmers in the questionnaire study report using ag bags. In *Table 11*, the range of amounts of LDPE farmers used per year is reported as different amounts depending on the type of plastic. In *Table 12* these amounts were converted to weights using a conversion factor to give an estimate of the range of weights of different types of plastic farmers purchase per year. These estimates produced from the quantities given by farmers will be lower than the mass of plastic waste arisings because plastic film picks up contamination during use, which significantly increases the weight collected.

The actual weight per square metre of plastic bunker cover is likely to vary greatly depending on the individual farmer's practice. Several gauges of plastic are available and some farmers put a thin primary sheet and a more robust secondary sheet for physical protection against damage.

| Q3. How much farm film plastic do you buy each year? Farm Type | Number of Bales | Bale Silage (tonnes) | Ag bag Silage (tonnes) | Pit (Bunker) Silage (tonnes) | Crop cover (hectares) |
|---|---|---|---|---|---|
| **Arable; Anaerobic digestion plants** | 400 - 1,500 | | 1,000 | 500 - 30,000 | 5.3 |
| **Beef & Sheep** | 36 - 15,000 | 20 - 2500 | 20,000 | 800 - 4,000 | |
| **Dairy** | 180 - 3,050 | 125 - 1700 | | 1,200 - 7,200 | |
| **Contractor** | 3,500 - 10,000 | 4,900 - 4,900 | | | |
| **Vegetable growers / horticulture** | 375 - 1,000 | 650 | | 850 | 2 - 140 |
| **All Farm types** | **36 - 15,000** | **20 - 4,900** | **1,000 - 20,000** | **500 - 30,000** | **2 - 140** |

**Table 10: Range of responses on quantities of farm film plastic purchased annually**

| Q7. How much LDPE do you purchase per year? Farm Type | Number of rolls of bale wrap | Number of Ag bags | Length of Ag bags (m) | Area of silage clamp cover (m2) | crop cover (hectares)2 |
|---|---|---|---|---|---|
| **Arable; Anaerobic digestion plants** | 150 - 150 | 3 - 3 | 50 - 50 | 1,150 - 7,650 | 5.3 - 5.3 |
| **Beef & Sheep** | 2 - 480 | 20 - 20 | 100 - 100 | 150 - 2,340 | |
| **Dairy** | 4 - 100 | | | 700 - 5,500 | |
| **Contractor** | 85 - 480 | | | | |
| **Vegetable growers / horticulture** | 10 - 35 | | | 550 - 550 | 2 - 270 |
| **All Farm types** | **2-480** | **3 - 20** | **50 - 100** | **150 - 7,650** | **2 - 270** |

**Table 11: Range of responses to how much LDPE purchased per year by farm type**

Table 12 shows estimated range of weights (in tonnes) of different types of farm film plastic purchased by farmers per year. Weights were calculated using the reported amounts and multiplying by a standardised factor for each type of plastic. These factors were informed from our knowledge gained from interviews with plastic suppliers and from previous research work on plastics (ADAS 2007). The following figures provide an approximation and should be used with caution:

- 1m2 of bunker cover = 0.003 tonnes (0.3kg/m2)
- 1 roll of bale wrap = 0.024 tonnes (24kg)
- 1 hectare of crop cover = 0.5 tonnes (0.05kg/m2)

| Farm Type | Tonnes of bale wrap | Tonnes of silage clamp cover | Tonnes of crop cover |
|---|---|---|---|
| **Arable; Anaerobic digestion plants** | 3.6 - 3.6 | 0.345 - 2.295 | 2.9 - 2.9 |
| **Beef & Sheep** | 0.048 - 11.52 | 0.045 - 0.702 | - |
| **Dairy** | 0.096 - 2.4 | 0.21 - 1.65 | - |
| **Contractor** | 2.04 - 11.52 | - | - |
| **Vegetable growers / horticulture** | 0.24 - 0.84 | 0.165 - 0.165 | 1.1 - 148.5 |
| **All Farm Types** | 0.048 - 11.52 | 0.045 - 2.295 | 1.1 - 148.5 |

[1]Ag bag weights are not included in this table as only two farmers in the questionnaire study reported using ag bags.

**Table 12: Estimated range of weights (in tonnes) of different types of farm film plastic purchased by farmers per year[1]**

### *7.2.4 Purchasing of LDPE*

Farmers were asked if they purchase their own LDPE film plastic, and typical quantities. Their responses are summarised in *Table 13*.

| Q4. Do you buy your own farm film plastic? | Yes | No | No response |
|---|---|---|---|
| Count | 50 | 20 | 5 |
| Percentage | 67% | 27% | 7% |

**Table 13: Summary of responses to whether farmers purchase their own farm film plastic.**

The study indicates that two thirds of the farmers source their own supply of LDPE film plastic, and a third do not. It is therefore assumed that a third of farmers are supplied through farm contractors. The exceptions were in Argyll & Bute where only 50% purchase their own farm film plastic and Shetland and Orkney where 100% of the respondents said they do not buy their own. The farmers' responses relating to when they purchased LDPE film plastic are summarised in *Table 14*.

| Q11. When do you purchase farm film plastic? | Count of responses | Percentage |
|---|---|---|
| Autumn | 1 | 1% |
| Spring | 25 | 33% |
| Spring & Autumn | 1 | 1% |
| Spring & Winter | 1 | 1% |
| Summer | 22 | 29% |
| Summer & Spring | 4 | 5% |
| No response | 21 | 28% |
| **Grand Total** | **75** | **100%** |

**Table 14: Farmer responses to when LDPE film plastic is purchased**

It is apparent that the majority of the farmers surveyed purchase their LDPE in spring (33%) and summer (30%). This indicates farmers tend to purchase their LDPE at the point of use and farmers do not forward purchase their stock. The purchase is usually just before crop establishment (crop cover film) and just before the grass harvest season (silage wrap and clamp film) for use in the same year.

### *7.2.5 Re-use of LDPE*

Farmers were asked whether they re-use farm film plastic. Their responses are summarised in *Table 15*.

| Q8. Do you reuse any farm film plastic? | Yes | No | No response |
|---|---|---|---|
| Count | 17 | 56 | 2 |
| Percentage | 23% | 75% | 3% |

**Table 15: Summary of responses to whether farmers re-use any farm film plastic**

This indicates that the majority of farmers (75%) do not re-use any of their farm film plastic, instead sending it to be recycled and purchasing new plastic film every year.

Farmers were also asked how they re-use farm film plastic, and how many times they re-use it. Their responses to these questions are summarised in *Table 16*.

| Q9. How do you reuse any farm film plastic? | Count of responses | Percentage |
|---|---|---|
| Original use | 15 | 88% |
| Other use | 2 | 12% |
| **Grand Total** | **17** | **100%** |

**Table 16: Summary of responses of farmers who do re-use their film plastic to how they re-use farm film plastic**

| Q10. How many times do you re-use farm film plastic before disposal? | Count of responses | Percentage |
|---|---|---|
| 1 | 3 | 18% |
| 2 | 4 | 24% |
| 2 or 3 | 3 | 18% |
| 3 or 4 | 2 | 12% |
| 3 to 10 | 1 | 6% |
| 6+ | 1 | 6% |
| 10 | 1 | 6% |
| as many as possible | 1 | 6% |
| minimum 2 | 1 | 6% |
| **Grand Total** | 17 | 100% |

**Table 17: Summary of responses of farmers who do re-use their film plastic to how many times they re-use farm film plastic**

*Table 17* indicates that the number of times plastic is re-used varies greatly in the type of response. Very few farms re-use their plastic more than 4 times. With only 3 farmers responding that they definitely re-use their film more than 4 times

Of the 23% of responders who do re-use plastic the vast majority (88%) do so for the same use. *Table 18* shows that this is most likely to be for covering silage clamps, possibly as a secondary cover or for

side walls of clamps, and for the vegetable growers to use as crop cover. By its nature wrap film re use is less obvious.

| Use of LDPE (in most cases, farmers reported multiple uses - reuse type as shown) | Original use | Other use |
|---|---|---|
| LDPE ag bags; LDPE silage cover | 7% | 0% |
| LDPE bale wrap; LDPE silage cover | 33% | 50% |
| LDPE bale wrap; LDPE silage cover; LDPE soil cover | 0% | 50% |
| LDPE silage cover | 40% | 0% |
| LDPE silage cover; LDPE bale wrap | 7% | 0% |
| LDPE soil cover | 13% | 0% |
| **Grand Total** | **15** | **2** |

**Table 18: Percentage of re-use for original or different use for different types of farm film plastic**

### *7.2.6 LDPE collection*

Farmers were asked whether agricultural film waste was collected from their farms. Their responses are summarised in *Table 19.*

From farmers' responses, over half of farms have a collection service in all areas of Scotland with the Exception of Argyll and Bute, Tayside on the mainland, Shetland and Eilean Siar. This is an indication that collection may be challenging on the islands and remote west coast. Boat passage is quite expensive probably even in bulk and the small farmsteads and crofters on the islands probably cannot afford the cost of plastic disposal. There is no explanation for a low uptake in Tayside. The study included response from collectors who indicate that there is national coverage offers by a number of collectors, and it may be that services are not marketed or promoted out to more remote areas, or unwillingness to seek our recyclers by the farmer users of plastic.

