

Not to be dumped, burned, or
landfilled:

Recovery of agricultural plastics waste in Nova Scotia

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Acronyms used in this report:

APW = agricultural plastics waste
NSFA = Nova Scotia Federation of Agriculture
RRFB = Resource Recovery Fund Board
EPR = extended producer responsibility
PP = polypropylene
LDPE = low-density polyethylene
HDPE = high-density polyethylene

Agricultural plastics referred to in this report:

Plastics terms used	Plastic type	On-farm use
Plastic baling twine	PP	To wrap bales of hay and straw after harvest
Plastic grain bags or tubes	LDPE	To store grain and wheat
Silage/bale plastic	LDPE	(1) Protection of dry bales that are being stored outside (2) To make haylage by sealing and fermenting moist hay
Plastic containers	HDPE	Pesticide containers, pails, drums, and jugs
Plastic row covers/mulch film	LDPE	To protect the roots of the plants from climatic extremes and improve the effectiveness of water usage

For a detailed overview of each of these plastics see Appendix A.

1.0 Executive Summary

Research on agricultural plastics waste (APW) management suggests that common disposal practices do not typically include recycling. Depending on the jurisdiction and farming commodities being produced different plastics are used, but, many of the same problems arise. The waste plastics are produced in small quantities at widely distributed geographic locations, they are disposed of at varying times of year, and are often contaminated and/or physically degraded. Limited research has been done on methods for labeling and monitoring farm plastics waste that allows for it to be directed to appropriate recycling technologies after leaving the farm. Elsewhere, a handful of jurisdictions have developed successful farm plastics recycling programs through legislation or voluntary programs. The purpose of this study is to evaluate the state of plastics waste management on farms in Nova Scotia (NS) and identify the barriers to implementing an effective, accessible farm plastics recycling program within the farming community. This study identifies types of plastic and commodity groups that merit special attention regarding a recycling program, and the attitudes of farmers regarding the importance of farm plastics recycling, as well as the likelihood of their participation in any new recycling programs. Research methods included a mail-out survey to farmers in NS and e-mail surveys with APW recycling organizations in other jurisdictions, waste management groups in NS, and Nova Scotia Environment. Feedback on recommendations was sought from the Nova Scotia Federation of Agriculture (NSFA) Council of Leaders and individual farmers during site visits. The farming community of NS has shown a positive predisposition to environmentally responsible disposal of APW, and have expressed some frustration with the lack of services or support in this respect. Considering the situation as it is understood in NS, and the success of related programs elsewhere, it seems likely that a dedicated stewardship program that educates, co-ordinates and facilitates APW recycling efforts would be feasible. Managed and funded collaboratively by the plastics producers/dealers/importers and the farmers, such a program could address most APW. However, many of the NSFA Council of Leaders expressed a preference for simply increasing education regarding APW recycling and co-ordinating farmers and waste managers. It is intended that the results from this study will provide the necessary insight to help guide the development of a farm plastics waste recycling program in Nova Scotia.

2.0 Background

2.1 Management methods of end-of-life plastics:

2.1.1 General overview:

Plastics, or synthetic polymers, are usually derived from petrochemicals, and require petrochemical energy for their production. Approximately 4% of world oil and gas production is converted to plastics, while another 3-4% is used to supply energy in the conversion process (Al-Salem, Lettieri, & Baeyens, 2009; Hopewell, Dvorak, & Kosior, 2009); plastics are inextricably linked to the world's supply of non-renewable carbon energy. Industrial scale production of plastics began in the 1940's (Al-Salem et al., 2009) and has grown on average ~10% per year since that time, with global production soaring from 1.3 million tonnes in 1950 to 300 million tonnes in 2014 (Panda, Singh, & Mishra, 2010; PlasticsEurope, 2015). While amounts vary depending on jurisdiction, the use of plastics for packaging represents upwards of 40% of plastics demand – much of it is single-use packaging (Al-Salem et al., 2010; PlasticsEurope, 2015; Brems, Baeyens, & Dewil, 2012; Enviro, 2001; Thompson, Moore, Vom Saal, & Swan, 2009; Thompson, Swan, Moore, & Vom Saal, 2009). Approximately 60% of all plastics waste is either discarded in the

environment or landfilled, meaning as much as 160 million tonnes (Al-Salem, Lettieri, & Baeyens, 2010) of plastics waste is accumulating in both terrestrial and marine ecosystems annually.

2.1.2 Management of agricultural end-of-life plastics:

Around the world each year approximately 2 to 3 million tonnes of plastics are discarded after use within the agriculture sector (Briassoulis et al., 2010). There is a paucity of peer reviewed research that has focused specifically on the management of farm plastics waste, although specific case studies have emerged from Europe (Briassoulis et al., 2010; Briassoulis, Hiskakis, & Babou, 2013; Briassoulis, Hiskakis, Babou, Antiohos, & Papadi, 2012). In general, agricultural plastics management programs vary significantly between jurisdictions, based on local socio-economic, climatic, and geographic conditions, and matured independently of each other. Countries such as Ireland, Iceland, and Spain have legislation in place that deals directly with the issue, while plastic film producers in the United Kingdom, France, Norway, and Sweden have developed efficient voluntary schemes that engage the stakeholders in various ways (Briassoulis, Hiskakis, & Babou, 2013; EPRO, 2012).

One example is LabelAgriWaste, a research driven program developing a framework for the economically sustainable collection and valorization of farm plastics in Europe (Briassoulis et al., 2010). Briassoulis et al. (2010) describe the consequences of improper disposal of APW as follows:

Burning of APW in the fields:

Release of harmful substances with negative consequences to the environment (water, soil and air); release of harmful substances with negative consequences to human health; possible danger for the safety of the food produced in such fields with negative commercial impact.

Burying of APW in the fields:

Degradation of soil quality characteristics; irreversible soil contamination; possible danger for the safety and quality of the food produced in such fields.

Disposal of APW in the fields and landfills:

Aesthetic pollution and landscape degradation of regions of natural beauty and touristic areas; threat to domestic and wild animals; blocking of water flow through water channels; overload of landfills with an immediate environmental and financial impact; loss of material and energy.

The LabelAgriWaste program requires:

- Detailed tracking and labeling of plastics from the point of sale to final disposal
- Adherence to specific guidelines for the use, collection, treatment, and transportation of the plastics
- A financial scheme including payments and refunds controlled by a national agency
- Legislation framework implementation with monitoring and penalties for non-compliance (Briassoulis et al., 2010)

The program has detailed information regarding farm plastics management, but is limited in its transferability to other settings/jurisdictions, as it only provides information about one version of a potential management program. In particular it was developed in the context of Mediterranean agricultural production systems, and with much larger quantities of plastics than are found in NS, which allows the program to operate at significant economies of scale.

2.2 Management methods of end-of-life plastics in Nova Scotia:

2.2.1 General overview:

The most recent study of plastics waste in NS was published in 2008 by the Resource Recovery Fund Board of Nova Scotia (RRFB). It was estimated that 13.8% of plastics were diverted from landfill and sold to plastics recyclers in 2006 (RRFB, 2008). This estimated recycling rate for NS is comparable to the European countries which have the lowest rates - Malta (12%) and Cyprus (15%); the European average plastics recycling rate in 2012 was 26%, however, the amount going to landfill was only 38%, due to the fact that 36% of plastics were burned for energy recovery (PlasticsEurope, 2015). Therefore much less plastics are going to landfill in Europe, but, the average plastics mechanical recycling rate in Europe of 26% is still almost double the Nova Scotian plastics recycling rate which, as noted, was estimated to be 13.8% in 2006.

Obtaining a high recycling rate of plastics has proven difficult to achieve. Europe has been able to divert a large portion of plastics from landfill through mechanical recycling and burning municipal solid waste for energy recovery (PlasticsEurope, 2015). Nova Scotia continues to send these plastics to landfill – despite many of them being banned from landfill by law (Province of Nova Scotia, 2009). According to personnel within the Nova Scotia Department of Environment energy recovery has been used in NS, but was unable to comply with emission requirements and ceased operation (D. MacQueen personal communication, March 26, 2015). The *Plastics Study* published by the RRFB in 2008 recommended another option: the implementation of an extended producer responsibility (EPR)¹ program, with a mixed plastics waste processing facility. Progress has not been made regarding the recommendations of the RRFB as of now, however, expected changes to legislation in NS will require the implementation of EPR programs that deal specifically with packaging, including plastics, and will help divert them from landfill (D. MacQueen personal communication, March 26, 2015).

The drivers of plastics recycling are quantity, accessibility, and marketability (Al-Salem et al., 2009; Brems, Baeyens, & Dewil, 2012), suggesting that organizations responsible for actually managing plastics recycling would have very little control over these drivers. Nonetheless, increasing landfill diversion of plastics waste will benefit all of the stakeholders involved – and the fact that diversion rates are as abysmal as they are could be an indicator of a lack of political and private sector will regarding plastics waste management. Increasing plastics recycling rates in NS would create revenue and save valuable landfill space but waste managers are unable to increase diversion rates if there is nowhere for the plastics to go. The legislative environment regarding plastics waste management in NS strongly supports diversion from landfill but has not forced the waste management community to find solutions to plastics that are difficult to recycle. This problem may be addressed by the implementation of EPR programs; for now, however, difficult to recycle plastics waste streams such as APW continue to be sent to landfills in NS.

2.2.2 Management of agricultural end-of-life plastics in Nova Scotia:

Officials within the NS Department of Environment, various farming organizations, as well as waste management researchers have all confirmed that no dedicated recycling system exists for farm plastics in NS. There is uncertainty as to how much is being disposed of on-farm, how much is being landfilled, or if

¹ Extended Producer Responsibility originated in Sweden and Germany in the early 1990's as a policy strategy with the potential to: 1. Spur innovation in packaging design; 2. Access private sector know-how to achieve public sector goals; 3. Include waste management costs in product prices; 4. shift waste management costs to firms and consumers (Lifset, Atasu, & Tojo, 2013).

any is recycled via other programs (curbside residential, for example). Farm plastics generated in New Brunswick, NS and Prince Edward Island (the Maritimes) have been estimated to be 2124 tonnes/year, NS represents ~702 tonnes/year. Low-density polyethylene (LDPE) is the predominant plastic used on farms in the Maritimes; it was estimated that silage film and bale wrap account for ~80% of LDPE, followed by row covers and mulch film at ~8% (CleanFARMS, 2012)².

