Northern Ontario Agricultural Plastics Disposal Assessment Report

March 2018

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Executive Summary

Farmers in Northern Ontario face a number of unique challenges in regard to accessing sustainable end-of-life management options for their farm generated plastic wastes. Primary among these are the low value of recovered agricultural plastics, the geographical challenge of servicing an area of over 800,00 km^2, the lack of local recycling capacity and diminishing access to landfills as disposal facilities.

To better understand the challenge facing the Northern Ontario agricultural community, this study was commissioned to quantify the amounts of agricultural plastics generated on an annual basis, determine a five-year projection on this inventory and explore end-of-life options to divert this material from landfill. Additionally, a collection framework and cost model has been prepared to illustrate the design of a collection system and the associated costs.

There are two major crop categories in Northern Ontario, major field crops and livestock, and two smaller sectors, major fruit crops and major vegetable crops. Together these farming sectors are estimated to produce over 819 tonnes per year of recoverable agricultural plastic waste. To date this material has been subjected to on-farm storage and burial, open burning and landfill.

Farming Sector	Tonnes/Year
Major Field Crops	788
Livestock	23
Major Fruit Crops	4
Major Vegetable Crops	4
Total:	**819**

The five-year projection includes the largest sectors of agricultural activity; major field crops and livestock. Based upon farmer surveys, agricultural activity is expected to grow by 16% over five years, at an average of 3% per year.

Farm Sector	2017	2018	2019	2020	2021	2022
Major Field Crop	(tonnes/year)	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
PP Woven Bags	8	8	8	8	8	9
HDPE Containers	85	88	90	93	96	99
LDPE Film	6	6	7	7	7	7
LLDPE Film	519	534	550	567	584	601
PP Twine	122	126	129	133	137	141
PP Net Wrap	48	50	51	53	55	56
Total Plastic	**788**	**812**	**836**	**861**	**887**	**914**
Livestock						
PP Woven Bags	10	10	10	10	11	11
HDPE Containers	14	14	15	15	15	16
Total Plastic	**811**	**836**	**861**	**887**	**913**	**941**
Non-Stewarded Plastic	705	726	748	770	793	817

Diversion initiatives proposed in this study focused on the plastic waste from the largest farming sectors, generating the bulk of waste plastics, that were not managed under an existing recovery scheme - either an EPR program or Blue Box recycling. The materials included in the volume assessment were bale/silage wrap, silage bags and silage/bunker cover, twine, net wrap, and feed bags. Estimated quantities are illustrated in the following chart.

Plastic Waste (tonnes per year)	**PP woven bags**	**HDPE containers**	**LDPE film**	**LLDPE film**	**PP twine**	**PP net wrap**
Major Field Crops						
Silage/Grain Bags & Silage/Bunker Cover			6			
Bale/Silage Wrap				519		
Net Wrap						48
Baling Twine					122	
Livestock						
Feed Bags	10					
Total Select Unmanaged Plastic Waste					**705 tonnes**	

Based upon market conditions and accessible resource recovery facilities, there are currently three channels, which are cost effective for recovering resource value from agricultural plastics. Twine is destined for a recycler in Albert Lea, MN, film is intended for Tri-County Plastics in Brighton, ON and feed bags and net wrap are destined for Emerald Energy from Waste in Brampton, ON.

Estimated Recovery of Plastic Waste (in tonnes)	**LDPE Film**	**LLDPE Film**	**PP Twine**	**PP Net Wrap**	**PP Woven Bags**
Total Estimated Weight	6.2	518.8	122.0	48.5	9.5
Collection rate	25%	25%	25%	25%	25%
Estimated Collectable	1.5	129.7	30.5	12.1	2.4
Average Bale Weight	182 KG	455 KG	455 KG	455 KG	455 KG
Estimated Number of Bales Collectable	9	285	67	27	5
Estimated Loads	**8**		**2**	**1**	

With the launch of any collection program, and in the absence of a provincial ban on landfilling plastic agricultural waste, the recovery rate was estimated at 25% of available volumes.

The collection system proposes to distribute farmer operated basket compactors to five locations in each of the Northern Ontario Districts. The compactors would be accessible to the farmers to use on their farms to bale their clean, source separated plastics. At an appropriate time, farmers would deliver their bales to a local collection point, prior to consolidation at a district hub during periodic collection events.

The cost framework of a collection system is driven by three factors: revenues and expenses from material recovery, overhead to administer the system and the capital expenditure required to put the equipment in place.

Based upon the end-of-life facilities selected in this model, the twine generates a positive revenue, but requires commercial carriers to deliver the material to Minnesota. The bale wrap is collected and recycled at a zero cost to the system and the net wrap and feed bags are collected and disposed of at a cost. The overhead costs are estimated at $54,000 per year, with an initial capital investment of $36,000 (48 sites x 4 x $750/compactor delivered). Overhead costs are broken down as follows:

Overhead Expenses	Amount
Insurance	$4,000
Communications	$5,000
Program Administration	$35,000
Travel	$10,000
Total Overhead Costs	$54,000

A cost summary for the program is as follows:

Financial Item	Film	Net Wrap & Feed Bags	Twine	Total
Transportation Costs	N/C	$4,876	$14,828	
Disposal Costs/(Revenue)		$2,030	($12,505)	
Net End-of-Life Cost		$6,906	$2,323	$9,229
Overhead Costs				$54,000
Annual Net Operational Costs				$63,229
Total CAPEX				$36,000

On June 1, 2016, the Ontario Legislature passed Bill 151, the Waste-Free Ontario Act, 2016 (WFOA). WFOA replaces the Waste Diversion Act, 2002 (WDA) with a new producer responsibility framework that makes producers individually responsible and accountable for their products and packaging at end-of-life. Under this regime, producers become directly accountable for recovering resources and reducing waste as required by regulation.