Overall, 35% of the respondents report to not having their farm film waste collected. This could be due to many reasons such as low volume, difficult access, availability, or whether the farm has not sought a collection.

A high proportion of farmers in Dumfries and Galloway, and in Grampian said that plastic is collected from farms which may be influenced by the type of farm and readiness to recycle attracting collection services there.

| Q12. Is agricultural plastic film waste collected from your farm? | | | | | | |
|---|---|---|---|---|---|---|
| **Location** | **Yes** | | **No** | | **No response** | |
| Argyll & Bute | | 0% | 4 | 100% | | 0% |
| Ayrshire | 3 | 50% | 3 | 50% | | 0% |
| Clyde Valley | 3 | 50% | 3 | 50% | | 0% |
| Dumfries & Galloway | 13 | 87% | 2 | 13% | | 0% |
| Fife | 2 | 67% | 1 | 33% | | 0% |
| Grampian | 8 | 89% | | 0% | 1 | 11% |
| Highland | 4 | 57% | 3 | 43% | | 0% |
| Lothian | 1 | 100% | | 0% | | 0% |
| Eilean Siar | | 0% | 1 | 100% | | 0% |
| Orkney | 2 | 100% | | 0% | | 0% |
| Scottish Borders | 3 | 50% | 2 | 33% | 1 | 17% |
| Shetland | | 0% | 1 | 100% | | 0% |
| Tayside | 3 | 33% | 5 | 56% | 1 | 11% |
| No Response | 3 | 60% | 1 | 20% | 1 | 20% |
| **Total of responses from all locations** | **45** | **60%** | **26** | **35%** | **4** | **5%** |

**Table 19: Summary of responses to whether farm film plastic is collected from farms. The responses are broken down by location**

Farmers were also asked about reasons why they do not have their farm film plastic waste collected. Their responses are summarised in *Table 20*. Of the farmers who responded that their farm film plastic waste was not collected (n=26) the main reason given (27%) was that this was because there were no waste collectors in their area. This response seems inconsistent with the distribution of waste collection services. It is possible that this could be due to the specialised nature of agriculture (and the resultant film plastic waste arising) in some regions.

| Q15. Do any of these reasons for not using a plastic waste collector or recycling service apply to you? | Count | Percentage |
|---|---|---|
| Even if the waste is collected, I don't believe it gets recycled in any case | 1 | 4% |
| No space on the farm to store the material | 1 | 4% |
| There are no waste collectors in my area | 7 | 27% |
| No reason given | 17 | 65% |
| **Total farms who do not have their plastic waste collected** | 26 | 100% |

**Table 20: Summary of responses to reasons for not having farm film waste collected**

Farmers were also asked about how often their farm film plastic waste was collected. Their responses are summarised in *Table 21*. On the regularity of collection, it is apparent that most farms have their collections either 6 monthly (37%) or twelve monthly (45%). This will place a requirement on farmers to hold and store film plastic on the farm for prolonged periods of time, and for best practice stored in a dry place.

| Q13. How often do you have your plastic collected for recycling? | Count | Percentage |
|---|---|---|
| Every 12 months | 23 | 45% |
| Every 6 months | 19 | 37% |
| Every month | 7 | 14% |
| Less frequently than every 12 months | 2 | 4% |
| **Total farmers that responded** | **51** | |

**Table 21: Summary of responses to how often farm film plastic waste was collected from their farm**

### *7.2.7 Storage practice on farms in Scotland*

With most farms having an infrequent service for collection, farms are required to store plastics on the farm. Farmers were asked how they store plastic film waste on their farm. Their responses are summarised in *Table 22*.

| Q16. How do you store plastic film waste prior to recycling/collection? | Count | Percentage |
|---|---|---|
| Outside | 41 | 55% |
| Under cover | 26 | 35% |
| Under cover & outside | 3 | 4% |
| No response | 5 | 7% |
| **Grand Total** | **75** | **100%** |

**Table 22: Summary of responses to how farmers store their farm film plastic waste**

It is evident that many farmers do not collect and store plastics in a responsible manner, and this increases the risk of raised levels of contamination. 55% of farmers store plastic outside, most probably without any management, whist 39% of farmers take measures to keep at least some of their used plastic under cover.

## 7.3 Waste collection companies & sub-contractors

Information was gained through interviews with waste collection companies and online research.

### *7.3.1 Waste collection companies' operating areas and collection distance limits*

Collectors were asked to supply information on where they collect plastic in Scotland and the limit on distance travelled to collect. Responses are summarised in *Tables 23 and 24.* Waste collection company 5 and Waste collection company 9 offer collection services of agricultural plastics in all sub-regions. Waste collection company 6 offers the most extensive collection of the other collectors but excludes Grampian, Highlands and the islands.

The number of collectors covering each region is also shown. There are extensive collection services offered in all regions of Scotland, but reduced options for collector selection in the remote islands of Eilean Siar, Orkney and Shetland.

| Company Name | Argyll & Bute | Ayrshire | Clyde Valley | Dumfries & Galloway | East Central | Fife | Grampian | Highland | Lothian | Eilean Siar | Orkney | Scottish Borders | Shetland | Tayside | Regions Covered |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Waste collection company 1 | | | | | | | | | Y | | | Y | | | **2** |
| Waste collection company 2 | | | | | | | Y | | | | | | | | **1** |
| Waste collection company 3 | | | | | | | | Y | | | | | | | **1** |
| Waste collection company 4 | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | **14** |
| Waste collection company 5 | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | **14** |
| Waste collection company 6 | Y | Y | Y | Y | Y | Y | | | Y | | | Y | | Y | **9** |
| Waste collection company 7 | N/A | | | | | | | | | | | | | | **N/A** |
| Waste collection company 8 | | | | | | | Y | Y | | | | | | Y | **3** |
| Waste collection company 9 | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | **14** |
| | **4** | **4** | **4** | **4** | **4** | **4** | **5** | **5** | **5** | **3** | **3** | **5** | **3** | **5** | |

**Table 23. Waste collection companies' operating areas**

The distance covered by each waste collection company is shown in *Table 24.*

| Q5. Company Name | Distance limit to collections (km) |
|---|---|
| Waste collection company 1 | More than 200 |
| Waste collection company 2 | 100 – 200 |
| Waste collection company 3 | 25 – 50 |
| Waste collection company 4 | More than 200 |
| Waste collection company 5 | More than 200 |
| Waste collection company 6 | More than 200 |
| Waste collection company 7 | No response but assumed to be less than 100 |
| Waste collection company 8 | 100 – 200 |
| Waste collection company 9 | More than 200 |

**Table 24: Distance limit of waste recycling companies**

### *7.3.2 Planned expansion*

Asked whether there are plans to increase and expand the services offered, four of the collectors indicated that they would do so. Shetland, Tayside, Fife, East Central (one collector each) and Highland (two collectors) were the areas that companies would expand their services into.