The NSFA provided plastics management data collected via the Environmental Farm Plan (EFP) since 2010 (NSFA, n.d.). This initiative supports environmental audits of farms across NS with a focus on, among other things, a better understanding of the management of plastics waste on farms. In 2014, 471 EFP participants reportedly disposed of silage plastic and plastic mulch. The NSFA data show that approximately 83% of farmers that reported disposing of silage plastic and plastic mulch primarily disposed of it in landfill, some maintained a commercial dumpster on-site, and very few recycled or re-used these plastics. The remaining ~17% of this cohort of the EFP participants dispose of their plastics by burning (81%), dumping on-farm, or stockpiling.

3.0 Objectives

The purpose of this study is to evaluate the state of plastics waste management on farms in NS and identify the barriers to implementing an effective, accessible farm plastics recycling program within the farming community. Information provided by the NSFA confirms that farmers in NS burn, dump, or stockpile APW when they are not disposing of it in landfill, and that very few farmers recycle farm plastics. Considering these facts together steps taken towards a comprehensive APW management system in NS would be prudent. Following are the research questions that form the core of this project and address the problem of APW in NS. Also, answering these questions could help other jurisdictions structure management plans for APW.

1. What are current APW management practices in NS?
2. What are the main barriers to establishing a province wide system for the recycling of APW?
3. Are the barriers to establishing an EOL plastics recycling program specific to either the farming community in general or to APW in particular?
4. What solutions can be implemented in Nova Scotia to address these barriers currently or in the near future?

4.0 Methods

4.1 Research approach:

This research used a mixed methods approach. A mail-out survey was sent to farmers in NS that sought quantitative and qualitative data. Additionally, e-mail surveys were used to collect data from waste management groups as well as industry and government representatives in NS. An ethical application was reviewed and approved by the Dalhousie University Research Ethics Board.

4.2 Methodology:

² CleanFARMS is a not-for-profit industry stewardship organization with programs that manage agricultural plastic and other inorganic waste from farms across Canada.

4.2.1 Mail-out surveys to farmers in Nova Scotia:

Dillman (Dillman, Smythe & Cristian, 2008) support the notion that the best way to reach a large number of farmers in NS was through the use of a mail-out survey. Surveys were sent out by the NSFA using their mailing list of 2374 farms, which represents approximately 61.5% of active farms in NS (P. Brenton personal communication, December 22, 2014; Province of Nova Scotia, 2014). The surveys were accompanied by self-addressed and pre-paid postage envelopes. The survey consisted of a variety of question types including single choice, multiple choice, write-in answers, and Likert scale (1 to 5) questions. The open-ended write-in answers were coded thematically and analyzed using Microsoft Excel software. The survey generally followed Dillman's method in structure and procedure, however, follow-up reminders were not sent due to budget restraints (Dillman et al., 2008). The survey was also made available online using Opinio software accessed through Dalhousie University. The online survey was designed to be exactly the same as the mail-out survey with one question added to determine whether or not the respondent should be included in the population total of 2374 farms that were on the mailing list of the NSFA.

The survey was designed to obtain data on the following:

1. Farmer demographics
2. Commodities produced on the farm
3. Types and amounts of farm plastics
4. Practices and needs of farmers related to:
 - a. Farm plastics management
 - b. Farm plastics recycling
5. Opinions of the farmer on:
 - a. Environmental aspects of farm plastics management
 - b. Willingness to support a farm plastics recycling program
 - c. Level of responsibility of different stakeholders to organize and manage a farm plastics recycling program

See Appendix B for sample questionnaire.

4.2.2 Surveys for additional stakeholders:

Two additional surveys were developed to gain insight from other stakeholder groups about the operational and management considerations related to plastic recycling from various perspectives. The surveys were developed and tested with the assistance of personnel within the different organizations and were administered by email.

The first additional survey was developed to obtain information on the operational practices and capabilities of stakeholder groups that manage end-of-life (EOL) low-value plastics. It was tailored for and administered to representatives of:

1. Regional waste management organizations in Nova Scotia
2. Private waste management contractors in Nova Scotia
3. Plastics buyers/recyclers in Nova Scotia
4. Other provincial or international APW management programs

The second additional survey was developed for municipal and provincial government representatives to identify current legislation pertaining to the management of EOL low-value plastics, as well as any expected changes.

See Appendices C, D, and E for sample questionnaires.

5.0 Results

5.1 Descriptive statistics:

The majority of survey respondents were male (78%) and were aged 51 and over (72%). These demographic results are relatively consistent with agricultural census statistics for NS, conducted in 2011, which show that 74% of farm operators are male and that 54% of farmers are aged 55 years and over (Statistics Canada, 2015). The majority of respondents have operated their farm for 21 years or more (57%) and earn more than half of their income from farm activities (49%).

The top three commodity groups reported in the respondent population were *vegetables/fruits/plants* at 45% (the result of collapsing the categories *vegetables/fruits*, *hay/silage*, and *grains/cereals*), *beef cattle* at 17% and *dairy cattle* at 6%. Again these results are relatively consistent with 2011 NS agricultural statistics, as *vegetables/fruits/plants* farms were reported to represent 60% (the result of collapsing the categories *vegetable and melon*, *fruit and tree nut*, *greenhouse/nursery/floriculture*, and *other crop*), *beef cattle* at 11%, and *dairy cattle* at 7% (Province of Nova Scotia, 2014). *Vegetables/fruits/plants* farms are underrepresented in the respondent population, which could be attributed to the fact that certain plastics used on these farms were not addressed in the mail-out survey. Table 1 below shows the demographics and the dominant commodities from official statistics vs the survey respondent population.

Table 5.1: Comparison of official statistics and the survey respondent population

	Official Nova Scotia statistics	Survey respondent population
Age	54% (55+ years)	72% (51+ years)
Gender (male)	74%	78%
Vegetables/fruits/plants production	60%	45%
Beef cattle production	11%	17%
Dairy cattle production	7%	6%

The demographics of the farm operators and the commodities produced on their farms are particularly important for policy-makers and planners. A better understanding of these demographics will influence how to connect with and educate farmers in NS regarding EOL farm plastics management planning and implementation.

5.2 Current end-of-life plastics generation:

Respondents were asked to estimate the amount of EOL plastics generated annually on-farm. The plastic types the respondents could choose from were:

- Plastic baling twine
- Plastic grain bags or tubes
- Silage plastic
- Bale plastic
- Plastic containers
- Mixed agricultural plastics

Farmers were asked to select a weight category that represented the total amount of each type of plastic generated annually or to actually estimate the amount (in kilograms). A total of approximately 62 tonnes (Figure 5.2) of APW was reported by the 275 respondents. Considering that the 2374 farms on the NSFA mailing list represent approximately 61% of the total population of 3905 farms in NS (Province of Nova Scotia, 2014) it can be estimated that NS farms generate approximately 900 tonnes of APW annually (see Appendix H for an example calculation). This amount varied slightly from a 2012 study that calculated the amount of APW generated in NS annually to be 702 tonnes (CleanFARMS, 2012). Figure 5.1 below depicts the approach by which CleanFARMS calculated APW amounts. CleanFARMS did not use data collected directly from farms; instead they relied on estimates based on the amount of commodities produced, and the average amount of plastics waste generated by the production of a unit of each commodity.

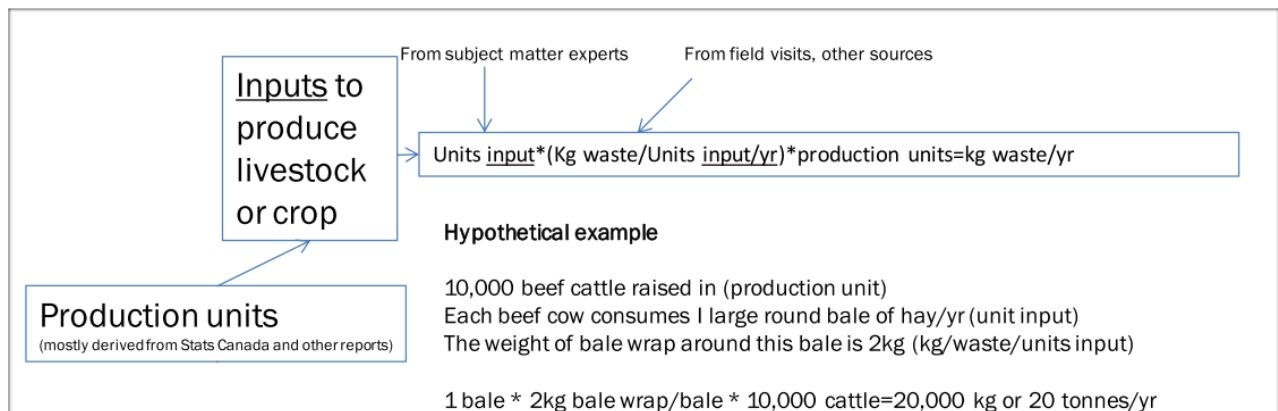


Figure 5.1: CleanFARMS method for calculating farm plastics waste

CleanFARMS (2012)

5.3 Current on-farm disposal methods:

Respondents were asked to indicate the management option(s) for each of the five plastic types noted in section 5.2. Options included:

- Recycle
- Re-use
- Transport to landfill
- Roadside collection for landfill
- Stockpile
- Burn on farm
- Other

The disposal methods *transport to landfill* and *roadside collection for landfill* represented approximately 50% of all the choices made by respondents. *Recycle* was chosen by respondents just under 20% of the

time and *burn on farm* was chosen approximately 10% of the time. Figure 5.3 below shows the results for each plastic type as a percent of the number of responses for each plastic type.