Under the Resource Recovery and Circular Economy Act, 2016 (RRCEA), the Minister is responsible for developing a *Strategy for a Waste Free Ontario (the Strategy)* which describes how to build a system that puts valuable resources destined for landfill back into the economy.

The Province's two primary goals in the Strategy are to achieve zero waste (the Province's new long-term waste diversion goal) and to achieve zero greenhouse gas emissions from the waste sector. The Strategy serves as the Province's roadmap to shift Ontario towards a circular economy and towards a zero-waste future.

The Strategy sets out a series of milestones that the Ministry of the Environment and Climate Change (MOECC) intends to achieve. The earliest opportunity for farm plastics to be designated under a new producer responsibility regulation would be either 2023 or 2025 based on the following milestones:

2023 – Complete transition of the Blue Box Program; and continue to designate additional materials under the producer responsibility regulations.

2025 – Continue to designate additional materials under producer responsibility regulations.

The Ontario Federation of Agriculture (OFA) has played an active role in providing feedback and guidance to the MOECC on how WFOA regulations should be implemented in the agricultural sector. Feedback and recommendations regarding a producer responsibility framework include:

- WFOA and accompanying regulations should expand recycling programs for pesticide and fertilizer containers, feed, seed and pesticide bags, plastic bale wrap and many other items used on the farm.
- An EPR framework should recognize the barriers of rural, northern, and regional waste diversion costs for pick-up, drop-off, and collection, to determine the logistics of cost-effective recovery of waste resources, beyond the proposed targets based on community size, density and geographic distribution.
- An EPR framework should recognize that there is no capacity for Agriculture to bear the responsibility for reduction, reuse or recovery of packaging used for the sale of farm production, and that responsibility should lie further along the distribution route. This strategy reconciles the mismatch between packaging for products originating outside the province with Ontario origin product packaging.
- The Waste-Free Ontario Strategy needs to assist industry initiatives, such as CleanFARMS, in implementing guidelines and programs, as opposed to imposing regulations.
- Expanding the collection of products for resource recovery and alternate uses should be encouraged and integrated within existing programs. This is a cost-effective approach of increasing services to rural Ontario (e.g. bale wrap collection).

These recommendations offer useful guidance for moving forward with a producer responsibility framework for waste plastic products and packaging generated by Ontario farms.

The opportunities for plastic waste diversion described in this report are consistent with these guidelines and could form the basis for cost-effective producer responsibility programs covering a wide range of plastic waste generated by the Northern Ontario agricultural sector.

1.0 Study Background and Objectives

In September 2017, the Northern Farm Innovation Alliance (NOFIA) issued a Request for Proposals (RFP) to retain a consulting firm to undertake a plastics disposal assessment for the agricultural plastic packaging waste generated by farmers in Northern Ontario. In October 2017, Envise Consulting Inc. (Envise) was engaged by NOFIA to conduct the assessment.

The RFP was issued in response to a growing rate of landfill bans on the disposal of agricultural plastic and the associated need to better understand the challenge agricultural plastics present for Northern Ontario communities and how this challenge might be strategically addressed.

In order to address the needs identified by NOFIA, Envise proposed to perform an assessment of the volumes of agricultural plastics being generated in Northern Ontario and to identify a strategic approach for managing the priority materials identified in the study. The agricultural plastic assessment study is comprised of a number of key steps:

1) Prepare an inventory of select agricultural plastic wastes generated by farms in Northern Ontario (current and projected 5 years).
2) Assess the end-use options available to farmers producing plastic waste in Northern Ontario, including consideration of the logistical challenges which may include how to clean, centralize and transport the plastic, and the identification of end users.
3) Develop a framework for meeting current disposal needs including associated costs and required infrastructure and, or, capital investment.
4) Identify the opportunities that the evolving extended producer responsibility legislative framework in Ontario brings to the challenge of managing plastic waste generated by farms in Northern Ontario.

2.0 Project Overview

2.1. Project Team

The project was conducted by Envise Consulting Inc. (Envise).

Fergal McDonough, Principal of Envise, has worked within the overlapping practices areas of waste management, diversion and resource recovery, and the plastics industry for over twenty years. In his capacity as Project Manager, Mr. McDonough was responsible for overall project development and design and ensuring that optimal solutions were developed for the sustainable management of the key agricultural wastes. Mr. McDonough oversaw the development of a strategic assessment of the agricultural plastic packaging wastes, preparation of an inventory of plastic products and packaging, identifying the constraints and risks associated with managing the end of life of agricultural plastics and the development of a model to quantify collection, transportation and processing costs for these targeted waste plastics.

Andrew Pollock, an associate consultant to Envise, directly engaged a broad range of Northern Ontario agricultural sector stakeholders, including farmers, agricultural product dealers, industry experts, government officials and potential contractors, including haulers, processors and end markets for waste plastics. Mr. Pollock also contributed to the development of the waste plastics inventory and the end-of-life management cost model.

Franz Lopez acted as the project researcher and assisted in the development of the plastics inventory and end-of-life cost model. These tools were used to produce the plastics inventory assessment and were based upon a broad range of data inputs including the NOFIA crop inventory assessments, an online farmers survey, farmer interviews and previous studies of plastic waste generated by Ontario farms.

2.2. General Project Description

Envise proposed to approach the agricultural plastics study by undertaking the following tasks to complete the project:

Task 1: Plastic Waste Characterization - Prepare a current year inventory and a projected five-year inventory of plastic waste generated by farms in Northern Ontario, segregated into selected types of plastic packaging, as identified by waste volumes generated.