### *7.3.3 Collection points*

Waste collectors were asked where they collected farm waste from, their responses are summarised in *Table 25*. Most offer an on-farm collection service from individual farm gates with some collectors offering an option of picking up from a farmer group, hub or a licensed waste site. One of the respondents offered farm film plastic waste only collection from a licensed waste site.

| Q6. Which of the following pick up points do you collect from? | Count of Response |
|---|---|
| Individual farm gate | 3 |
| Individual farm gate; Farmer group or hub | 1 |
| Individual farm gate; Licensed waste site | 3 |
| Licensed waste site | 1 |
| No response | 1 |
| Grand Total | 9 |

**Table 25: Collection point options offered by waste collectors**

Collectors were asked to indicate the scale of their operation; their responses are summarised in *Table 26*. The response shows that two of the operators have a large and extensive service collecting from more than 100 farms. A further two operators have moderate level of farm collections in the region of 50 to 100. Few waste collectors are such small scale that they collect from less than 50 farms, with only two of the waste collectors surveyed indicating that they collect from fewer than 50 farms.

| Q7. Approximately how many farms do you collect from? | Count of Response |
|---|---|
| Less than 10 | 1 |
| 10 - 50 | 1 |
| 50 - 100 | 2 |
| More than 100 | 2 |
| no response | 3 |
| **Grand Total** | **9** |

**Table 26: Summary of number of farms waste collection companies collect from**

Waste collectors were also asked to indicate how many central collection points they collect from. Their answers are summarised in *Table 27*. All of the respondents who answered this question indicated that they collect from fewer than 10 centralised collection points or licensed waste sites. This, along with results shown in *Table 25*, suggests that by far the most common method of collecting farm film plastic waste is by collection from the individual farms.

| Q8. Approximately how many central collection points and/or licensed waste sites do you collect from? | Count of Response |
|---|---|
| Less than 10 | 6 |
| No response | 3 |
| **Grand Total** | **9** |

**Table 27: Summary of number of collection points / licensed operations waste collectors collect from**

### 7.3.4 *Quantities collected*

Waste collectors were asked about quantities of waste farm film plastic of different types they collect in a year. Their responses are summarised in *Table 28*. Reports from one of the processors attributed over 3000 tonnes of bale wrap to a second collector. From the study responses the quantity of crop cover film collected is a small figure, which may indicate a reluctance to collect this type of film because of high contamination levels. It is interesting to note that one collector was reported by a processor to have delivered over 1000 tonnes of clear plastic crop cover.

| Q10. Company Name | LDPE bale wrap? (tonnes pa.) | LDPE bale bags? (tonnes pa.) | LDPE ag bags? (tonnes pa.) | LDPE silage cover? (tonnes pa.) | LDPE soil cover? (tonnes pa.) |
|---|---|---|---|---|---|
| Waste collection company 1 | 50 | | | | 10 |
| Waste collection company 2 | 140 | | | | |
| Waste collection company 3 | | | | | |
| Waste collection company 4 | | | | | >1000 |
| Waste collection company 5* | 720 | 720 | 720 | 720 | 720 |
| Waste collection company 6 | 3000 | | | | |
| Waste collection company 7 | | | | | |
| Waste collection company 8 | 100 | | | | |
| Waste collection company 9 | | | | | |

* A single response of 3600 tonnes was provided. This has been divided equally across the 5 categories

**Table 28: Collectors' estimates of quantities of different agricultural plastic collected**

Collectors were also asked to estimate the approximate tonnage of farm film plastic they collect per year. Their answers are summarised in *Table 29*. Two of the collectors offer a very limited service

collecting less than 100 tonnes. Two are an average size but two operators offer an extensive service collecting over 1000 tonnes per year with a third said to deliver over 1000 tonnes (by a reprocessor).

| Company Name | Q11. What is the approximate tonnage of farm film plastic waste that you collect each year? |
|---|---|
| Waste collection company 1 | 100 - 500 tonnes |
| Waste collection company 5 | Over 1000 tonnes |
| Waste collection company 3 | 1 - 100 tonnes |
| Waste collection company 2 | 100 - 500 tonnes |
| Waste collection company 8 | 1 - 100 tonnes |
| Waste collection company 4 | Over 1000 tonnes |
| Waste collection company 6 | 3000 |
| Waste collection company 7 | No response |
| Waste collection company 9 | Over 1000 tonnes |

**Table 29: Estimate of scale of operations of each collector's business**

### *7.3.5 Restrictions on collections*

In the survey the collectors were asked whether they applied any restrictions to collected plastics. Their responses are summarised in *Table 30* and *Table 32*.

*Table 30* indicates that all of the surveyed waste collectors who responded to this question apply restrictions to waste collections. The main issues were level of contamination, meaning collectors could refuse to collect plastic with a high level of contamination. Collectors also often require the producer at the farm to sort plastics into type so that it is effectively segregated at source, with over half (4 out of 7) of respondents who answered this question indicating that they apply this kind of restriction. One respondent indicated that they apply both contamination restrictions, plastic waste separation and also require packaging of plastic waste prior to collection.

| Q12. Do you put any restrictions on your waste collections? | Count of Response |
|---|---|
| Yes | 6 |
| no response | 3 |
| **Grand Total** | 9 |

**Table 30: Summary of responses to whether waste collectors apply restrictions to waste collections**

| Q13. What restrictions do you specify? | Count of Response |
|---|---|
| Amount of contamination | 2 |
| Amount of contamination; Packaging of waste; Separation of different types of plastic waste | 1 |
| Separation of different types of plastic waste | 4 |
| **Grand Total** | 7 |

**Table 31: Summary of restrictions on waste collections applied by surveyed waste collectors**

### *7.3.6 Waste packaging prior to collection*

Collectors were asked to indicate how their plastic waste is packaged before collection. Their responses are summarised in *Table 33*. The method of collection varies between collectors. The majority of collectors (5 out of 9) indicated that they collect in bags that can be handled to lift onto collection vehicles. One collector offers a branded collection bin for holding plastics on the farm for collection. Skips, and bins also appear to be an acceptable form of collection with some collectors, with 3 out of 9 collectors indicating they accept this method.

| Q14. How is the farm film waste packaged prior to collection? | Number of respondents who use this method of packaging |
|---|---|
| In bags | 5 |
| In bales | 1 |
| In containers – e.g. skips, barrels, bins | 3 |
| No packaging | 1 |
| Taken in bulk if delivered | 1 |

**Table 32: Summary of responses relating to packaging and presentation of plastics for collection**

### 7.3.7 *Additional services*

The survey asked collectors whether they offered any additional services to farmers. Their responses are summarised in *Table 33*. Just under half of the collectors failed to respond to this question which probably indicates that they offer no additional services. Of those that do, this included compaction and shredding service (1 respondent) and cleaning, compaction and shredding (2 respondents). Pelleting was offered by one of the collectors although this is most likely the service offered after collection and further into the processing. According to their website, the one collector that was reported by a reprocessor to have delivered over 1000 tonnes of clear plastic crop cover, offers a washing process.

| Q15. Do you offer any additional services at the point of collection? | Count of Response |
|---|---|
| Compaction; Shredding | 1 |
| Compaction; Shredding; Cleaning / removal of contaminants | 3 |
| Pelleting | 1 |
| no response | 4 |
| **Grand Total** | 9 |

**Table 33: Summary of responses relating to additional services offered by collectors**

### 7.3.8 *Frequency of collections*

Collectors were asked how their service was organised with farmers. Their responses are summarised in *Table 34*. The majority of collectors appear to prefer an organised and planned service of collection as well as collecting waste when requested to by the farmer. No company would reject a request for service, which presumably could develop into a planned service contract. The farm plastic collectors were asked the frequency of collection from farms. Two collectors offer a 6 month service and two a 12 month service. This correlates with the farmer's survey. The remainder of collectors could not comment or did not know, presumably collecting at a time suited to the farmer.

| Q16. Which of the following statements best describe your collection services? | Count of Response |
|---|---|
| We collect by individual request | 1 |
| We offer a regular planned collection service | 1 |
| We offer both a planned collection service and collection by request | 5 |
| No response | 2 |
| **Grand Total** | 9 |

**Table 34: Summary of responses on frequency of collection services**

## 7.4 Waste Reprocessors

Third party processors of the plastic waste were identified and contacted. When initial evaluation identified only one reprocessor, ADAS contacts were able to identify one other processor of agricultural plastic. Other reprocessors were identified that treated clear post-consumer plastics but these do not process agricultural plastic.

Both companies were interviewed with a questionnaire which was enhanced by their general comments on the company, suppliers and markets. Both companies reported difficult trading conditions at the moment as a result of the low oil price and price of new plastic.