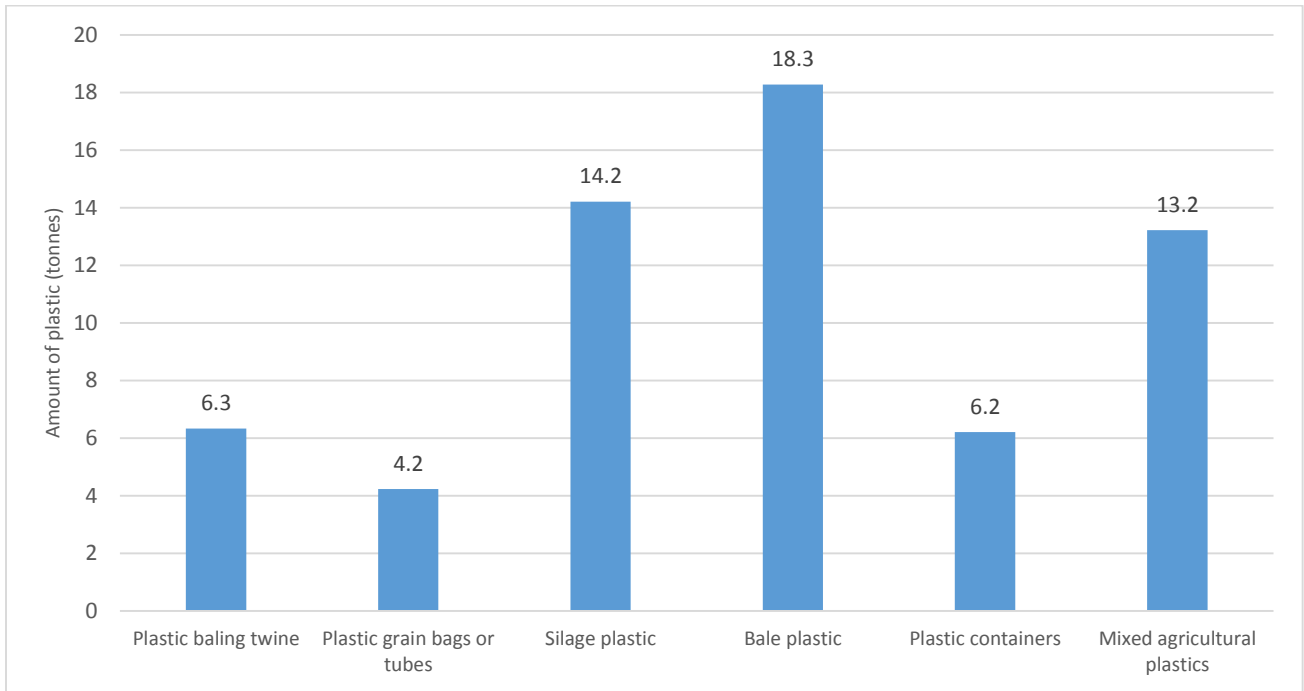


Figure 5.2: Plastics waste reported by survey respondents

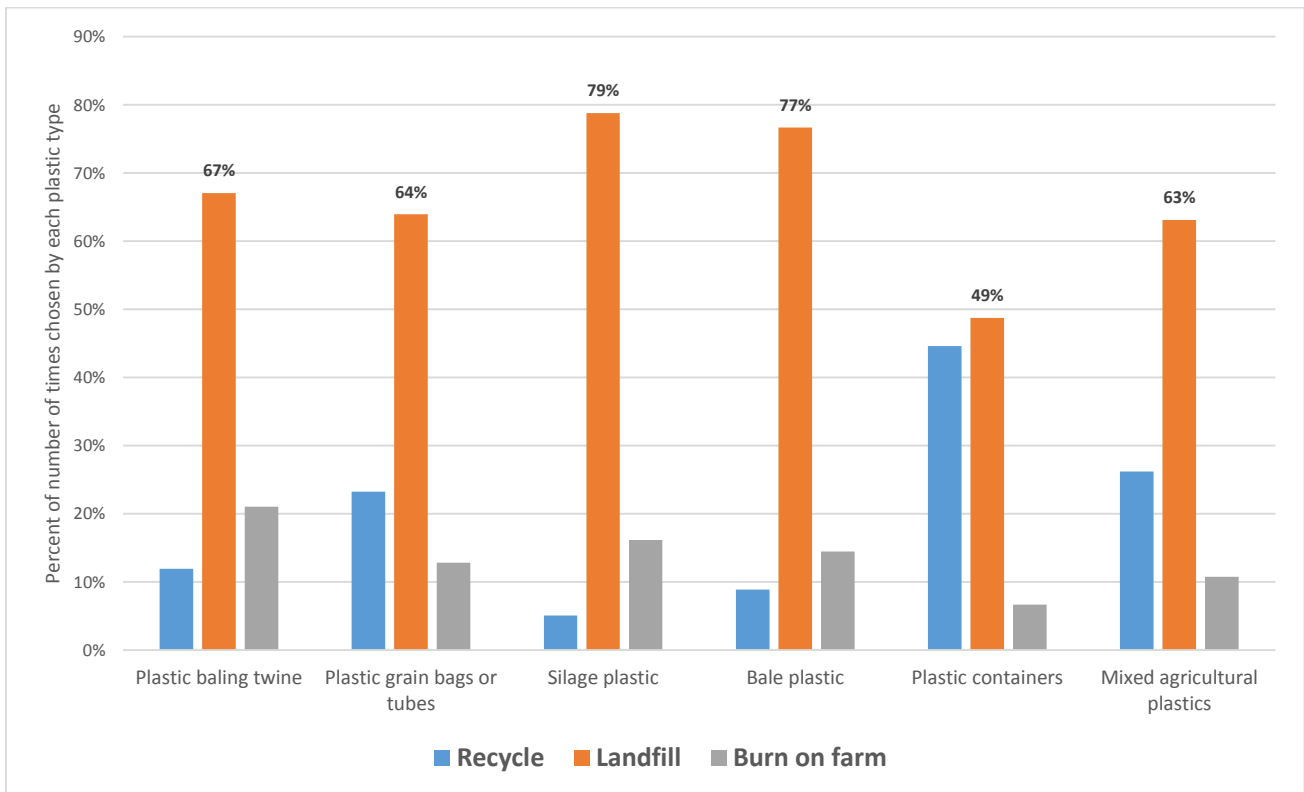


Figure 5.3: Disposal methods and rates by each type of agricultural plastic

5.4 Perspectives on farm plastics waste management:

The mail-out survey sought to gain insight to the farmers’ attitudes toward various elements of plastics management. This included questions that queried farmers’ perspectives on various disposal/management options for APW, their willingness to integrate various on-farm plastics management options into their own operations, willingness to pay to support an APW recycling program, and opinions about the level of responsibility of stakeholders for funding and administering an APW recycling program.

5.4.1 Farmer engagement

A likert scale was used in two questions to gauge the respondents’ opinions on disposal methods of agricultural plastics. The results show that it is important to the respondents that *farm plastics waste is recycled or disposed of in some other sustainable manner* (69%, n = 187), and that the *disposal of farm plastics waste in a public landfill is not an adequate method* (50%, n = 134). The first question reads: “It is important to me that farm plastics waste is recycled or disposed of in some other sustainable manner” and the answer “Strongly Agree” or “Somewhat Agree” was chosen by 90% of respondents. The second question reads: “From an environmental perspective, disposal of farm plastics waste in a public landfill is an adequate method of disposal”. The answer “Strongly Disagree” or “Somewhat Disagree” was chosen by 74% of respondents. Despite what is happening currently regarding APW disposal, farmers expressed a sentiment that landfilling such material is not acceptable, suggesting, in principle, that they could be engaged to support an APW recycling initiative. Figure 5.4 below displays the frequency of responses for both questions.

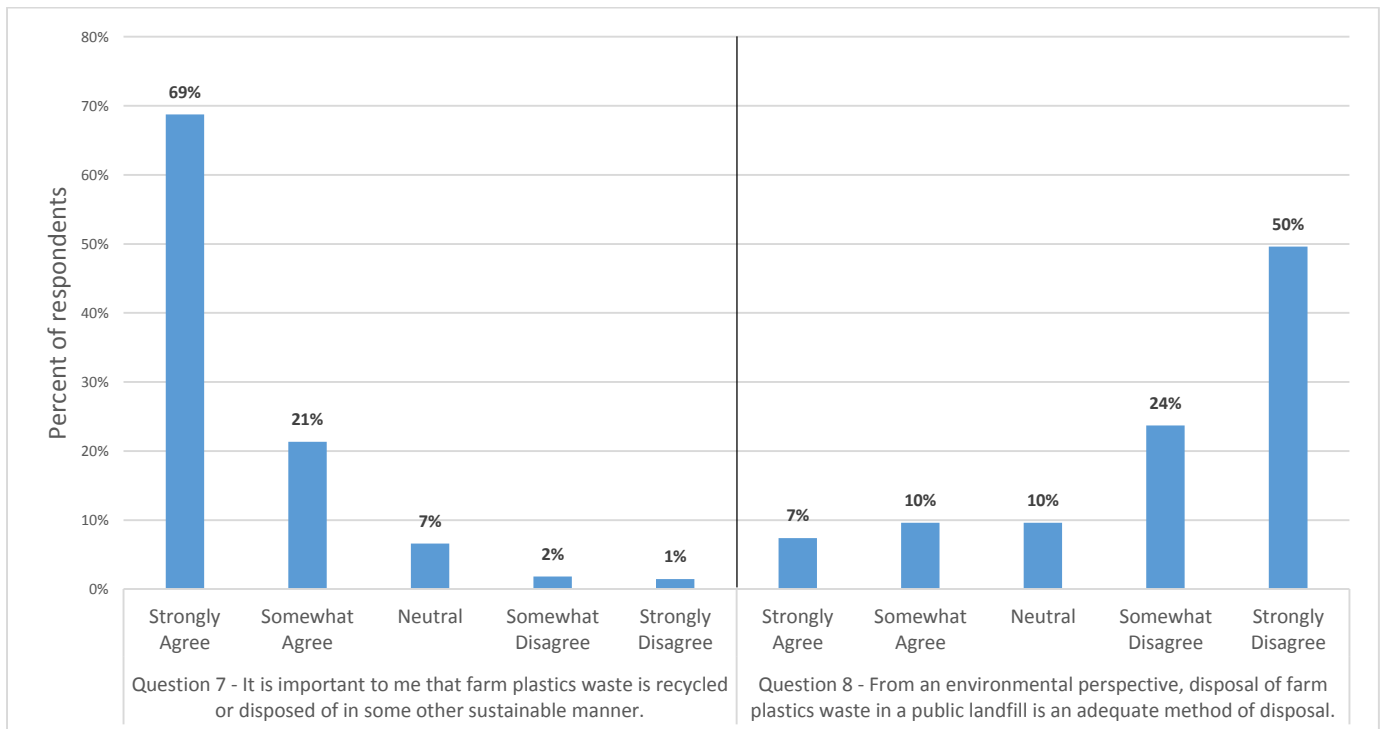


Figure 5.4: Opinions on farm plastics disposal

However, the degree to which farmers would modify their behaviour was a question, so respondents were queried about the actions they would be willing to take to facilitate APW collection and any barriers they may face related to on-farm activities. Specifically two questions in the survey dealt with this issue.