Task 2: Identification of End of Life Options - Assemble a list of readily accessible, potential end of life management options for the select plastic packaging identified in Task 1. Options include recycling and resource recovery facilities that will accept plastic farm waste. These options have been reviewed and selected based upon the need to be sustainable, not just for current requirements, but for future requirements as well.

Task 3: Cost Framework for Farm Plastic End-of-Life Management - Using the information obtained in Task 2, develop a cost model for selected agricultural plastic packaging. This model describes a system which can be integrated into existing farmer disposal practices and leverages the current community infrastructure and strategic partners in Northern communities. The model contains estimates for processing costs, revenues and capital costs as applicable.

Task 4: Potential for an Extended Producer Responsibility (EPR) Program – Prepare a brief analysis which investigates the potential timing and scope of the anticipated EPR program for farm plastics and summarize these findings for NOFIA.

3.0 Plastic Waste Characterization

3.1. Methodology

In order to quantify the amount of agricultural plastic packaging waste being generated in Northern Ontario, a number of resources were taken into consideration and incorporated in the analysis. Information resources included:

- NOFIA farm use census data 2016
- Statscan 2016 Census of Agriculture
- published industry standards, practices and guidelines
- customized online farm survey
- interviews with:
  - farmers,
  - government and non-government agencies
  - stewardship organizations
  - product and subject matter experts
- academic studies, previously published agricultural waste characterizations and literature reviews, and,
- internet searches

This study is focused on quantifying the volumes of agricultural plastic waste that generate significant waste volumes in Northern Ontario and that do not have a potential collection system in place. Plastic materials which were identified in this study include:

- **Polypropylene (PP, Type 5)** – products include: monofilament and braided baling twines, net wrap and woven fibre supersack bulk bags and sacks.
- **Low density polyethylene (LDPE, Type 4) and Linear Low-Density Polyethylene (LLDPE, Type 4)** – products include bale and silage wrap, silage and bunker covers, and, silage and grain bags
- **High density polyethylene (HDPE, Type 2)** – products include <23L jugs, drums and IBC containers.

Farm use data was combined with farming input variables including data from standard industry practices and information garnered from Northern Ontario farm activities to construct a profile of plastic wastes generated during a typical farming season in Northern Ontario.

3.2. Waste Types

Farm plastic waste consists of a wide variety of plastic types and formats including heavy bulk plastics which may present as 200 feet long silage bags to baling twine and bale wrap which are generated in high quantity, low weight pieces. Below are the higher volume plastics which are the focus of this Northern Ontario waste characterization.

3.2.1. Bale and Silage Wrap

Bale and silage wrap are made from linear low-density polyethylene plastic (LLDPE, Type 4). The linear properties of the film provide the stretch quality which allows it to cling to the bales. Bale and silage wrap is used to package hay for cattle feed when forage feeding is not available and to package straw for cattle bedding. The properties of this plastic are its ability to seal tightly to itself, even during extreme weather conditions.

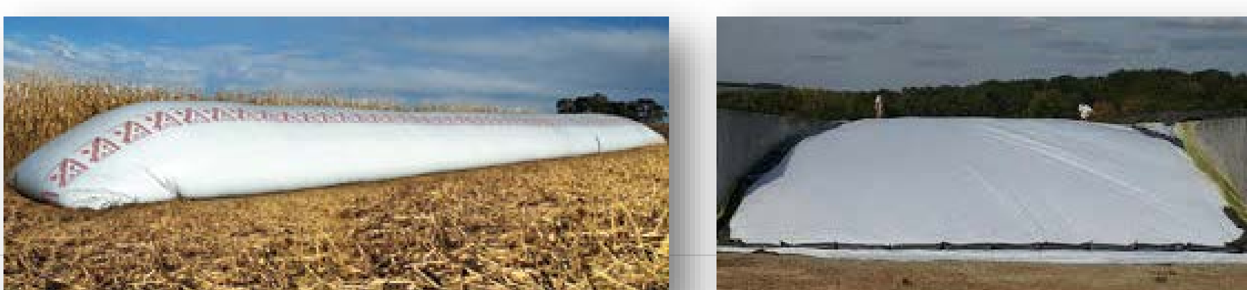
Figure 1 – Bale wrap

3.2.2. Grain Bags, Silage Bags and Silage/Bunker Covers

Grain bags, silage bags and silage/bunker covers are composed of LDPE film and are used for crop storage and protection. Grain bags and silage bags are essentially the same product, which is a long tubular plastic tunnel in which is stored grain or silage. These bags are typically a multi-layer film, between 9-10 mil in thickness and ranging from 200 to 330 feet in length. Plastic is available in white with various UV inhibitors. Bags are valuable for storing grain offsite and silage in bulk when permanent storage solutions are not practical, or capacity constraints exist. These storage bags reduce spoilage from rot, pestilence, and adverse weather conditions.

Silage covers are also made of multi-layer LDPE film and are large sheets that are cut to size to cover mounds of silage in a field or silage stored in a concrete bunker (bunker cover).

Figure 2 – Silage Bag and Silage/Bunker Cover



3.2.3. Net Wrap

Net wrap is composed of woven strands of polypropylene fibres which provide a strong structure for bale production with a minimal amount of plastic usage. This allows farmers to bale more quickly and with less baling plastic. Net wrap provides increased efficiencies for bale preparation but does generate more contamination when removed from the bale as organic matter tends to become stuck in the webbing.