Reprocessing company 1 is not based in Scotland and does not receive material from Scotland. It operates elsewhere in the UK. This facility was established to process waste from clean sources but incorporated a washing section. This had been specified for the clean post-consumer plastic, but an opportunity arose to fill a gap in treatment of black film plastic as other processors in their location concentrate only on clear plastic. The washing facility had been specified for clean plastic but proved to be capable of taking black agricultural film, albeit at a significantly reduced throughput as a result of the high levels of contamination. The company would like to invest in higher washing capacity but the economic case is not viable at current recycled plastic prices.

Reprocessing company 2 receives material from Scotland. The company website indicates that it recycles black and clear plastic from a wide range of sources within the UK, Irish Republic and France. During the interview this was qualified to be plastic from all sources.

### *7.4.1 Farm film plastic processing - quantity*

The companies were asked how much farm film plastic was processed at their sites. Reprocessing company 2 commented that they had significant capacity (17,000 tonnes pa) but the quantities of material received from some suppliers had actually reduced.

| Company | Type agricultural plastic processed | Quantities |
|---|---|---|
| Reprocessing company 1 | Black LDPE film | 200 - 300 tonnes/month |
| Reprocessing company 2* | Black LDPE film | 5250 tonnes/year |
| Reprocessing company 2* | Clear LDPE film | 1500 – 2000 tonnes/year |

* The quantities of film reprocessed are the quantities that are delivered from Scottish farms. The clear and black processes are at separate facilities. Additional film processed in Scotland is said to be transported from England, Ireland and France.

**Table 35: Quantities of farm film plastic processed**

### 7.4.2 *Farm film plastic processing – type and products*

The companies were asked which types of film they processed at their site and their products.

| Company | Type | Products |
|---|---|---|
| Reprocessing company 1 | Black LDPE film | Recycled plastic pellets/granules |
| Reprocessing company 2 | Black LDPE film | Garden furniture, structural elements, refuse sacks, damp proof membrane (Visqueen) |
| Reprocessing company 2 | Clear LDPE film | |

**Table 36: Processing site materials and products**

### 7.4.3 *Material currently processed*

The companies were asked how much of the material the they received was reprocessed into product and the fate of material that could not be recycled.

| Company | Product | Landfilled | Water fraction | Permitted energy recovery |
|---|---|---|---|---|
| Reprocessing company 1 | 40 - 50% | 50 - 40% | | |
| Reprocessing company 2 | 40% | 35% | 20% | 5% |

**Table 37: Recycled product and recovery**

### 7.4.4 *Quality specifications*

The companies were asked about restrictions they placed on supply.

| Company | Restrictions | |
|---|---|---|
| Reprocessing company 1 | Do not accept silage sheet | Do not accept crop cover |
| Reprocessing company 2 | Rejection of contaminated material outside specification | Separation of types of plastic |

**Table 38: Supply quality requirements**

Reprocessing company 1 concentrated only on silage wrap film. They produce a granule for sale to extruders that use recycled plastic for remanufacture into new film. Customers feedback was that the granules made farm silage bunker sheet was unsuitable for the moulding companies to use in manufacture. This was believed to be as a result of the additives that are used to manufacture the wide rolls of bunker plastic. Information was required on the additive so the process might be adapted.

Reprocessing company 2 said that they had a specification for material which was adhered to by the supplying collectors. Loads that were unsuitable for processing were rejected and sent back.

As a result of the high haulage cost this latter sanction is a strong incentive to introduce a film cleaning process into the collector services.

## 7.5 Farm Film Plastic Suppliers

Five farm film supplies were approached. The selection was informed by responses to the farmer study questionnaire. Where possible it was aimed to gain the selection for an even geographic spread. The larger agricultural suppliers and agricultural engineers have several branches the Scotland.

The companies were initially contacted by telephone with a view to identifying the most appropriate salesperson for the response. Some requested further details by email and this was supplied. Due to the increasing pressures paced on business as a result of the social and economic effect of the Covid 19 pandemic, responses were not provided by three of the selected organisations. Where possible these gaps were filled by interrogation of the company website.

| Company | Supply company 1 | Supply company 2 | Supply company 3 | Supply company 4 | Supply company 5 |
|---|---|---|---|---|---|
| Branches | Ayrshire, Central & South West | Tayside | South East and Borders | Western Central, South and Borders | North and Central |

**Table 39: Location of company HQ and branches**

### *7.5.1 Sources and sales*

The suppliers were asked whether they imported, manufactured or re-sold the materials of interest. One respondent said that they re-sold and website investigation of the remainder showed that these were also reseller agents of established brands.

Suppliers were also asked whether they supplied direct to farmers or via contractors or both. From the single response received it was evident that both routes were supplied.

The suppliers were asked which of the LDPE products they supplied and how much of each material is provided. This is reported in the table below.

| Supply of LDPE by merchants | Supply company 1 | Supply company 2 | Supply company 3 | Supply company 4 | Supply company 5 |
|---|---|---|---|---|---|
| LDPE soil cover | N | 10 sheet rolls | N/R | No response | No response |
| LDPE silage cover | Y | 130 sheet rolls | | Y* | N |
| LDPE bale wrap | Y | 120 rolls | | Y* | Y* |
| LDPE bale bags | y | N | | N | N |
| LDPE ag bags | Y | N | | N | N |

* web site information

**Table 40: Film types supplied**

### 7.5.2 *Mass of plastic sold*

Suppliers were asked for roll weights. The only direct report was that a roll weighs approximately 24kg or 42 rolls per 1 tonne pallet. This corresponded to the manufacturers quoted weights on pallets from web site information. The brands sold by the suppliers included Silawrap, Topwrap and Claas Wrapex.

| Width | Length | Rolls/pallet | Approx no. of bales | Thickness | Colours |
|---|---|---|---|---|---|
| 500mm | 1800m | 24 | 26-28 | 25 Microns | Black<br>White<br>Eco Green |
| 750mm | 1500m | 40 | 30-34 | | |

**Table 41: Typical shipment properties of bale wrap (Topwrap)**

The most commonly quoted size is the 750mm wide roll, but other sizes include:

- 250mm x 1800mm rolls at 48 rolls per pallet in White or Eco-Green
- 360mm x 1500mm rolls at 30 rolls per pallet in White or Eco-Green

For the other brands web search provided similar weights for their equivalent 750mm roll product:

- Silawrap (Supply company 1) supplies 40 rolls to a 1100 kg pallet with a roll weight of 27.5 kg
- Class Wrapex (Supply company 5) is supplied in 750 mm rolls, 40 to a pallet

### 7.5.3 *Association with Recycling Schemes*

The suppliers were asked if any film plastic product sold belonged to a manufacturers recycling scheme. One respondent reported that they no longer did so as the scheme had been discontinued. A second respondent indicated that they were involved in the APE UK manufacturer's co-responsibility recycling initiative (see Literature Review – section 4) and are collecting payments for this recycling scheme.

# 8 Summary and analysis

## 8.1 Flow diagram of farm film plastic used in agriculture in Scotland

The figure below *(Figure 9)* illustrates the flow of plastic (blue arrows) and the flow of agricultural waste plastic (red arrows) into a recycled product (green arrow). If support is included (black broken arrow) there would be a cash flow in the form of Levy or membership to support the collection infrastructure. The recovery note option would be put in place to support a producer responsibility.