Firstly, respondents were asked which of the following actions (if any) they would undertake for each APW type:

- Separate, bundle, and deliver to depot
- Separate, bundle, and store for pickup
- Consolidate and store for pickup (without separating)
- Return to supplier

Most often, respondents selected *separate, bundle, and store for pickup*, both as a whole and for each APW type. The next most likely action was *consolidate and store for pickup (without separating)*. Actions that required farmers to transport APW either to a depot or to a supplier return facility were less popular; those surveyed indicated about half as often that they would be willing to transport the APW in addition to any on-farm collection and preparation (Figure 5.5).

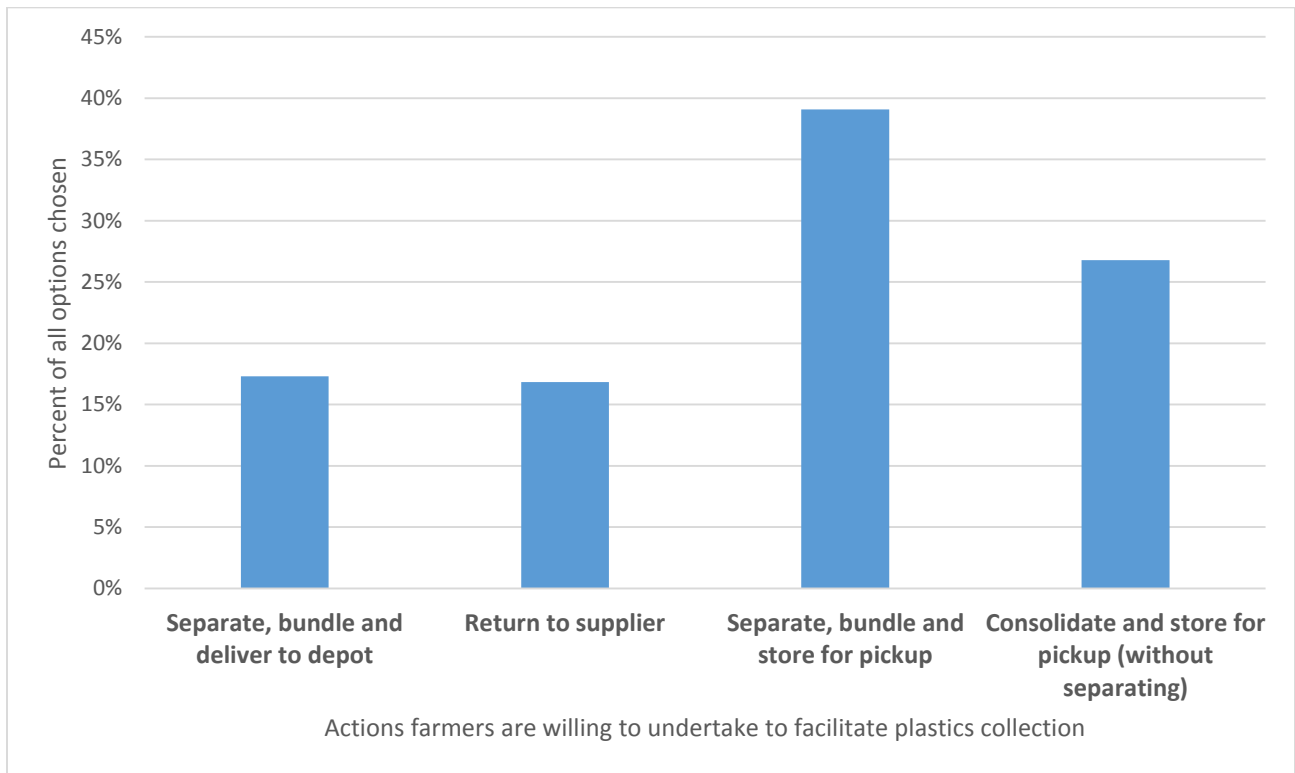


Figure 5.5: Willingness of farmers to take certain actions to facilitate plastics collection

Secondly, respondents were asked about the barriers that could impact their ability to undertake one of the above actions, specifically related to *consolidating plastics into one location on farm* to enable some kind of collection. The responses were coded thematically, themes and categories were developed by reviewing the answers and identifying keywords and phrases that could be used to categorize and label each answer accordingly. 45% stated clearly they did not perceive there to be any barriers to participating in a recycling program (by collecting and consolidating the plastics for easy collection). Lack of storage space was noted by 20% respondents as a barrier, and 14% pointed to problems such as time,

convenience, and lack of motivation as barriers to collecting and consolidating APW. The idea that the plastics are too dirty or degraded to be recycled is often cited by recyclers and managers of programs that recycle farm plastics, however, just 10% of respondents mentioned it as a barrier to collecting and consolidating plastics on-farm for recycling. Table 5.2 below shows all of the categorized responses.

Table 5.2: Perceived barriers to farmers consolidating plastics for collection by a recycler

Category description	Response keyword/summary	Count	Total	% of total # of answers
No barriers to consolidating plastics on farm	none	70	90	45%
	no problem	4		
	no barriers	11		
	nothing	5		
Lack of space/storage	storage/container	24	40	20%
	space	16		
Effort by the farmer	time	22	31	15%
	convenience	5		
	laziness	2		
	not enough plastic to bother	2		
Lack of a recycling program or organized structure for collection	no recycler	11	20	10%
	no collector	4		
	lack of education/co-ordination	5		
Plastics are not considered recyclable	dirty/wet/degraded	21	21	10%

Although respondents expressed reservations about various elements related to their participation in a new APW diversion program, overall the results suggest most would likely engage in such an initiative, as long as certain caveats were in place. For example, the majority have no interest in a program that requires them to transport APW to collection depots. Others expressed concern about the level of on-farm activities such as separating vs not-separating, or the possibility of needing to clean or prepare APW in advance of collection. However, none of these results would indicate any permanent hurdles to a properly developed APW management program in NS.

5.4.2 Program funding and delivery

There are various mechanisms to generate the funding required to operate diversion programs. Commonly funding will come from one or more of the relevant stakeholders - usually - government, producers/dealers/importers, and end-users. Evidence gathered in this research suggests that two scenarios are common for APW recycling programs: 1. legislation that requires the producers/importers and the farmers to fund a program; 2. voluntary initiatives that are primarily funded by the plastics producers/dealers/importers, and to a lesser extent by the farmers. As farmers were the stakeholders being engaged with more in this research it was a good opportunity to gauge their willingness to pay to support an APW recycling program. Personnel within CleanFARMS suggested that approximately 5-7% of front-end plastic costs would be needed to fully fund such a program in Nova Scotia (B. Friesen personal communication, May 8, 2015). Therefore, knowing how much farmers are willing to pay would help determine how much funding would need to be acquired from other sources.

Respondents were asked to identify the dollar amount that they would be willing to pay to support an APW management program. The amounts they could choose from were posed as a dollar amount that would be paid on top of a fictitious amount being spent on a specific type of farm plastic (bale wrap).

Approximately 31% of respondents indicated that they would not be willing to pay for such a program, while ~56% expressed a willingness to pay between 1% and 4% of the amount already being spent on plastics. Less than 5% of respondents would pay between 5% and 10%. This finding is significant as it sets precedent for what could be an acceptable upper limit for fees imposed on the farmer to support an APW recycling program. While 4% of plastics costs is not sufficient to fully cover programmatic costs - as noted above - it could supply more than 50% of the required funding.

In addition to a better understanding of the willingness to pay for a program is the necessity to ensure the appropriate cohort is responsible for – or at least included in – the delivery of such an APW recycling program. The four groups identified were:

- The plastics producer/dealer/importer
- The farmer
- The municipal government
- The provincial/federal government

These four groups were included because they are common stakeholders in waste management programs. Government agencies are often expected to facilitate waste management directly or indirectly, the end users (in the case of APW, the farmer) of materials are burdened with disposing of the wastes generated, and EPR legislation, where implemented, has obliged the producers/dealers/importers of materials to pay for the management of the waste they sell into the market.

Respondents indicate that *plastics producer/dealer/importer* are preferred to bear the responsibility (financial and operational) of such programs, being selected 45% of the time. This was followed by the *farmer*, selected by 21%, *the provincial/federal government* at 19%, and the *municipal government* at 15%. Interestingly, more farmers place the responsibility of funding and managing a program on the *producer/dealer/importer* and the *farmer*, and not the *municipal* or *provincial/federal governments*, despite the fact that most waste diversion/recycling programs in NS are municipally operated and the legislation related to what is diverted and what is permitted to be landfilled falls under provincial jurisdiction.