Figure 3 – Net wrap

3.2.4. Twine

Baling twine is composed of multi strand, braided polypropylene plastic, which is used to bale round and square bales. Round bales are often tied with multiple end strands to ensure bale integrity with regular spacing of strands across the bale at 4" to 6" apart. Baling twine is typically sold in balls or spools ranging from 3,000 feet to 28,000 feet

Figure 4 - Twine

3.2.5. Polywoven Sacks and Bulk Bags

Polywoven sacks and bulk bags are a Flexible Intermediate Bulk Containment (FIBC) system primarily composed of woven polypropylene (PP) fabric and reinforced with nylon stitching. FIBCs can hold up to 1000KG of granular product and are typically used for seed, feed and fertilizer in farming applications. PP sacks are typically 25KG capacity and are used primarily for animal feed; however, they have also been used for transporting seed.

Figure 5 – PP Bags

3.2.6. Pesticide and Liquid Fertilizer Containers

Pesticide and fertilizers are sold in small format and bulk containers, primarily in a liquid format, although there are some granular products on the market. Containers used for liquid pesticides and fertilizers are typically HDPE with a Polypropylene cap. Chemicals are often distributed in concentrate and are sold in high volumes in a variety of container sizes: small containers (less than 23 Litres), drums (110 Litres to 220 Litres) and intermediate bulk containers (IBCs), typically 540 Litres to 1040 Litres in capacity.

Figure 6 – HDPE Containers

3.2.7. Sanitation Products

Sanitation products are used in the livestock sector and include chemicals used for cleaning and disinfecting cattle, sheep, hogs, and poultry, including chickens, and turkeys. Sanitation product containers are similar to pesticide and fertilizer containers and are primarily made up of HDPE plastic. These products are sold in a variety of sizes depending on product formulation and demand and range from 1 Litre to <23 Litre in small quantity format to larger sizes which can include 110 Litre drums up to 1040 Litre IBC containers.

3.3. Northern Ontario Estimated Waste Tonnages – Current Estimate

Farm plastic waste tonnages were calculated using 2016 crop area inventory data provided by NOFIA. Crop divisions were divided as follows:

- Major Field Crops
- Livestock
- Major Vegetable Crops
- Major Fruit Crops

Crop acreage and head count data enabled the calculation of a unique Northern Ontario waste generation characterization and reflected the unique mix of crops present in the twelve designated districts of:

- Algoma
- Cochrane
- Kenora
- Greater Sudbury
- Manitoulin
- Muskoka
- Nipissing
- Parry Sound
- Rainy River
- Sudbury
- Thunder Bay
- Timiskaming

Plastic waste generation calculations reflected input from industry sources, crop experts, published academic research, standard industry practices planning tools, interviews with product experts, farmers and associations representatives. Previous waste characterization studies were also referenced to identify waste production factors and metrics. Sales figures for the districts were not readily available, and at best would only account for direct sales, and not extra-provincial imports of materials and overseas purchases of supplies which farmers have reported as significant channels for farm supplies.

Detailed calculations are included in the attached Appendix A, and reflect the data and information used to determine estimates for available plastic in Northern Ontario.

Table 1 - Plastic Waste Generated by Farming Sector, shows the various farm sectors and associated farm plastic wastes identified in the 2016 farm use census and existing waste diversion channels. Certain farm generated plastic wastes, such as waste oil containers, pesticide and fertilizer containers and seed bags, are currently diverted to some extent through existing Extended Producer Responsibility (EPR) programs. Small HDPE sanitation product containers are sometimes diverted via municipal curbside recycling programs while larger HDPE sanitation product containers are diverted via return to retailer (R2R) programs. For this study, certain streams will not be quantified as they are otherwise addressed by existing programs.

Table 1 – Plastic Waste Generated by Farming Sector

Farming Activity	Category	Waste Types	Plastic Type and	Diversion Channel
Major Field Crops	Seeds	small and large seed bags	PP	EPR
	Fertilizers	jugs < 23L, drums >23L and <220L, IBC 540L and 1040L	HDPE	EPR
	Pesticides	jugs < 23L, drums >23L and <220L, IBC 540L and 1040L	HDPE	EPR
	Silage/Grain	silage/grain bags, silage cover	LDPE	
	Hay/Straw	Bale/silage wrap	LLDPE	
	Hay/Straw	net wrap and baling twine	PP	
Livestock	Feed	small and large feed bags	PP	
	Sanitation Products	jugs < 23L, drums >23L and <220L, IBC 540L and 1040L	HDPE	Blue Box, Reuse, Return to Retail (R2R)
Major Fruit Crops	Seeds	small and large seed bags	PP	EPR, Reuse
	Fertilizers	jugs < 23L, drums >23L and <220L, IBC 540L and 1040L	HDPE	EPR
	Pesticides	jugs < 23L, drums >23L and <220L, IBC 540L and 1040L	HDPE	EPR
Major Vegetable Crops	Seeds	small and large seed bags	PP	EPR
	Fertilizers	jugs < 23L, drums >23L and <220L, IBC 540L and 1040L	HDPE	EPR
	Pesticides	jugs < 23L, drums >23L and <220L, IBC 540L and 1040L	HDPE	EPR
Miscellaneous	Mixed plastic waste	Mixed plastics e.g. plastic wrap, plastic inserts, plastic caps, trays, and clamshells.	Mixed	Blue Box

Farms in Northern Ontario vary in size and complexity of operations. For the purposes of the calculations in this study, certain assumptions have been made in terms of farm operations, general practices and standardized operations. These calculations are based upon several factors such as estimated usage rates, average weights of supplies and consumption patterns and are intended to present a broad picture of farm waste potential. It is acknowledged that variations in these waste generation rates may be impacted by many subjective factors, such as different expert opinions and user consultations in addition to external factors such as climate changes and farm innovations.