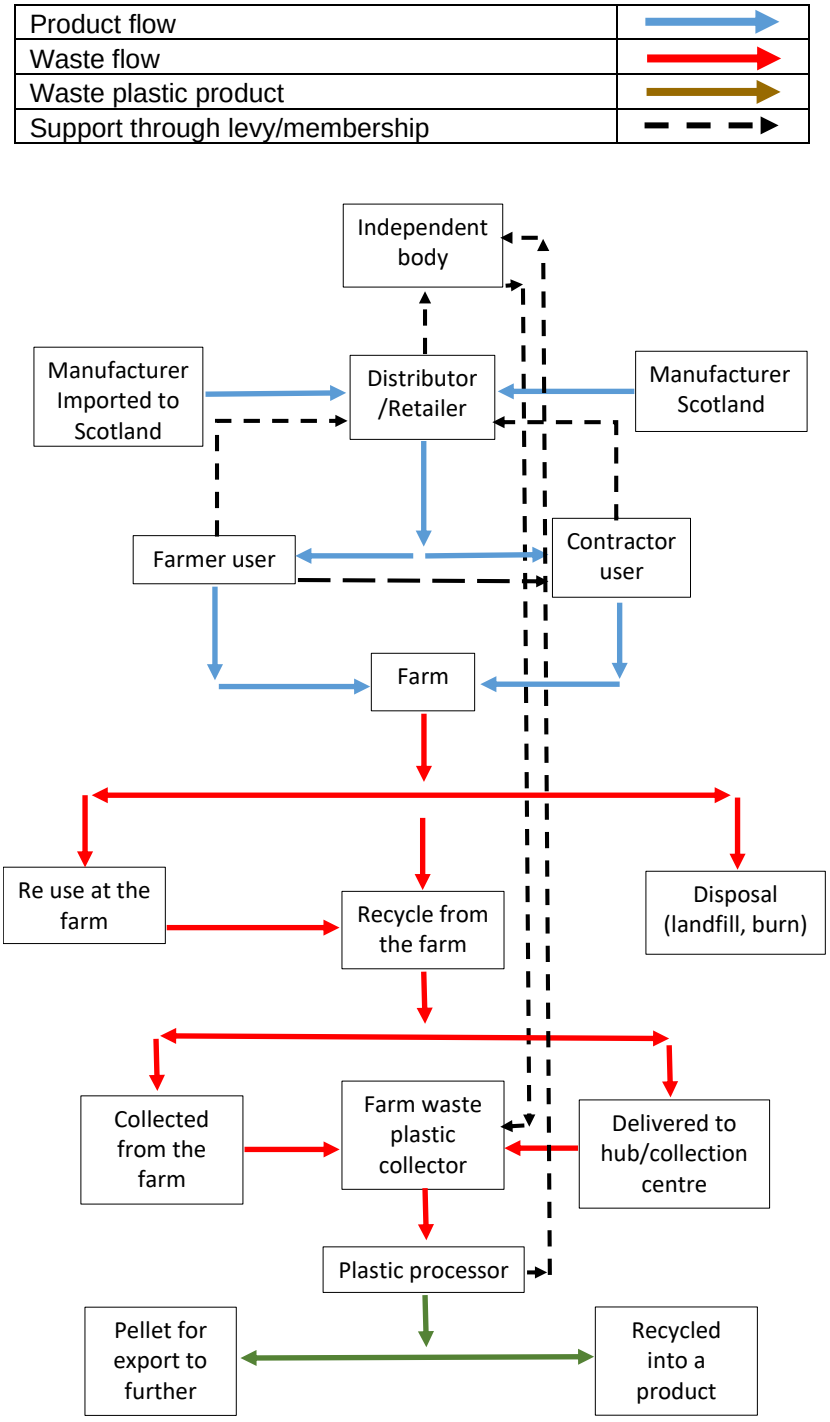


**Figure 9: Flow diagram of farm film plastic used in agriculture in Scotland**

## 8.2 Findings from mapping study and how they link to questionnaire study findings

The modelled data, used to inform the mapping study, was successful in being able to calculate LDPE arisings from farm film plastic waste at sub regional level in Scotland from first principles. By using the most up to date livestock and crop area statistics (Scottish Government, 2016a; 2016b; 2017a), this study gives a robust estimate of the possible arisings, including contamination incurred during usage and storage of plastic on farms, that may potentially be collected and recycled. The total quantity of LDPE arisings from farms in Scotland was estimated to be around 21,849 tonnes.

### *8.2.1 Bale Wrap plastic*

Silage bale wrap made up the majority of plastic arisings across all types of farming, with 18,033 tonnes of arisings from this type of LDPE plastic. These findings are supported by the Questionnaire study, which revealed silage bale wrap as the most common usage of LDPE plastic in farmers' responses. Across all regions, the vast majority of bale wrap plastic arisings were found to be from the beef farming sector which contributed 14,517 tonnes. The beef & sheep sector makes up the majority of farms across Scotland so this is to be expected. The smallest contribution to bale wrap plastic arisings came from the sheep farming sector, which contributed just 1,397 tonnes to the total as a result of the lower ensiled or baled forage feeding levels. Across the Scottish regions, Grampian had the largest arisings from bale wrap, proportional to the total, as shown in *Figure 6*. The Islands of Eilean Siar and Shetland had the lowest proportion.

### *8.2.2 Clamp cover plastic*

Silage clamp covers made up a much smaller proportion of the calculated total LDPE plastic arisings in Scotland, with 1,955 tonnes of arisings thought to come from this type of plastic. The questionnaire study indicated this was the second most common use for LDPE plastic, supporting the mapping study findings. The study also found that this type of plastic was more likely to be re-used than silage bale wrap plastic, meaning there is much less of this type of plastic purchased on an annual basis and subsequently available for recycling. As a result of the dominance of beef farming in Scotland the majority of arisings again came from this type of farming, with 1,372 tonnes of clamp cover plastic coming from this sector. Nevertheless the larger proportion of silage that is made in clamps by the dairy industry and higher number of dairy farms in the sub region meant that Dumfries and Galloway had the largest proportion of clamp cover arisings, as shown in *Figure 5*. Shetland and Eilean Siar again had the lowest proportion.

### *8.2.3 Crop cover plastic*

This type of plastic arisings was the smallest of the three types of plastic revealed by the questionnaire study as the most common uses of LDPE plastic in Scottish farms. The mapping study calculated a total of 1,861 tonnes of crop cover plastic arisings, with the vast majority coming from the vegetable farming sector. Fruit farming was only a tiny proportion of the final total with only one region producing more than 10 tonnes of LDPE arisings from fruit crop cover. Again, re-use of this type of plastic was found to be common by the questionnaire study. Across all regions, most had less than 10 tonnes of LDPE arisings from fruit & vegetables. The exceptions being Tayside, with 889 tonnes (the largest proportion), Fife, Grampian, Scottish Borders and Lothian. These East coast regions, shown in *Figure 4* make almost all of the LDPE plastic arisings from crop cover.

### *8.2.4 Total LDPE plastic arisings*

The total LDPE plastic arisings from these three uses of plastic was calculated for each Scottish sub region. The region with the highest calculated amount of LDPE plastic arisings was Grampian with 5,752 tonnes as shown in *Figure 7*. Shetland an Eilean Siar had the lowest. Across all sub regions, silage bale wrap was the largest contributor, with the exception of Tayside, where crop cover plastic was the largest contributor.

It would be useful if the calculated quantities of farm film plastic arisings could be reconciled with data on the amount purchased from suppliers. However, as noted in section 6.5, the information provided by the suppliers interviewed was insufficient to enable this to be done as part of this study.

## 8.3 Conclusions

### *8.3.1 Quantities of agricultural film plastic arisings in Scotland*

The mapping study shows that the potential quantity of plastic for collection in Scotland is just under 22,000 tonnes with 9% of this from the horticultural sector and 91% from livestock. In terms of the type of farm film plastic waste, 82% is from silage bale wrap, 9% is from silage clamp cover and 9% is from crop cover. The processing capacity should be prepared for the difference in processing requirement that this presents.

| Product | Tonnes | % of total by LDP E type | Beef | Dairy | Sheep | Veg | Fruit | Region where use is greatest |
|---|---|---|---|---|---|---|---|---|
| Silage bale wrap | 18,033 | 82% | 14,517 | 2,119 | 1,397 | | | Grampian |
| Silage clamp cover | 1,955 | 9% | 1,372 | 506 | 77 | | | Dumfries & Galloway |
| Crop cover | 1,861 | 9% | | | | 1,825 | 37 | Tayside |
| **Total** | **21,849** | | **15,889** | **2,625** | **1,474** | **1,825** | **37** | |
| **% of total by farm sector** | | | **73%** | **12%** | **7%** | **8%** | | |

**Table 42: Summary of findings from mapping study**

### *8.3.2 Geographical influence of agricultural film plastic arisings in Scotland*

The crop film is mainly arising from the Eastern side in Grampian, Tayside, Fife, Lothian and Borders. Collection services should be prepared for any differences in the collection services required of this sector in these areas.

The silage clamp cover arisings are mainly from the southern areas of Scotland, East Central, Clyde Valley, Ayrshire, and Dumfries & Galloway, and through the central area of Grampian and Tayside. This is also reflected in a similar way for bale wrap.