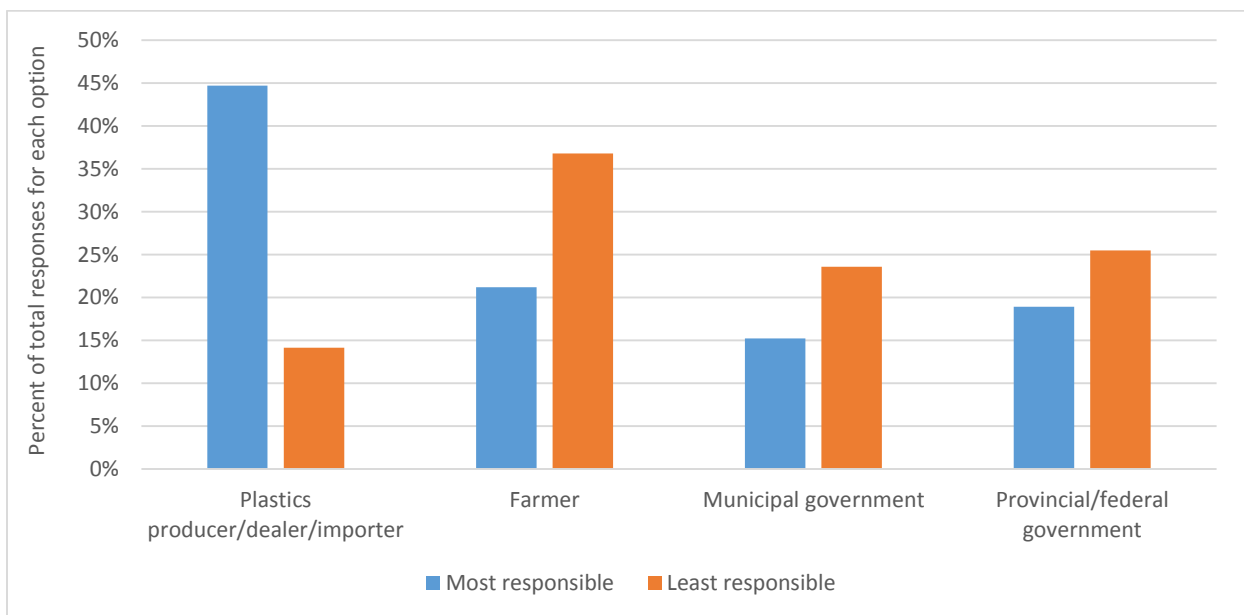


Figure 5.6: Responsibility for funding and managing a farm plastics recycling program

5.5 Result variations

The cost-efficiency and effectiveness of an APW recycling program may be increased by targeting subsets of the farming community who may represent a disproportionately high percentage of the total amount of APW generated in NS, or a more easily engaged cohort. Analysis of specific cohorts was undertaken to identify which produce the most plastics, and what idiosyncrasies exist between them that could have bearing on the effectiveness of a program. For example, a program that targets the *dairy cattle* and *vegetables/fruits* farmers would engage with the groups that produce the majority of APW in NS. The data show that *dairy cattle* farms produce much more plastics waste per capita than *vegetables/fruits* farms, but, because there are more of the latter represented in this study the total plastics generated per cohort are not disparate. Additionally, official NS statistics show that *vegetables/fruits* farms are underrepresented in this study, and so it can be assumed that the APW produced by this cohort is more than what is reported here. Interestingly, the data show that *beef cattle* farms report burning plastics twice as often as any other group.

Dairy farmers – or farmers that reported *dairy* as their most important commodity from a financial perspective - represented approximately 13% of the respondent population. These respondents reportedly generated ~26.2 tonnes of plastics waste each year, which, when extrapolated to the total population of farms in NS is ~372 tonnes of APW. This cohort reported sending their APW primarily to landfill; the remainder burn APW on-farm almost as often as they recycle it. The majority of this cohort expressed a willingness to *consolidate and store plastics waste for pickup (without separating)*.

Those that reported *vegetables/fruits* as the most important commodity on their farm in terms of financial value represented just over 30% of the respondent population. This cohort is more likely than others to recycle plastics waste, however, they still send the majority to landfill. This cohort also indicated a heightened willingness to *separate, bundle, and store plastics waste for pickup* compared to other cohorts that were more willing to consolidate plastics but not to separate them by type. The 87 *vegetables/fruits* farmers in this study reported 17 tonnes of plastics waste, which, when calculated to all of Nova Scotia represents ~242 tonnes.

Larger farming operations represented by farmers who earn 50% or more of their income from farm activities and produce a minimum of 45kg of bale plastic waste and/or silage plastic waste, represented 20% of the respondent population; they also produce ~35% of all the estimated APW in NS. Most reported either sending bale and silage plastics primarily to landfill, or burning plastics on farm; they did not recycle any of these plastics. Just over 50% of these respondents are *dairy* farmers, followed by *beef cattle* farmers at 21%. According to the amounts of plastics reported in the mail-out survey this cohort generate about 24 tonnes of bale and silage plastics waste, which, when extrapolated to the entire population of farmers in NS represents ~338 tonnes of bale and silage plastics waste per year, or, as noted ~35% of all of the APW in NS. Interestingly, the majority of this cohort indicated that they would be willing to engage with an APW program by integrating consolidation and storage activities into their on-farm operations. They would not, however, be willing to separate the various APW streams.

Approximately 20% of respondents report burning plastic on their farm. Of this cohort, over 80% are age 51 or over; 50% have operated their farm for more than 30 years. These farmers had a greater propensity for being satisfied with their current methods of plastics disposal. Plastic baling twine was the dominant plastic type reportedly being burned at 35%, while bale and silage plastics combined represent ~30%. 30% of the farmers that report burning plastics on-farm are *beef cattle* producers, followed by

dairy and vegetables/fruits/plants farmers, each at 15%. The results of this research indicate that as many as 800 farmers in NS are burning APW on-farm, and are not necessarily dissatisfied with this practice. An APW recycling initiative in NS will need to highlight the environmental and human health concerns related to the open-air burning of plastics waste.

5.6 Operational considerations in Nova Scotia

5.6.1 Waste managers

Surveys were conducted by email with a number of waste management professionals working in or with the Municipal governments of NS. The survey sought information on the management of APW and plastics waste in general from an operational perspective.

The managers of the material recovery facilities (MRFs), which collect and sell recyclables, decide which plastics are collected for recycling based on which materials are banned from landfill and the availability and reliability of markets for selling what will be collected. According to these waste managers all types of APW would be accepted at all of the MRFs, in theory, as long as it is clean and dry. However, the MRFs cannot risk collecting material that is unmarketable, as this material will then become a financial burden to them in terms of transportation costs and tipping fees for disposal in landfill. Time and effort is required to change practices at the point of disposal, both in the residential and commercial contexts, combine this with the fact that a market must be established and reliable and it becomes very difficult for MRFs to divert low-value plastics waste, including APW, from landfill. The waste collectors and MRFs have limited influence when it comes to farm waste management, as farms are commercial entities and are therefore solely responsible for disposing of their waste (Province of Nova Scotia, 2009).

5.6.2 The legislative environment

A survey was completed by a representative of the Nova Scotia Department of Environment. Its purpose was to identify barriers to the recycling of APW, and to evaluate the legislative environment related to plastics waste management in general.

Through the *Environment Act* and the *Environmental Goals and Sustainable Prosperity Act* the NS Government is actively pursuing a waste diversion rate of 50% and a waste disposal target of no more than 300kg/person/year by the year 2015 (Nova Scotia Environment, 2011). The *Solid-Waste Resource Management Regulations* of NS were first created under section 102 of the *Environment Act* in 1994-95. These regulations establish a *Resource Recovery Fund* which:

- develops and implements industry stewardship programs
- funds municipal or regional diversion programs
- develops and operates a deposit-refund system for beverage containers
- develops education and awareness of source reduction, reuse, recycling and composting
- promotes the development of value-added manufacturing in the Province

The fund is administered by a board known as the *Resource Recovery Fund Board (RRFB)* – which was incorporated as a not-for-profit organization under the laws of NS in 1996. The RRFB supports organizations and businesses that collect, manage, recycle, and dispose of post-consumer waste materials in the province.

Though there is no legislation that deals specifically with APW, most of the farm plastics considered in this research are banned from landfill. It is the responsibility of end-users and waste managers, with support from the RRFB and under the scrutiny of the NS Department of Environment, to ensure that banned materials do not end up in landfill. Many of the plastics that are banned still end up in landfill because they are too difficult and costly to recover and recycle. According to the respondent, improved diversion rates can be expected in the coming years with the enactment of EPR legislation, but, implementing the stewardship programs will take time. While no specific solutions outside of the enactment of EPR legislation are apparent, it was suggested that establishing the methods for achieving a maximum amount of plastics separation in the short term could provide industrial inputs, such as fuel for cement kilns, which is a common end-use for low-value plastics waste in Europe (Briassoulis et al., 2010; PlasticsEurope, 2015)

5.7 APW recycling programs in other jurisdictions:

Surveys were completed by email with five organizations currently involved in APW collection/diversion programs in other jurisdictions. The purpose of the survey was to identify and articulate the operational specifics of functioning APW recycling programs.

- Iceland Recycling Fund – Iceland
- IFFPG – Ireland
- Gront Punkt AS – Norway
- ERDE (RIGK GmbH) – Germany
- Island Waste Management Corporation – Prince Edward Island

In all cases, the APW collected is intended for diversion to mechanical recycling operations; Table 5.3 provides an overview of the pertinent points related to each program. It should be noted that two of the programs (Germany and Prince Edward Island) have such low participation rates it was decided that the responses from the individual representatives would not be included in Table 5.3 or discussed further. However, details of the programs can be found in Appendix F.