3.3.1. Summary of Plastic Waste Generation by Farming Sector

Due to the unique geography and climate of Northern Ontario, farming activity has focused heavily on livestock and the associated forage and fodder crops that livestock require for feed. The plastic waste generated by the four key farming sectors are summarized in Table 2 – Summary of Plastic Waste Generation.

Table 2 – Summary of Plastic Waste Generation Estimates

Farming Sector	Tonnes/Year	Comments
Major Field Crops	788	All categories included.
Livestock	23	All categories included.
Major Fruit Crops	4	All categories included.
Major Vegetable Crops	4	All categories included.
Total:	**819**	

The estimates in Table 2 above, reflect all categories of plastic identified in Table 1, except for mixed plastic waste. For the purposes of identifying key focus areas for end-of-life program development, plastic waste associated with the Major Fruit Crops and Major Vegetable Crops categories was excluded from the model development due to the low waste volumes generated. Plastics also excluded in the Major Field Crops category were stewarded products such as pesticide and fertilizer containers and seed bags; all of which are managed through the CleanFARMS EPR program (where available). Livestock sector materials excluded from model calculations were sanitation containers such as jugs and bulk containers which are recovered through Blue Box programs, reuse, and Return to Retail facilities (where available). These materials were also not identified as materials of concern through consultations with users.

Table 3 – Summary of Select Plastic Waste Streams reflects the targeted volumes of plastic waste from the largest farming sector generators.

Table 3 – Summary of Select Plastic Waste Streams

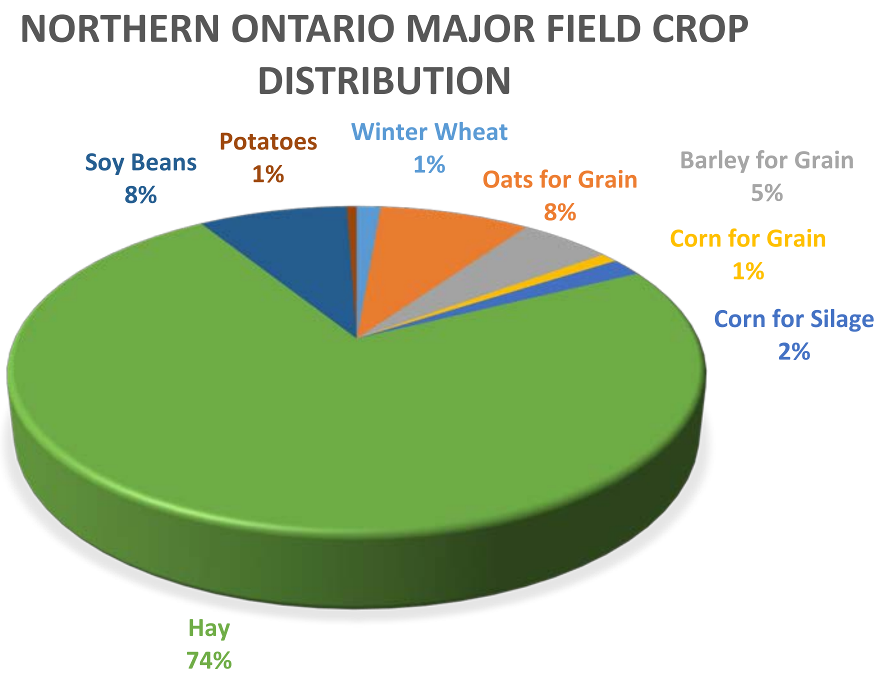
Farming Sector	Tonnes/Year	Comments
Major Field Crops	695	included: bale/silage wrap, silage bags and silage/bunker cover, twine and net wrap excluded: seed bags, fertilizers and pesticides. (EPR)
Livestock	10	included: feed bags; excluded: sanitation products. (R2R, reuse, Blue Box)
Major Fruit Crops		Entire category excluded due to low volumes
Major Vegetable Crops		Entire category excluded due to low volumes
Total:	**705**	**Combined total tonnes of select plastics available for collection in Northern Ontario**

3.3.2. Major Field Crops

Hay production, and to a lesser extent corn for silage, are key drivers of plastic waste in the Major Field Crops Sector. Packaging wastes from these crops contribute to the highest volumes of plastics requiring an alternative end-of-life management destination. Extended Producer Responsibility (EPR) programs have developed over time for plastic packaging such as seed bags, fertilizer containers and pesticide containers. However, EPR programs have not been introduced in Ontario for plastic crop storage products such as bale/silage wrap, silage/bunker covers, grain/silage bags, twine and net wrap due to the logistical challenges of collecting, transporting and accessing clean, sorted plastic streams.

Major Field Crops, as defined in the NOFIA census are represented in Chart 1 – Northern Ontario Major Field Crop Distribution.

Chart 1 - Northern Ontario Major Field Crop Distribution



For the purposes of this study, it was assumed that the fodder crops grown in Northern Ontario were consumed in Northern Ontario and not exported outside the twelve districts. Additionally, it was also assumed that typically, fodder crops were not imported into the North, thereby generating additional waste film volumes which are not accounted for.