Effective collection schemes depend on an economic return, and this is related to volume of material collected. Scotland features two contrasting areas of high agricultural production in the Lowlands and low agricultural production in the Highlands, with an additional unique feature of multiple Islands off the coast of the mainland which present their own logistic challenge.

About 20% of recyclable material is produced in remote areas with little or no collection services. A scheme introduced into Scotland will need to address this. The Somerset FFWAG trials conducted in

South West England demonstrated what could be achieved with mini hubs in remote areas. This model could be adapted for remote parts of Scotland. Schemes in these areas of Scotland will require both consideration of the logistics and a degree of community involvement. This could be through neighbouring farmers clubbing together to form collection points and should also involve local authority initiatives to involve general community collection services.

For mainland areas the lower concentration of farms and greater distance from the reprocessing facility can lead to increased collection cost and time input.

Further analysis on a grid basis would identify areas of concentration that may guide efficiencies of collection and areas where support would be most needed.

The study of farmers indicated a high range of the quantity of plastic that needed collection from individual farms. A collection service must be mindful of this variation. There could be some efficiency incentives for the smaller scale famers to and larger scale farmers to form hubs to improve the overall efficiency, and effectiveness of collection.

### *8.3.3 Geographical differences in collection services of agricultural film plastic arisings in Scotland*

There is an apparent gap in collection services offered, which is mainly in the more remote areas of the Islands and the Highlands. Companies with collection services offer a national service, and yet some farmers report that they have no service in their area. This could be a promotion and communication issue that could be addressed and supported. It could also be an issue of the high cost of collection for small collection quantities.

### *8.3.4 Seasonality of purchasing of agricultural film plastic*

The study showed that farmers and growers purchase single use plastics just prior to time of use, which is spring and through the summer. Supply services should be prepared to have stock levels to respond to demand as farmers do not hold their own stocks.

The supplier's interviews and information sourced from other websites indicate that silage film is re sold as branded product from a select group of manufacturers, and films are supplied both directly to farmers and indirectly through sales to contractors. Silage film is sold by agricultural engineers as consumable for the machinery that they sell and service

### *8.3.5 Seasonality of collection of agricultural film plastic arisings*

The study of farmers indicates collection services in Scotland appear to favour an offer of annual or biannual collection off farms. This requires farmers to develop good storage facility at the farm to maintain quality, which will require education and promotion. The processing capacity in Scotland should be prepared for the variation of supply if the annual and biannual collection is related to season (not confirmed by the study)

### *8.3.6 Education and promotion of best practice in agriculture for collecting agricultural film plastic arisings*

Many of the schemes reviewed in the literature sections operate with protocols and guidance to farmers presenting waste plastics for collection and recycling, including storage, cleanliness, separation, and packaging of wastes. Some initiatives including APE in Europe include education as an important part of a schemes success and should be included in any supported scheme in Scotland.

There are opportunities to reuse single use plastic on farms, and 23% of farmers in the study find they can re-use some plastics. The re-use on silage clamps was the most popular method. This concept of re-use may be an area that could be developed through education of best practice and could form solution in part to collection from more remote areas.

### 8.3.7 *Current involvement of supplier and manufacturers of agricultural film plastic with supporting collection*

The indications are that two of the main brands of silage film sold by one supplier will carry the APE UK co-responsibility levy. CLAAS farm machinery manufacturing is a partner in the APE supported scheme for Germany, therefore it is likely that this too will also carry the levy. The remaining major brand Silotite is a product from a reprocessing company who are leading members of APE Europe sponsors of the APE UK co-responsibility levy backed scheme. No independent importing outside these brands was identified which strengthens the hand of the APE UK co-responsibility approach for recycling film. A threat to this will come from imports of nonaligned brand materials that fall within future trade agreements e.g. Vinayak Polymers LLDPE Silage Stretch Film for Packaging Industries (https://www.indiamart.com/proddetail/lldpe-silage-stretch-film-17190307430.html).

### 8.3.8 *Further support for the industry in Scotland.*

Further support for the industry should include a number of initiatives to ensure efficient recovery of agricultural film plastic from point of use on farms. It may also be that further research is required to understand other underlying trends not covered in this report.

This should include education to promote best practice on farms to present waste plastic in its most marketable form and promotional support – advertising and coordination of collection, through postal and electronic media, including website for advertising and arranging collections. A scheme sold partner with established collectors to develop most effective collection infrastructure, as opposed to most economic. This could extend to partnerships with communities to facilitate collection in remote and lower populated areas of highlands and islands. Partnering should also include processors to coordinate the flow volume, and quality protocols to optimise and maximise the levels of recycling and reduce the volume of rejections.

Another strong influence in farm practices are the farm producer protocols (such as red tractor) and supermarket schemes are important drivers in the agricultural industry.

# APPENDIX 1 - TABLES OF MULTIPLICATION FACTORS & ORIGINAL DATA USED IN MAPPING STUDY

Table 1. Estimates of the amount of LDPE plastic waste arising from different ages of cattle and sheep. Data from ADAS Valpak final mapping report – 'ADAS, 2007. *Research study into the quantities of UK packaging/non-packaging waste farm plastic arising from farms*. AWP Programme Management Board.'

| | Lowland | | | Upland | | | | |
|---|---|---|---|---|---|---|---|---|
| **LDPE use** | Dairy cows & cattle > 2yr old | Cattle 1-2 yr old | Cattle <1 yr old | Dairy cows | Cattle & >2 yr old & Beef herd | Cattle 1-2 yr old | Cattle <1 yr old | Breeding Ewes (sheep) |
| **Silage bale wrap (kg LDPE)** | 7.05 | 5.63 | 2.82 | 7.05 | 19.7 | 15.8 | 7.9 | 0.525 |
| **Silage clamp cover (kg LDPE)** | 1.81 | 1.44 | 0.72 | 1.81 | 0.74 | 0.58 | 0.29 | 0.029 |

Table 2. Estimates of the amount of LDPE plastic arising from different crop types and percentage of the crop area covered by plastic film. Data from 'Horticultural Crops Grown Under Protection - Impact of Use of Temporary Covers and Plastic Mulches on UK Agronomic Practice' (ADAS, 2011)

| kg LDPE per ha | Peas for canning, freezing or drying | Beans for canning, freezing or drying | Turnips/ swedes | Calabrese | Cauliflower | Carrots | Other vegetables | Total Vegetables for human consumption | Strawberries | Raspberries | Blueberries | Blackcurrants and other fruit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Kg of LDPE film** | No mention | No mention | 260 | 1,020 | 1020 | 1500 | No mention | No mention | 510 | 1020 | No mention | 1020 |
| **Kg of perforated LDPE film** | No mention | No mention | No mention | No mention | No mention | 1125 | No mention | No mention | No mention | No mention | No mention | No mention |
| **Percentage of crop covered by film** | Peas for canning, freezing or drying | Beans for canning, freezing or drying | Turnips/ swedes | Calabrese | Cauliflower | Carrots | Other vegetables | Total Vegetables for human consumption | Strawberries | Raspberries | Blueberries | Blackcurrants and other fruit |
| **Proportion using film** | | 90% | 15% | 5% | 5% | 20% | 10% | | 80% | 25% | | 6.66% |
| **Proportion using perforated film** | | | | | | 19% | | | | | | |

Table 3. Numbers of Livestock in Scottish sub regions. Data from in '*Economic Report On Scottish Agriculture - Section C Time Series'* (Scottish Government, 2017a)'.