The programs in Norway, Ireland, and Iceland all presented potential strategies/options that could be integrated into a successful APW recycling program in NS. Of the three, the Gront Punkt AS program in Norway is the only program that is entirely voluntary, it also does not require the farmer to pay for disposing of the plastics (unless the plastic is dirty). The Norway program is not necessarily an ideal example for NS, as the farmer is required to arrange transport of the EOL plastics themselves, an unpopular management method according to results from the mail-out survey to farmers. However, the program in Norway accepts all plastics, has a nearly 100% recovery rate, reaches “most” of the farming community, and has been active since 1996. A detailed description of how the Gront Punkt AS program works can be found under Appendix G. An important aspect of this program is that a department exists that focuses entirely on recruiting producers and importers to the system – who then pay a weight based fee on plastics they sell in Norway. The programs in Ireland and Iceland both operate under legislation that forces the organizations putting the plastics on the market, and the farmers, to pay to support collection and recycling efforts. Though the farmers pay to support the recycling programs in Iceland and Ireland the transportation of the plastics is incorporated in this price and does not require the farmers to transport the plastics themselves.

Table 5.3: Farm plastics recycling organizations in other jurisdictions

	Iceland - Iceland Recycling Fund Contact: Ms. Iris Gunnarsdottir - iris@urvinnslusjodur.is Website: www.irf.is	Ireland - IFFPG Contact: Mr. Liam Moloney - liam.moloney@farmplastics.ie Website: new.farmplastics.ie	Norway - Gront Punkt AS Contact: Mr. Svein-Erik Rodvik - svein.erik@grontpunkt.no Website: www.grontpunkt.no
Voluntary?	NO	NO	YES
Producer/importer pays?	YES (mandatory)	YES (mandatory)	YES (voluntary)
Farmer pays?	YES (at point of disposal)	YES (at point of disposal) - discount given if proof of purchase of levied plastic provided	NO (unless the plastic is dirty)
Farmer transports plastic?	NO	NO	YES
Specific plastic targeted/accepted	Wrap (film)	Silage wrap (film)	All plastics
% Recovery	100%	75% (23000 tonnes in 2013)	Approx. 100% (11000 tonnes in 2013)
% Participation	85-90%	35000 farmers per year* (30.5%) *many farmers dispose of plastics every 2 or 3 years	"most"
Year of inception	2005	2000	1996

*red indicates an attribute which may not be conducive to a successful program in Nova Scotia

Information has been gathered from farmers, waste managers and government representatives in NS, as well as organizations recycling APW in other jurisdictions. This information offers insights into the situation regarding APW management in NS today, the barriers to implementing an APW recycling program in NS, as well as potential solutions to these barriers. Following, section 6.0 will review and synthesize the most relevant results and consider recommendations for the development and implementation of an APW recycling program in NS.

6.0 Discussion and recommendations

6.1 Engaging the farming community

The results of the mail-out survey can arguably be considered a proxy for the farming community of NS. The basic demographics and commodity mix do not vary excessively between this study and official NS statistics, with the noted underrepresentation of *vegetables/fruits/plants* farms, and the lesser overrepresentation of *beef cattle* farms. It was extrapolated (based on the survey data) that ~900 tonnes of APW are generated in NS annually, as much as half of that amount is silage and bale plastic. Except for polypropylene baling twine - all agricultural plastics considered in this research are banned from landfill; despite this, currently most of these materials are still sent to landfills for disposal. The results show as well that burning plastics waste is a common practice on NS farms; this was corroborated by farmers during farm visits conducted as part of the study for the purpose of ground-truthing a number of research assumptions. A former President of the NSFA also supported these interpretations of the current reality and went on to explain that farmers commonly maintain a dumping area on their property, which is periodically set on fire (see Appendix I for images from farm visits).

The results suggest that many farmers are not sufficiently dissatisfied with the practices of landfilling and/or burning to warrant their own individual action to find alternative options. This emphasizes the need for a recycling program that is easy to engage with and does not require the farmer to invest more money and effort than is absolutely necessary.

However, results also indicate that farmers are concerned about the problem of objectionable disposal practices and would likely support an APW recycling program. The majority of farmers in this study reported that: a) farm plastics should be recycled or disposed of in some other sustainable manner; b) sending APW to landfill is not an acceptable option; and c) they are willing to pay at least a small amount to support a recycling program. While, most of the survey respondents are not willing to transport the EOL plastics to disposal points themselves, they are willing to participate in some capacity in an APW recycling program. Most farmers stated specifically that no barriers exist to prevent them participating in a plastics recycling program by collecting and consolidating plastics on-farm for ease of collection by a recycler. A minority of respondents cited a lack of storage space or a lack of education/understanding as barriers, but these problems could be solved with the implementation of a well-designed program. All of these results together paint a picture of a farming community that is ready and willing to contribute to and participate in a recycling program – however, it should be noted that stated attitudes, intentions, and willingness are considered at length in the academic literature as poor indicators of the real-life actions a person will take (Ajzen, Brown, & Carvajal, 2004; Bhatia & Fox-Rushby, 2003; LaPiere, 1934; Lusk, 2003). Strong institutional and peer support would be necessary to transition expressions of willingness into action.

6.2 Moving forward

Waste managers in NS are unable to recycle plastics that are wet, dirty, or degraded, but most APW is recyclable in principle and could enter recycling streams if kept relatively clean and dry by farmers and waste collectors. Municipalities are not responsible for collecting commercial waste resources; therefore farmers are left to manage large amounts of plastics waste that is costly and effort intensive to dispose of. Many farmers resort to stockpiling and burning it on-farm, a situation that runs contradictory to legislation in place in NS that deals with plastics waste, as the majority of these plastics are banned from landfill and open burning of plastics is prohibited (Province of Nova Scotia, 2009). Ideally a stewardship program that manages APW efficiently can be implemented. Such programs exist elsewhere and are valuable sources of information for planning a program for NS. When implemented and operational it is possible that a farm plastics stewardship program would be able to capture most of the APW that is currently being sent to landfill or burned on-farm.

Alternatively, a less co-ordinated approach is possible; for example, a campaign to educate farmers and waste collectors about APW recycling, combined with the provision of drop-off locations, could increase recycling rates. Pilot programs have been tested in Prince Edward Island and the Municipality of Colchester NS (Government of Prince Edward Island, 2012; Nova Scotia Environmental Farm Plan, 2015); both have collected APW and received positive feedback from the farming community. However the limited success of these projects could suggest that isolated programs with no obligatory participation divert small quantities of APW from landfill. A response to the problem of APW management in NS should at the very minimum aim to educate farmers about the negative repercussions of burning, dumping, and landfilling APW, as well as provide locations for easy disposal. For example, *plastic containers* are recycled almost as much as they are sent to landfill, which is a much higher recycling rate than any other APW in NS. This is due to the fact that a pesticide and fertilizer container recycling program has been active in NS since 1989, and has recovered an average of ~30,000 containers per year for the last five years (CleanFARMS, 2015). The CleanFARMS empty pesticide and fertilizer container collection program was suggested by a number of farmers as a successful model for addressing the general farm plastics problem in NS, and it is an excellent example of how recycling rates can be increased substantially with education campaigns and drop-off locations for farm waste.

To garner insight and feedback from farmers about these potential solutions we engaged with the farming community in two ways; a presentation was made to a NSFA Council of Leaders meeting (followed by a question and answer session that ended with the soliciting of feedback from the audience) and a number of farm visits were completed. The farms visited produce dairy, fruits/vegetables, and organic fruits/vegetables.

The majority of the attendees of the NSFA Council of Leaders meeting indicated that the preferred course of action regarding APW management would be to educate and co-ordinate farmers and waste handlers, while the rest agreed that a stewardship program would be the best approach. The Council Members communicated the general sentiment that keeping plastics clean and dry is a definite barrier to recycling. We assumed that due to the advent of biodegradable row covers and mulch film farmers typically would not dispose of large amounts of row covers and mulch film. However, farmers explained that such products are much more expensive than traditional plastics, are not as effective, and do not bio-degrade when tilled into the soil. This sentiment was reiterated during the site visits. For example, one organic farmer expressed concern about soil quality issues related to plastics contamination (see Appendix I for images from farm visits).

The Council of Leaders were also concerned about farmers having to invest time and money into managing plastics waste, when farmers have very little time and money to spare. During the farm visits, the sentiments expressed echoed the diversity of attitudes noted throughout the survey responses. Disposing of plastics waste in landfill is seen to be costly and is not the desired option; many farmers would be willing to pay to support a recycling program - and - are willing to invest time and effort to manage the plastics effectively. However, currently the easiest and cheapest way to dispose of APW is to burn it on-farm. Any alternative solution would need to be both cheap and simple, such as annual drop-off events or on-farm storage bins; having the plastics leave the farm is preferred.

Though concerns have been expressed about the difficulties farmers will encounter keeping the plastics clean and dry, this research finds that it has been proven feasible in other jurisdictions. Stewardship programs that levy the producers/importers/dealers and the farmers have been seen to be effective as well and could be for many farmers achieved at no extra cost, as they are already paying for the transport and disposal of their plastics in landfill. The farmers that are not paying for disposal now may incur extra costs but an effective stewardship program would minimize these and provide a much needed service. There are many examples of waste streams that have progressed from landfill banes to valuable sources of material, one of the most obvious being that of used tires (Sienkiewicz, Kucinska-Lipka, Janik, & Balas, 2012). Stewardship programs such as the massive network in place for used tire recovery in Europe force the valorization of a waste stream, which in turn spurs innovative management strategies.

7.0 Conclusions

The results of this research form a core of information that helps characterize the state of APW management in NS. A clear picture of the realities, attitudes, opinions, and systems in place here is an important first step in solving a resource and environmental dilemma being faced by the farming and waste management communities of NS.

The case for APW plastics recycling has been made years ago in other jurisdictions, and should be made now in NS. The plastics that are going to landfill and being burned on farms are valuable materials, a fact not lost on the farmers themselves. Also, farmers have expressed how irreplaceable plastics have become in their daily operations – therefore they will continue to be used and the waste will continue to accumulate until solutions are implemented. The situation for farmers is couched in the wider problem of managing EOL low-value plastics waste; these plastics are difficult to recycle mechanically and are being landfilled in the thousands of tonnes in NS every year. If mechanical recycling is not currently an option for these plastics, including APW, then options other than landfill should be considered.