Plastic waste production generated through the Major Field Crops sector are broken out into the plastic types in Table 4 – Major Field Crops Plastic Waste Summary**.**

Table 4 – Major Field Crops Plastic Waste Summary

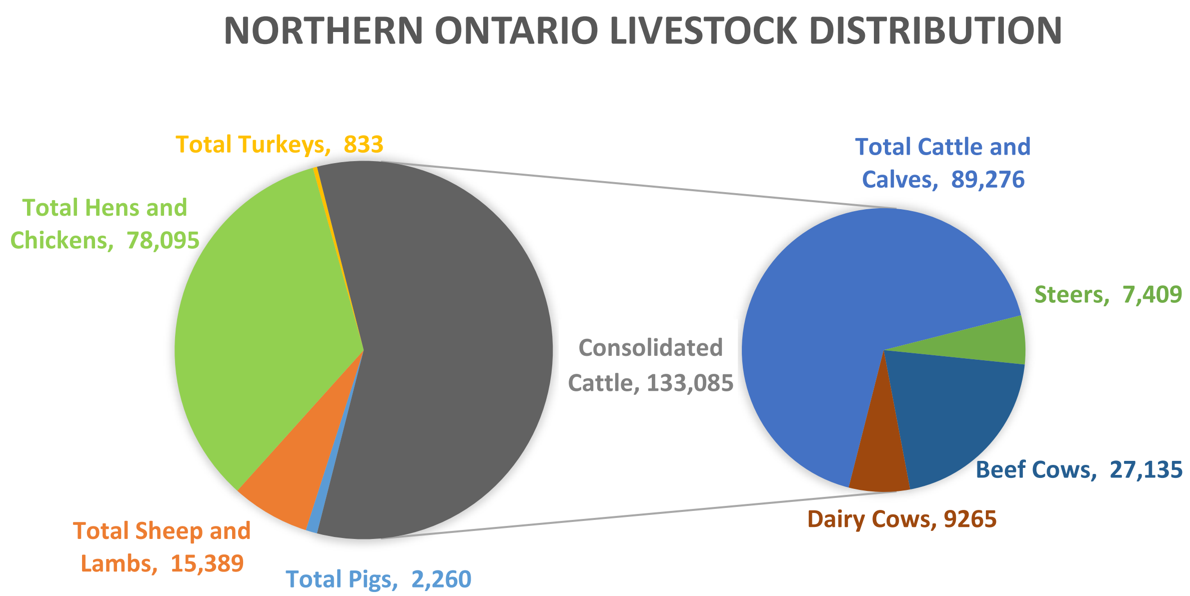
Major Field Crops Plastic Waste (tonnes per year)	PP woven bags	HDPE containers	LDPE film	LLDPE film	PP twine	PP Net Wrap
1.1. Small Seed Bags - Up to 25kg	4					
1.2. Large Seed Bags - Greater than 25kg	3					
2.1. Fertilizer Jugs - < 23L		9				
2.2. Fertilizer Drums - >23L and < 220L		42				
2.3. Fertilizer IBC - 540L		2				
3.1. Pesticide Jugs - < 23L		23				
3.2. Pesticide Drums - >23L and <220L		5				
3.3. Pesticide Chemical IBC - 540L		4				
4.1. Silage and Grain Bags			0.7			
5.1. Bale and Silage Wrap				519		
5.2. Silage and Bunker Cover			5.5			
6.1. Net Wrap						48
6.2. Baling Twine					122	
Total	**8**	**85**	**6.2**	**519**	**122**	**48**
Managed		**93**				
Unmanaged Major Field Crops Plastic Waste						**695**

The major drivers of unmanaged plastic waste volumes in Northern Ontario are the linear low density (LLDPE) bale wrap plastic film and the polypropylene (PP) twine. Both of these materials are recyclable and are suitable for collection and diversion from landfill.

3.3.3. Livestock

Livestock production in Northern Ontario is heavily oriented towards cattle, steer, beef and dairy cows. For the purposes of this study, these subcategories were grouped together for calculating feed related plastics wastes under "Consolidated Cattle", however, dairy cows were separately weighted when calculating sanitation products, due to the significant requirement for sterilization in the dairy industry. Livestock distribution in Northern Ontario is represented in the Chart 2 – Northern Ontario Livestock Distribution.

Chart 2 – Northern Ontario Livestock Distribution



As indicated in Chart 2, when the Cattle and Calves, Steers, Beef and Dairy Cows are combined for modelling purposes, the strong influence of "Consolidated Cattle" in general in the Livestock sector is more apparent than those of other livestock. This focus on "Cattle" related farming strongly influences the plastic farm waste production, especially as it relates to driving crop production in the Major Field Crop Sector.

Plastic waste production generated through the Livestock sector is broken out into the different plastic types in Table 5 – Livestock Plastic Waste Summary.

Table 5 – Livestock Plastic Waste Summary

Livestock Plastic Waste Production	HDPE Containers	PP Woven Bags
1.1. Small Feed Bags - Up to 25kg		1.9
1.2 Large Feed Bags - Greater than 25kg		7.6
2.1. Sanitation Jugs - Less than 23L	5.1	
2.2. Sanitation Drums - >23L and <=220L	7.8	
2.3. Sanitation IBC - >220L	0.7	
Total	13.7	9.5
Otherwise Managed	13.7	
Unmanaged Livestock Plastic Waste		9.5

3.4. Northern Ontario Estimated Waste Tonnages – 5 Year Projection

Projecting future volumes of current plastic waste generation estimates is a relatively simple procedure when national or provincial sales figures are available and can be extrapolated based upon key growth factors. Unfortunately, when looking at distinct areas such as the twelve districts which make up Northern Ontario, specific sales figures, consumption patterns and industry information is not readily available.

In order to assess the potential changes in plastic volumes in Northern Ontario, a survey of farmers was undertaken to generate an understanding of how the farm owners believed their operations would change over a five-year time period. Of the farmers surveyed, 94 responded with indications of whether they expected their farm operations to increase production, decrease production or maintain a constant size.

Three farms reported that they expected to decrease operations, while 49 farmers reported expected increases, and 42 reported that operations were expected to remain constant. The reported changes were weighted based upon the average rate for the number of respondents per category. Table 6 – Northern Ontario Average Five Year Growth Rate in Agricultural Plastic Waste demonstrates how the growth rate was calculated.