| Livestock | Shetland | Orkney | Na h-Eileanan Siar | Highland | Grampian | Tayside | Fife | Lothian | Scottish Borders | Total | East Central | Argyll & Bute | Clyde Valley | Ayrshire | Dumfries & Galloway | Scotland |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Female Dairy Cattle** | | | | | | | | | | | | | | | | |
| Female Dairy Cattle aged 1-2 | c | 421 | c | 540 | 2,624 | 1,210 | 1,729 | 713 | 1,907 | 49,061 | 2,291 | 1,695 | 7,068 | 11,584 | 26,423 | 58,284 |
| Female Dairy Cattle 2 years and over with offspring | c | 2,205 | c | 1,780 | 7,152 | 3,333 | 3,683 | 2,679 | 4,330 | 148,968 | 6,566 | 5,918 | 20,427 | 37,047 | 79,010 | 174,442 |
| Female Dairy Cattle 2 years and over without offspring | 104 | 334 | 0 | 297 | 1,253 | 511 | 924 | 673 | 902 | 37,016 | 1,058 | 1,831 | 5,707 | 10,863 | 17,557 | 42,014 |
| **Total Female Dairy Cattle** | **478** | **2,960** | **17** | **2,617** | **11,029** | **5,054** | **6,336** | **4,065** | **7,139** | **235,045** | **9,915** | **9,444** | **33,202** | **59,494** | **122,990** | **274,740** |
| **Female Beef Cattle** | | | | | | | | | | | | | | | | |
| Female Beef Cattle aged 1-2 | 421 | 10,013 | 408 | 12,331 | 57,451 | 12,850 | 6,004 | 5,977 | 16,109 | 71,467 | 4,536 | 4,703 | 11,642 | 14,630 | 35,956 | 193,031 |
| Female Beef Cattle 2 years and over with offspring | 1,466 | 26,032 | 2,628 | 46,888 | 86,405 | 32,168 | 12,663 | 13,666 | 42,258 | 168,638 | 12,773 | 19,529 | 28,038 | 29,068 | 79,230 | 432,812 |
| Female Beef Cattle 2 years and over without offspring | 210 | 3,363 | 523 | 6,551 | 19,236 | 5,000 | 1,789 | 2,091 | 5,753 | 33,985 | 2,568 | 3,651 | 6,035 | 6,985 | 14,746 | 78,501 |
| **Total Female Beef Cattle** | **2,097** | **39,408** | **3,559** | **65,770** | **163,092** | **50,018** | **20,456** | **21,734** | **64,120** | **274,090** | **19,877** | **27,883** | **45,715** | **50,683** | **129,932** | **704,344** |

| Livestock | Shetland | Orkney | Na h-Eileanan Siar | Highland | Grampian | Tayside | Fife | Lothian | Scottish Borders | Total | East Central | Argyll & Bute | Clyde Valley | Ayrshire | Dumfries & Galloway | Scotland |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Male Cattle** | | | | | | | | | | | | | | | | |
| Male Cattle aged 1-2 | 276 | 7,850 | 180 | 8,789 | 62,216 | 11,704 | 8,705 | 7,107 | 15,508 | 76,521 | 5,458 | 3,228 | 12,722 | 16,924 | 38,189 | 198,856 |
| Male Cattle aged 2 and over | 171 | 1,848 | 247 | 3,348 | 18,856 | 3,081 | 2,180 | 1,914 | 4,010 | 29,233 | 2,127 | 1,993 | 5,154 | 6,479 | 13,480 | 64,888 |
| **Total Male Cattle** | **447** | **9,698** | **427** | **12,137** | **81,072** | **14,785** | **10,885** | **9,021** | **19,518** | **105,754** | **7,585** | **5,221** | **17,876** | **23,403** | **51,669** | **263,744** |
| **Calves** | | | | | | | | | | | | | | | | |
| Female Dairy Cattle under 1 | 55 | 428 | 11 | 543 | 2,559 | 1,170 | 1,669 | 624 | 2,174 | 46,659 | 2,231 | 1,394 | 6,760 | 10,620 | 25,654 | 55,892 |
| Female Beef Cattle under 1 | 700 | 12,574 | 1,089 | 20,497 | 43,358 | 15,072 | 6,257 | 7,203 | 20,007 | 97,870 | 6,554 | 9,501 | 15,390 | 19,074 | 47,351 | 224,627 |
| Male Cattle under 1 | 723 | 12,857 | 1,043 | 20,830 | 47,590 | 16,995 | 8,647 | 8,121 | 21,165 | 120,385 | 7,826 | 9,844 | 18,684 | 24,526 | 59,505 | 258,356 |
| **Total Calves** | **1,478** | **25,859** | **2,143** | **41,870** | **93,507** | **33,237** | **16,573** | **15,948** | **43,346** | **264,914** | **16,611** | **20,739** | **40,834** | **54,220** | **132,510** | **538,875** |
| **Total Cattle** | **4,500** | **77,925** | **6,146** | **122,394** | **348,700** | **103,094** | **54,250** | **50,768** | **134,123** | **879,803** | **53,988** | **63,287** | **137,627** | **187,800** | **437,101** | **1,781,703** |
| **Sheep:** | | | | | | | | | | | | | | | | |
| Ewes for breeding | 122,042 | 44,292 | 61,894 | 361,496 | 242,390 | 256,387 | 33,013 | 77,756 | 421,917 | 1,039,669 | 110,933 | 179,929 | 162,924 | 175,609 | 410,274 | 2,660,856 |
| **Total sheep** | **284,831** | **120,486** | **144,509** | **895,635** | **681,412** | **666,609** | **95,569** | **218,631** | **1,167,676** | **2,709,659** | **283,165** | **428,035** | **445,229** | **466,248** | **1,086,982** | **6,985,017** |

Table 4. Crop areas for each Scottish sub region. Table section A. shows reported numbers from '*Economic Report On Scottish Agriculture - Section C Time Series'* (Scottish Government, 2016a)'. Table section B. shows calculated areas of different crop types from percentage areas reported in ''*Results from the June 2016 Scottish Agriculture Census'* (Scottish government, 2016b)'.

| A. Reported Crop areas (hectares) | Shetland | Orkney | Na h-Eileanan Siar | Highland | Grampian | Tayside | Fife | Lothian | Scottish Borders | East Central | Argyll & Bute | Clyde Valley | Ayrshire | Dumfries & Galloway | Scotland |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Total Vegetables for human consumption** | c | c | 12 | 468 | 2,257 | 8,595 | 3,027 | 1,487 | 2,069 | 63 | 4 | 70 | 61 | 41 | 18,168 |
| **Total Orchard & soft fruit** | 0 | 0 | 4 | 43 | 166 | 1,389 | 300 | 17 | 12 | 2 | 5 | 28 | 3 | 10 | 1,977 |
| **B. Calculated Crop areas (ha)** | **Shetland** | **Orkney** | **Na h-Eileanan Siar** | **Highland** | **Grampian** | **Tayside** | **Fife** | **Lothian** | **Scottish Borders** | **East Central** | **Argyll & Bute** | **Clyde Valley** | **Ayrshire** | **Dumfries & Galloway** | **Scotland** |
| **Vegetables for human consumption** | | | | | | | | | | | | | | | |
| Peas for canning, freezing or drying | c | c | 5 | 194 | 937 | 3567 | 1256 | 617 | 859 | 26 | 2 | 29 | 25 | 17 | 7540 |
| Beans for canning, freezing or drying | c | c | 1 | 46 | 222 | 846 | 298 | 146 | 204 | 6 | 0 | 7 | 6 | 4 | 1789 |
| Turnips/swedes | c | c | 1 | 38 | 185 | 705 | 248 | 122 | 170 | 5 | 0 | 6 | 5 | 3 | 1491 |

| A. Reported Crop areas (hectares) | Shetland | Orkney | Na h-Eileanan Siar | Highland | Grampian | Tayside | Fife | Lothian | Scottish Borders | East Central | Argyll & Bute | Clyde Valley | Ayrshire | Dumfries & Galloway | Scotland |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Calabrese | c | c | 1 | 41 | 196 | 745 | 262 | 129 | 179 | 5 | 0 | 6 | 5 | 4 | 1575 |
| Cauliflower | c | c | 0 | 8 | 38 | 146 | 51 | 25 | 35 | 1 | 0 | 1 | 1 | 1 | 309 |
| Carrots | c | c | 2 | 84 | 404 | 1538 | 542 | 266 | 370 | 11 | 1 | 12 | 11 | 7 | 3252 |
| Other vegetables | c | c | 1 | 57 | 275 | 1046 | 368 | 181 | 252 | 8 | 0 | 8 | 7 | 5 | 2211 |
| Soft fruit grown in the open | | | | | | | | | | | | | | | |
| Strawberries | 0 | 0 | 0 | 2 | 6 | 51 | 11 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 73 |
| Raspberries | 0 | 0 | 0 | 3 | 11 | 90 | 19 | 1 | 1 | 0 | 0 | 2 | 0 | 1 | 128 |
| Blueberries | 0 | 0 | 0 | 0 | 1 | 12 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 18 |
| Blackcurrants and other fruit | 0 | 0 | 1 | 8 | 32 | 271 | 58 | 3 | 2 | 0 | 1 | 5 | 1 | 2 | 386 |

# APPENDIX 2 SAMPLE QUESTIONNAIRE

**ZERO WASTE SCOTLAND FARM FILM PLASTIC SURVEY**

**QUESTIONNAIRE FOR FARMERS AND GROWERS**

**Background information for Interviewer**

Since January 2019, the Scottish Environment Protection Agency (SEPA) has stated that they will strictly enforce the requirements of waste legislation, bringing an end to the common practice for farmers and land managers to burn most types of agricultural waste on farms under a waste management exemption.