8.0 Limitations

Despite having reached a wide range of farm types and sizes across much of NS, the survey response rate of 11.58% is a relatively small sample which limits the generalizability of the results. Time constraints limited the amount and types of analyses that could be performed on the data collected. Finally, more attention should have been paid to the horticulture and plant based sector of the farming community and the plastics waste that they generate specifically.

9.0 Recommendations for future studies

Future research should focus on three management needs for the development of an APW recycling program. First, practical hands-on audits should be conducted to categorize the actual plastics waste being generated on farms and evaluate the physical state and potential recyclability of the plastics. Second, guidelines should be developed that will ensure the plastics waste is handled correctly and recycled if possible. Finally, investigation into alternative disposal routes for these plastics needs to be undertaken; while it is possible that much of the plastics waste generated on farms in NS is recyclable, it is likely that new routes need to be uncovered as well.

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11.0 Appendices

Appendix A: Farm plastics details

Baling twine:

Product description	Twine can be made from a multitude of products including both natural and synthetic fibres. Natural fibers include hemp, sisal and cotton. It is sold in rolls and ranges in length. Common sizes are anywhere from 1,220 m to 12,200 m. 2,200 m weigh approximately 7.7 kg on average
Product composition	Synthetic twine is made up of strands of polypropylene twisted together to form a rope-like product
Farm operation where the product is primarily used	It is used to wrap bales of hay and straw after harvest
Point of purchase	Twine can be purchased from farm supply stores and hardware stores
Product benefits	Farmers use synthetic twine because it is lower cost and stronger/more durable than natural twine
Current disposal options	Landfill or burning are common disposal techniques currently being used
Disposal/recycling challenges	Poly-twine can vary in size and colour, thus some recycling applications and end market uses may require separation by colour and, in some cases, by size.

Plastic grain bags or tubes:

Product description	Grain bags are an affordable, temporary way to store grain and wheat. Grain bags are often confused with silage and ag-bags, however their purpose and composition are different. The main reasons grain bags differ from silage bags (1) Different thickness (2) High strength and low stretch whereas silage bags are the reverse Grain storage bags are becoming increasingly prevalent throughout the world, particularly in Canada's Prairie Provinces. Since the product was introduced into Canada in 2003, its popularity has grown exponentially
Product composition	Made from a combination of three separate laminated layers of low-density polyethylene. The white plastic that comprises the top two layers of the bag function as a UV filter and the black third layer designed to keep sunlight out
Farm operation where the product is primarily used	Used to store grain and wheat
Point of purchase	Farm supply stores and agricultural retail stores
Product benefits	Grain in bags maintains its grade, has fewer insect problems and doesn't heat as much as grain stored in piles
Current disposal options	Recycling options are available in some regions
Disposal/recycling challenges	Grain bags can weigh up to 125 kg therefore are difficult to clean, dry and transport to recycling facilities

Silage/bale wrap:

Product Name	Bale Wrap
Alternate name	Silage Wrap
Product description	<p>Bale wrap is used to preserve and store crop nutrients with the help of lactic acid bacteria to ensure rapid fermentation in air-free conditions. It is recommended that each bale has 6 layers of plastic for optimal performance. It is applied after the harvest has been baled and secured, usually with <i>twine</i></p> <p>It is commonly available in white and a light green shade; the lighter shades help reflect sunlight which helps prevent heat build-up. The practice of wrapping ones bales in a protective plastic wrap has become a great alternative for farmers</p>
Product composition	Low-density polyethylene
Farm operation where the product is primarily used	<p>Bale wrap is used for two reasons</p> <p>(1) Protection of dry bales that are being stored outside</p> <p>(2) When farmers are storing hay with a high moisture content to make haylage</p>
Point of purchase	Can be purchased at farm and agriculture retail stores
Product benefits	Wrapping round bales of hay has proven to be a great solution for preservation of harvest quality, extending both the life and the value of the harvest
Current disposal options	Farmers have the option of recycling in some regions, or they bring it to the landfill
Disposal/recycling challenges	The plastics are often contaminated and degraded

Plastic containers:

Product description	The most common plastic containers found on farms are pesticide and fertilizer containers, however, containers are used for many purposes and vary greatly in size and shape
Product composition	Plastic containers are most often made of high-density polyethylene
Farm operation where the product is primarily used	Plastic containers are most often used for transport and storage of pesticides and fertilizers
Point of purchase	Farm supply stores and directly from pesticide and fertilizer manufacturers
Product benefits	Without the use of pesticide and fertilizer many crops would grow to be marketable
Current disposal options	Many return programs exist, with farmers being required to triple rinse and deliver containers to drop off locations
Disposal/recycling challenges	Pesticides and fertilizers are potent chemicals therefore the containers cannot be recycled without extra washing and preparation as well as special protection for workers

Row covers and mulch film:

Product description	<p>Mulch film is available in three types (1) transparent (2) white and, (3) black. Transparent is used to encourage early season plant growth and early cropping. Black is used to control weeds. White is used to provide reflected sunlight to the plants</p> <p>When using mulch film, the crop is grown through slits or holes in the film and is typically used in combination with drip irrigation</p> <p>It is sold in rolls and can vary in length anywhere from 30 to 1,220 m. Typical mulch film is less than 0.15 cm thick and can be expected to last for one season. The 0.25 to 0.315 cm mulch films last up to five years</p>
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Product composition	Typically linear low-density polyethylene
Farm operation where the product is primarily used	Used to protect the roots of the plants from climatic extremes and improves the effectiveness of water usage
Point of purchase	Mulch film can be purchased at farm supply stores and agricultural retail locations
Product benefits	When mulch film is used with drip irrigation, the benefits include: earlier planting dates, soil moisture retention, weed management, reduction in the leaching of fertilizer, improved crop quality and reduction of root damage and soil compaction
Current disposal options	Current disposal options include burning and landfill
Disposal/recycling challenges	A lot of labour is required to remove and dispose of mulch film, it can take up to 8 hrs to remove 1 acre of mulch

Appendix B: Mail-out survey

AGRICULTURAL PLASTICS WASTE MANAGEMENT IN NOVA SCOTIA

Is it a problem for you?

Greetings,

My name is Isaac Muise, I am a graduate student at Dalhousie University and for my thesis research I am investigating how farmers in Nova Scotia are currently managing plastics waste on their farms. You have been chosen to participate because you are a farmer in Nova Scotia. We do not have your contact details; this survey is being sent via the Nova Scotia Federation of Agriculture.

This questionnaire should be filled out by the primary farm decision maker and should only take approximately 20 minutes.

Please try to answer all of the questions by either: ticking a box, circling the appropriate answer or number, or writing in the space provided. If there are any questions that you do not wish to answer, leave them blank and move to the next question. Partial responses are still useful to me.

All of your answers will remain anonymous. No identifying information will appear with your answer, and only a summary of everyone's answers will be made public. If direct quotes are used they will be anonymous in nature.

If you prefer, the same questionnaire is also available online at <http://tinyurl.com/nsfasurv>. If you prefer to complete the questionnaire on paper, please return your completed survey using the postage paid envelope provided.

If you do not wish to complete the survey and want to avoid being sent any reminders please mail the blank copy of the survey or call me at the number below and your name will be removed from the Nova Scotia Federation of Agriculture mailing list used for this study.

Thank you for taking the time to read this and to consider helping me out in my research. If you have any questions regarding the survey, or about the survey findings please contact me at the details below, or my supervisor, Dr. Michelle Adams, at michelle.adams@dal.ca or 902-494-4588.



Isaac Muise

BSc Environment and Resource Management
Master of Environmental Studies Candidate 2015

Isaac.muise@dal.ca or 902-999-5744

School for Resource and Environmental Studies, Faculty of Management, Dalhousie University



AGRICULTURAL PLASTICS WASTE MANAGEMENT IN NOVA SCOTIA:

Questionnaire

The first half of your postal code is requested.

This is not mandatory. If provided it will only be used to better understand the geographic distribution of the participants.

1. Are you male or female?

Male Female

2. What is your age range?

20-35 36-50 51-65 65+

3. Approximately how long have you been operating your farm?

0-5 years 6-10 years 11-15 years 16-20 years 21-25 years 26-30 years > 30 years

4. What percentage of your income comes from farming?

<10% 10-25% 25-50% >50%

5. Please list, in order of greatest to least, the 5 most important commodities produced on your farm in terms of financial value.

1 _____
 2 _____
 3 _____
 4 _____
 5 _____

6. Please list, in order of greatest to least, which commodities contribute most to your plastics waste.

1 _____
 2 _____
 3 _____
 4 _____
 5 _____

7. It is important to me that farm plastics waste is recycled or disposed of in some other sustainable manner.

Strongly Agree Somewhat Agree Neutral Somewhat Disagree Strongly Disagree

8. From an environmental perspective, disposal of farm plastics waste in a public landfill is an adequate method of disposal.

Strongly Agree Somewhat Agree Neutral Somewhat Disagree Strongly Disagree

9. What types of plastics waste are generated on your farm? Please check the amount of plastics waste generated on your farm for a given year.

	0 KG	1-5 KG	6-15 KG	16-25 KG	26-35 KG	36-45 KG	>45 KG (provide estimate)
Plastic baling twine							
Plastic grain bags or tubes							
Silage plastic							
Bale plastic							
Plastic containers							
Mixed agricultural plastics							

1/2



AGRICULTURAL PLASTICS WASTE MANAGEMENT IN NOVA SCOTIA:

Questionnaire

10. How do you typically dispose of each type of plastic? Multiple options are possible if you reuse some plastics before disposing of them.

	recycle	reuse	transport to landfill	roadside collection for landfill	stockpile	burn on farm	other	Are you satisfied with this method of disposal?	
Plastic baling twine								yes	no
Plastic grain bags or tubes								yes	no
Silage plastic								yes	no
Bale plastic								yes	no
Plastic containers								yes	no
Mixed agricultural plastics								yes	no

11. Do you need more information on how to recycle these plastics?

	Comments?	
Plastic baling twine	yes	no
Plastic grain bags or tubes	yes	no
Silage plastic	yes	no
Bale plastic	yes	no
Plastic containers	yes	no
Mixed agricultural plastics	yes	no

12. What barriers, if any, prevent you from collecting and consolidating plastics into one location on your farm for easier collection by a recycler?