Table 6 – Northern Ontario Average Five Year Growth Rate in Agricultural Plastic Waste

Change in Size	# of Farms Score (1:1)	Average Change		Weighted Score
Decrease	3	↓ 20%		2.4
Increase	49	↑ 32%		64.7
Same	42			42.0
Total Score	94	A	B	109
Rate of Change ((B/A)-1)*100				16%

The five-year estimated rate of growth for Northern Ontario farms was then applied to the overall plastic waste volume estimates summarized earlier in this report. Table 7 – 5 Year Projected Agricultural Plastic Waste Volumes illustrates the annual growth rate of 3% over five years, which results in a 16% increase in farm operations during that time period.

Table 7 – 5 Year Projected Agricultural Plastic Waste Volumes

Farm Sector	2017	2018	2019	2020	2021	2022
	Base Year	3.0%	3.0%	3.0%	3.0%	3.0%
Field Crop Waste	(tonnes/year)	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
PP woven bags	8	8	8	8	8	9
HDPE Containers	85	88	90	93	96	99
LDPE Film	6	6	7	7	7	7
LLDPE Film	519	534	550	567	584	601
PP Twine	122	126	129	133	137	141
PP Net Wrap	48	50	51	53	55	56
Total Plastic	**788**	**812**	**836**	**861**	**887**	**914**
Total Non-Stewarded Field Crop Plastic	695	716	738	760	783	806
Livestock Waste						
PP Woven Bags	10	10	10	10	11	11
HDPE Containers	14	14	15	15	15	16
Total Non-Stewarded Livestock Plastic	10	10	10	10	11	11
Total Plastic	**811**	**836**	**861**	**887**	**913**	**941**
Total Non-Stewarded Plastic	705	726	748	770	793	817

While this projection is based upon farm input variables remaining constant, it does not account for changes in variables such as technology, crop selection, or climate. LLDPE film indicates the largest increase over the five-year period, however, this may be impacted by two key forces, the increasing rate of adoption of silage bags to store hay at the point of generation, and the introduction of new wrapping systems. For example, a recently introduced wrapping system, which uses bale wrap only, would increase the volume of bale wrap, a recyclable material, and would reduce the amounts of twine and net wrap (a non-recycled material). Bale wrap typically has lower rates of contamination as it is easier to clean and dry than twine and net wrap.

Additional trends in farming practices could see a shift from twine usage to net wrap as there are time (faster wrapping) and material cost savings (less plastic) associated with using net wrap. The drawback to net wrap is the high level of contamination caught in the wrap, which renders the plastic non-recyclable by existing mechanical recycling systems.

3.5. Identification of End of Life Options

Districts in Northern Ontario are currently at a cross roads regarding how agricultural plastics are managed in their landfills. A growing number of landfills have or are in the process of prohibiting the disposal of these recyclable agricultural plastics. Farmers require the use of these materials as essential farm production inputs, however, they are now facing a common challenge that the recycling industry is dealing with across Canada, which is the lack of domestic capacity for recycling polyethylene plastic film and polypropylene.

A list of potential end-of-life management options for the different plastic waste types generated by Northern Ontario farms was developed by first grouping plastic products and packaging into three categories:

- Existing Programs – includes those items which are currently managed through an existing recovery program, such as CleanFARMS, the Blue Box program or Return to Retail (R2R)
- Recycling – includes those materials that could be recycled through the use of existing processing technologies and sent to stable end use markets; and,
- Resource Recovery – includes those materials that could be converted to resources such as chemicals or energy by existing conversion technologies.

3.5.1. Existing Plastic Waste Recovery Programs

The only EPR farm plastic recovery programs currently in place in Northern Ontario are the two CleanFARMS collection programs for high density polypropylene (HDPE) pesticide and fertilizer containers and for polypropylene (PP) and paper seed and pesticide bags. CleanFARMS is a nation-wide program funded voluntarily by stewards (producers and first importers) of agricultural pesticides, fertilizers and seeds. In Western Canada, CleanFARMS has piloted additional agricultural waste collection programs for bale wrap, grain bags and PP twine.

On March 9, 2018, the Saskatchewan government announced CleanFARMS would be operating the first regulated agricultural plastics recycling program in Canada, with the launch of the Grain Bag Recycling Program. This program is not an EPR program but is partially funded by the province and partially by a user fee of $0.25/KG fee applied at the point of sale, effective in November 2018.

In Ontario, in the pesticide and fertilizer container collection program, CleanFARMS provides selected retail dealers of agricultural products (ag dealers) with large clear plastic collection bags. The collection bags are distributed by the ag dealers to farmers who purchase pesticide and fertilizer products at the ag dealer stores. The farmers triple rinse the containers, remove all paper booklets, place the containers in the large plastic bags and deliver the full bags back to the ag dealer. A contractor hired by CleanFARMS collects the bags from the ag dealer, weighs the bags, bales the containers and then ships the bales to its recycling facility.

The seed and pesticide bag collection program operate in a similar fashion. CleanFARMS provides the selected ag dealers with large green plastic collection bags which are distributed to farmers who purchase bagged seed and pesticide products from the ag dealers. The farmers tightly roll and place the empty seed and pesticide bags, which can be made from either PP plastic or paper, into the large plastic collection bags and deliver the full bags back to the ag dealer. A CleanFARMS contractor collects the bags from the ag dealer, weighs the collection bags, then bales the seed and pesticide bags and ships the bales to an energy recovery facility. The bags cannot be recycled because of pesticide contamination in the treated seed bags in addition to the non-recyclable nylon strapping on the PP bags.