The ending of the exemption followed extensive engagement between SEPA, the Scottish Government, Zero Waste Scotland, the National Farmers Union Scotland (NFUS) and recycling service providers, and compliance is non-negotiable.

However, discussion have identified there is a lack of detail on the actual amount of farm film plastic – such as silage wrap, soil cover and crop cover – utilised in Scotland that will require collection and processing as a result.

Zero Waste Scotland has appointed ADAS / SAC Consulting to undertake a mapping survey of farm film plastic used within the Scottish agricultural sector, including its type, purpose and location. The data gathered will provide a better understanding of the scale of farm film plastic use in Scotland and help identify new resource management and circular economy opportunities.

Rigid farm plastics such as chemical drums and other farm plastics, such as fertiliser and feed bags, twine and net wrap, are out of scope.

Under the agreed interview procedure, each interviewee is to be contacted by telephone up to 3 times in order to carry out the interview. Call back dates and times should be recorded on page 2. If the third call does not result in an interview, this should be recorded as a nil response.

**Suggested Introduction**

Interviewer: Request to speak to main contact as advised.

Good morning/afternoon, my name is _____, I'm calling from SAC Consulting on behalf of Zero Waste Scotland. We are carrying out a survey on the volume and location of farm film plastic used annually within Scottish Agriculture – such as silage wrap, soil cover and crop cover. We are talking to farmers and waste management companies across Scotland about how much farm film plastic waste is being generated on farm and how this can best be collected and recycled effectively.

1. Would you be willing in taking part in this short survey? It will take no more than 10 minutes. All information gathered is confidential and reported as a sub-regional amalgamated response. (If no go to 2, if yes go to 3)

2. Why are you not interested in taking part? INTERVIEWER – record reasons for not wishing to take part.

   .....

3. Would you have 10 minutes now to complete the interview, or would you like to arrange a more convenient time for me to call back?

(If not convenient arrange to call back at a suitable time)

All information provided will remain completely confidential and will only be used by SAC Consulting / ADAS staff in relation to this project.

Interview detail to be filled in by interviewer from database information before conducting the Interview.

| (A) Telephone number |
|---|

| | |
|---|---|
| (B) Farm / business name and address including postcode | |
| (C) Farm type<br><br>(multiple response allowed) | ☐ Beef & sheep<br>☐ Dairy<br>☐ Vegetable growers / horticulture<br>☐ Arable<br>☐ Anaerobic digestion plants |
| (D) Name of person contacted | |
| (E) Interviewed by | |
| (F) Date of interview | ...../...../2020 |
| (G) Date and time of 1st call back | |
| (H) Date and time of 2nd call back | |
| (I) Farm location | ☐ Shetland<br>☐ Orkney<br>☐ Na h-Eileanan Siar<br>☐ Highland<br>☐ Grampian<br>☐ Tayside<br>☐ Fife<br>☐ Lothian<br>☐ Scottish Borders<br>☐ East Central<br>☐ Argyll & Bute<br>☐ Clyde Valley<br>☐ Ayrshire<br>☐ Dumfries & Galloway |

**Overall guidance notes:**

1. **The questionnaire is designed for farms which use LDPE plastic film. Please establish this with the interviewee before the start.**
2. **Nearly all the questions are closed questions, requiring you to tick a box or enter a numerical response.**
3. **If there is any doubt about a question, enter nothing and move on to the next one.**
4. **Q1 – Q11 are about the farm and the use of plastic film**
5. **Q12 – Q16 are about the disposal of plastic film waste**
6. **Instructions for interviewer are in bold. These do not need to be read out.**

## THE INTERVIEW FOR FARMERS AND GROWERS

***Part 1. About the farm***

| | |
|---|---|
| Q1. Please tell me about the stock number and cropping on your farm.<br>**Interviewer: please read out the list**<br>**Estimates are acceptable** | Enter number of:<br>Suckler cows……<br>Yearling cattle……<br>Finishing cattle……<br>Dairy cows ……<br>Dairy replacements and dry cows……<br>Ewes……<br>Enter number of hectares of:<br>Field vegetables……<br>Fruit (eg field strawberries)……<br>Energy crops…… |

***Part 2. Use of plastic film on the farm***

| | |
|---|---|
| Q2. What are the uses of LDPE (Low Density Polyethylene) plastic film on your farm?<br>(multiple response allowed) | ☐ LDPE bale wrap<br>☐ LDPE bale bags<br>☐ LDPE ag bags<br>☐ LDPE silage cover<br>☐ LDPE soil cover ie. black film over furrows of eg. strawberries/carrots |

| | |
|---|---|
| Q3. How much produce do you use plastic film for?<br>***Read out list*** | Number of bales……<br>Bale silage ……tonnes<br>Ag bag silage……tonnes<br>Pit (bunker) silage…… ……tonnes<br>Crop cover……hectares |
| Q4. Do you buy your own farm film plastic?<br>(single response) | ☐ Yes, I buy my own farm film plastic **(Go to Q5)**<br>☐ No, it is supplied by a contractor **(Go to Q6)** |
| Q5. Please provide details of the company that you buy your plastic film from (if known). | Company name……<br>Product brand name/s……<br>Manufacturer……<br>Contact person ……<br>Telephone number ……<br>**Go to Q7** |
| Q6. Please provide details of your contractor so that we can contact them about purchase of farm film plastic. | Contractor name……<br>……<br>Contact person ……<br>Telephone number ……<br>**Go to Q7** |
| Q7. How much farm film plastic do you buy each year (either directly or via a contractor)?<br>***Read out list*** | Bale wrap ……..number of rolls<br>Ag bags……number of bags……length<br>Bunker cover……..m² (approx bunker area +30%)<br>Crop cover……hectares |
| Q8. Do you reuse any farm film plastic?<br>(single response) | ☐ Yes **(Go to Q9)**<br>☐ No **(Go to Q11)** |
| Q9. How do you reuse any farm film plastic?<br>(single response) | ☐ For its original use **(Go to Q10)**<br>☐ Other use (eg. road construction) **(Go to Q11)** |
| Q10. How many times do you reuse farm film plastic before disposal? | ……..number of times reused |
| Q11. When do you purchase farm film plastic?<br>(multiple response allowed) | ☐ Spring<br>☐ Summer<br>☐ Autumn<br>☐ Winter<br>☐ When the silage is made by contractor including film supply |

***Part 3. Disposal of plastic film waste***

| | |
|---|---|
| Q12. Is agricultural plastic film waste collected from your farm?<br>(single response) | ☐ Yes **(Go to Q13)**<br>☐ No **(Go to Q15)** |
| Q13. How often do you have your plastic collected for recycling?<br>(single response) | Every month ☐<br>Every 6 months ☐<br>Every 12 months ☐<br>Less frequently than every 12 months ☐ |
| Q14. Please provide the name of your waste collector or recycling provider. We are only asking for the name so that we can track all collectors across Scotland, and avoid missing any that we are unaware of. | Waste collector / recycling provider name.....<br>.....<br>Contact person .....<br>Telephone number .....<br>**Now go to Q16** |
| Q15. Do any of these reasons for not using a plastic waste collector or recycling service apply to you?<br>Please note, our only interest in the response is to help review and inform further collections, not to report those not recycling.<br>(multiple response allowed)<br>***Read out list*** | ☐ There are no waste collectors in my area<br>☐ The local collectors are unreliable<br>☐ No space on the farm to store the material<br>☐ No time to remove soil and rubble from the waste material<br>☐ Don't see the need to recycle<br>☐ Collection is too expensive. It can be burnt for free<br>☐ Even if the waste is collected, I don't believe it gets recycled in any case<br>☐ I didn't know that plastic film waste needs to be recycled |
| Q16. How do you store plastic film waste prior to recycling / collection?<br>(multiple response allowed) | ☐ Under cover<br>☐ Outside |

**END: Thank you for your time**

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