13. What action would you be willing to take to divert the plastics waste from your farm into a recycling program?

	Separate, bundle & deliver to depot	Separate, bundle & store for pickup	Consolidate & store for pickup (without separating)	Return to supplier	Other (please indicate)
Plastic baling twine					
Plastic grain bags or tubes					
Silage plastic					
Bale plastic					
Plastic containers					
Mixed agricultural plastics					

14. If, for example, a roll of bale wrap costs \$75, how much would you be willing to contribute to support an agricultural plastics recycling program?

\$0.00 \$0.75 \$1.50 \$2.25 \$3.00 \$3.75 \$7.50

15. Who should have the organizational and financial responsibilities associated with agricultural plastics waste management? Choose those you feel should be included and indicate order of responsibility if the level is not equal (1 - most responsible, 2 - 2nd most responsible, etc.)

- The plastics producer/dealer/importer
 The farmer
 The municipal government
 The provincial/federal government

Appendix C: Waste manager survey

Isaac Muise - Dalhousie – SRES – 2015
Isaac.muise@dal.ca – (t) 902-999-5744 – (f) 902-494-3728

The following questions are designed to help me understand better the operational specifics of the management of different types of plastics waste at the municipal level in Nova Scotia, with a particular focus on low-value mixed plastics. If you have any further insights or comments please feel free to write them in the space at the end of this document. If you find that any questions are not applicable to you please write NA and continue to the next question. There are many questions here, if you would prefer to run through them quickly over the phone please call me any time at 902-999-5744. Otherwise please feel free to respond to the questions directly in this email, in the Microsoft Word document attached, or fax a hard copy to the number above. Thank you in advance for your time and help.

1. What type of waste management facility will you be providing information on? (MRF, landfill, transfer station, other)
-
2. Where is the facility located? (Municipality)
-
3. Do you accept waste from any other municipality?
-
4. How does your facility (or municipality) determine which plastics will be accepted?
-
5. How much plastics is handled at this facility annually (in tonnes)? What % of the plastics end up in landfill?
-
6. Which industries, companies, commercial groups, or institutions produce the most plastics waste?
-
7. Do you currently stockpile any plastics?
If yes, why? -
What types and how much? -
For how long? -
Comments -
8. Are you aware of any recyclers in the Maritimes (or North America) that accept mixed, low-grade/low-value plastics?
-
9. Is there a different approach on how you collect and manage waste from residential, institutional, and commercial generators?
-

10. Do you accept agricultural plastics at your facility? If so, what types, and how much?

-

Under what circumstances could you not accept the following plastics?

Polypropylene (#5) -

Low-density polyethylene (#4) -

High-density polyethylene (#2) -

Plastic films (mixed) -

11. What factors influence your ability to collect plastics waste from farms?

-

Please feel free to comment on any coming changes policies, regulations, or requirements that will influence the collection and marketing of different types of plastics:

➤

General comments:

➤

Appendix D: Government personnel survey

Isaac Muise
Dalhousie – SRES
2015

The following questions are designed to help me understand better the legislative situation as it pertains to the management of end-of-life plastics in Nova Scotia, with particular interest in agricultural end-of-life plastics. If you have any further insights or comments please feel free to write them in the space at the end of this document. Thank you in advance for your time and help.

1. What plastics are currently banned from entering landfills?
2. How are new plastics types added to the list of banned materials?
3. What landfill bans concerning plastics are expected to come into effect in the next five years?
4. To what extent are material bans monitored and enforced?
5. What mechanisms are in place that deal specifically with agricultural plastics waste?
6. Would extended producer responsibility legislation increase the capture rate of agricultural plastics waste?
7. Would all plastics typically found on farms be considered packaging materials under an extended producer responsibility program? If not, could you foresee an extended producer responsibility category for such things as plastic sheet materials used for silage, wrapping and shipping products, etc.?
8. What barriers exist regarding the establishment of plastics waste recycling systems in NS that will not require exporting the material?
9. What changes to legislation or regulations are expected regarding plastics waste management systems that are not mechanical recycling or landfilling?

Appendix E: Farm plastics recycler survey

Isaac Muise
SRES 2014

Regarding the responsible management of agricultural plastics waste in your jurisdiction.

1. What roles and responsibilities fall on this organizing body? How does the organization remain financially viable? If this organization did not exist is it likely that another existing organization would take its place?
2. What roles and responsibilities fall on the farmer? What financial burdens or rewards are applied to the farmer in connection with this program? What level of farmer participation do you have in this program?
3. What roles and responsibilities fall on the plastics producers supplying your jurisdiction? What financial connections do they have to the program? Would the program be able to carry on successfully without the participation of the plastics producers?
4. What roles and responsibilities fall on the plastics recyclers themselves? What limits do the recyclers impose regarding amount, type, and condition of plastics provided? What problems have been encountered while selling material to the plastics recyclers?
5. What roles and responsibilities fall on the local government? Does the local government provide financial viability gap support for the program? Does the local government participate in the collection of this plastic? Does the local government monitor and enforce laws associated with this waste?
6. What roles and responsibilities fall on the national government? Does the national government provide financial viability gap support for the program? Does the national government provide financial incentives to any of the stakeholder groups? Has the national government passed relevant legislation?
7. What roles and responsibilities fall on the agencies that collect the plastics? What arrangements exist between the collection agency and any other stakeholders? What financial or organization support are provided to the agency by any of the stakeholders?

Appendix F: Farm plastics recycling programs (Germany and PEI)

	Germany - RIGK GmbH ERDE Contact: Mr. Jan Bauer - Bauer@rigk.de Website: www.pelle-netti.de	Prince Edward Island - IWMC Contact: Heather Myers - hmyers@iwmc.pe.ca Website: www.iwmc.pe.ca/history.php
Voluntary?	YES	YES
Producer/importer pays?	YES (voluntary)	NO
Farmer pays?	NO (and the farmer is given discounts on future plastics purchases)	NO (unless the plastic is dirty)
Farmer transports plastic?	YES	YES
Specific plastic targeted/accepted	All plastics	Silage wrap (film)
% Recovery	15-20%	Very low (~90 tonnes in 3 years)
% Participation	Unknown	Unknown
Year of inception	2014	2012

*red indicates an attribute which may not be conducive to a successful program in Nova Scotia

Appendix G: Detailed description of farm plastics recycler in Norway

	<p>Norway - Gront Punkt AS Contact: Mr. Svein-Erik Rodvik - svein.erik@grontpunkt.no Website: www.grontpunkt.no</p>
Roles and responsibilities of the organizing body	Gront Punkt AS invoices suppliers and manufacturers of plastic packaging according to the number of kilograms of plastic they sell - they fund collection companies that QA and compress the plastic - a full department exists that just works on recruiting producers and importers to the Gront Punkt AS system -- it is unlikely that another organization would take this responsibility if Gront Punkt AS did not exist, as there is a market for plastics, but it is unlikely that there would be an organized collection system and then the government would not get any statistics at all on these plastics - the other option is that the government would put a high fee on the products, so the product would be much more expensive to buy
Roles and responsibilities of the farmers	The farmer delivers used plastics to a collector for free, or arranges for a collector to come and pick it up at the farm - the transport is not in managed in the Gront Punkt AS system and is arranged between the farmer and collector, usually there is a transport fee paid by the farmer - the plastics have to be as clean as possible for the farmer to avoid paying at the point of disposal as well - The farmer needs to ensure that the plastics are as clean as possible, avoiding soil, product residue, sand, and other types of plastic is a problem - a pamphlet is provided to farmers that guides them on managing the plastics and what specifically to exclude
Roles and responsibilities of the plastics producers/dealers/importers	The fees that the plastics producers/dealers/importers pay Gront Punkt AS finances the entire farm plastics recycling program
Roles and responsibilities of the local government	The local government run a collection system for household waste, and sorting sites for the households - some of these sorting sites that are owned by the local government also take waste from farmers and local businesses - some places you have to pay a fee, others not, this is up the local government
Roles and responsibilities of the national government	The national government does not provide any financial support for this program - they follow the EU regulations, but very often they set higher goals for collection - in 1996 the national government told the plastic producers and importers that if they did not take responsibility for all the plastic waste, the national government would have to put a high fee on these products - this is the reason that the importers and producers formed Gront Punkt AS, which took responsibility for the waste, and the high fee on products has not been enforced
Roles and responsibilities of the collection agencies	They collect and send the different fractions to different recycling companies that they choose themselves, from a list of approved recycling companies - the collectors report the weight in a Gront Punkt AS database - in this way Gront Punkt AS has a good basis for reporting to the Government how much of the plastics are collected in Norway - after the collector has reported the weight Gront Punkt AS pays the collector a fee per ton, which is different for different types of plastic

Appendix H: Example calculation for plastics totals

					Calculated total for survey population	Calculated Nova Scotia total	
amount of plastic type reported in kg	number of respondents that reported the plastic type	average amount produced by each respondent	% of respondent population that reported plastic type	# of farms expected to generate plastic type in the survey population	amount if expected number of generators produced avg. amount	# of farms expected to generate plastic type in Nova Scotia	amount if expected number of generators produced avg. amount
1000 kg	100 farms	10 kg	36%	863 farms	8630 kg	1406 farms	14060 kg
		total reported weight / number of respondents that reported the plastic type	100/275 (total respondents)	2374 (survey population total) X 0.36 (percent of expected generators)	average weight generated per respondent X number of farms expected to generate plastic type	3905 (all farms in Nova Scotia) X 0.36 (percent of expected generators)	average weight generated per respondent X number of farms expected to generate plastic type

Appendix I: Plastics on farms in Nova Scotia