Currently, two ag dealers in Northern Ontario are participants in both the CleanFARMS Container Management Program (CMP) and Seed Bag program – the Temiskaming Ag Centre in Temiskaming Shores and the Verner CO-OP store in Nipissing District. Despite these two stores providing collection services to farmers in the Districts of Timiskaming, Cochrane, Sudbury, Parry Sound and Nipissing, farmers in other Northern Ontario Districts do not have convenient access to CleanFARMS collection programs.

3.5.2. Plastic Recycling Opportunities

At the present time, four types of farm plastics are being recycled to some extent in North America: linear low-density polyethylene (LLDPE) bale wrap and silage wrap, low-density polyethylene (LDPE) silage bags, grain bags and silage bunker covers, polypropylene (PP) bale twine and high-density polyethylene (HDPE) pesticide, fertilizer and sanitation containers.

LLDPE Bale Wrap

LLDPE bale wrap constitutes the largest tonnage of plastic waste generated by farms in Northern Ontario. Bale wrap is used primarily to wrap bales of hay grown as fodder the cattle sub-sector.

Although LLDPE plastic film is recyclable, contamination of bale wrap by mud, hay and rocks creates challenges for the recycling process. Envise contacted four Ontario companies that were currently recycling or had previously recycled bale wrap – Switch Energy, Think Plastics, EFS Plastics and Tri-County Plastics.

<u>Switch Energy, Clifton, ON</u>

Switch Energy had previously operated a bale wrap collection program at no charge to users, accepting bale wrap from farmers in Southwest, Central and parts of Northern Ontario. Switch Energy processed it to produce pellets for use in plastic product manufacturing. Don Nott, owner of Switch Energy, reported that the company was no longer producing pellets from bale wrap and until recently had been shipping bales to processing plants in China.

In the last eighteen months, the crackdown by the Chinese government on the level of contamination in plastic waste imported by China had severely limited Switch Energy's ability to export bale wrap. Mr. Nott was in the process of shipping a load of bale wrap to India at a significantly reduced price and stated that he was unable to accept any more bale wrap from Ontario farmers at the present time.

Think Plastics, New Hamburg, ON

Think Plastics has also previously accepted used bale wrap from farmers in Southwest and Central Ontario and converted it into a plastic lumber product called Baleboard. Think Plastics has since closed and ceased operations, with the assets of the company sold to a new firm called Fusion Thetics. The owner of the new company, Dwayne Burnett, stated that they were still producing plastic lumber, but they were purchasing polyethylene pellets for feedstock rather than using waste bale wrap.

EFS Plastics, Listowell, ON

EFS Plastics produces plastic resin for resale to manufacturers. EFS started Ontario in 2007 and now has over 75,000 sq. ft. at the Listowell, ON plant and over 90,000 sq. ft. at the Hazelton, PA plant in the United States.

EFS has effectively processed loads of bale wrap during an Ontario municipal depot pilot project, however did have concerns with cleanliness. EFS is equipped with wash tanks and can handle the material, however, due to the National Sword campaign of the Chinese government, it is working at capacity to manage domestic volumes of curbside collected, post-consumer LLDPE film and does not have additional capacity for agricultural film plastic.

Tri-County Plastics, Brighton, ON

Tri-County Plastics produces plastic pellets from a range of recycled plastic feedstocks. The company has also recently gone through an ownership change. The new owner, Douglas LeBlanc, reported that the processing facility has a shredder, grinder, densifier and four extruders to make pellets. Tri-County Plastics is currently commissioning a new washing and drying system which would allow the facility to also accept bale wrap as a feedstock. This system is expected to be operational by April 1, 2018. The company has also recently purchased equipment to manufacture plastic lumber which will enable it to produce a finished product from plastic pellets.

Mr. Leblanc stated that he had entered into an exclusive bale wrap supply agreement with a local Prince Edward County farmer named Lynn Leavitt, who has established a bale wrap collection service, called U-Pac Agri Service.

U-Pac Agri Service

Lynn Leavitt established a family business called U-Pac Agri Service (U-Pac) in 2015 to manage waste bale wrap in a more environmentally sustainable manner than landfilling or on-farm burning. He designed and built a "basket compactor" that farmers could use to bale their bale wrap on their farm. The basket compactor consists of two components: 1) a 40 in. wide by 40 in. long by 60 in. high (with an open top and bottom) rectangular wooden compactor "basket" (made from 2x4 and 2x6 pressure treated lumber) that sits on a separate wooden base, and 2) a wooden compactor blade (made from 2x4 lumber) attached to a metal bracket and pole. The pole is hinged on a metal sleeve that slides over a forklift blade of a farm tractor.

The baling process is composed of 5 steps:

1. Packing the basket
2. Compressing the plastic
3. Tying off the bale
4. Removing the basket
5. Moving the bale

Figure 7 – U-Pac Basket Compactor

Step 1 – Packing the basket

The farmer places their loose bale wrap in the wooden basket. This can be done over time if the farmer has purchased the basket compactor or can be done at one time if multiple farmers are combining their small plastic volumes to make a full bale.

Step 2 – Compressing the plastic

The farmer uses his farm tractor with the attached compactor blade to compact the bale wrap. Compacting can occur multiple times as the basket is filled, to ensure that all of the air is removed and the plastic is fully compressed. Some farmers have allowed their tractor weight to compress the plastic overnight to ensure full compaction, but this is not required for the system to work effectively.

Step 3 – Tying off the bale

Once the basket is filled to 45 in. the farmer hand ties the bale with baler twine by running the twine inside of the channels formed by the 2x4 framing and spaced every 4 inches. This can be done on both sides of the bale to ensure bale integrity and cohesion during handling. Typical bales are approximately 1000 lb. in weight.

Step 4 - Removing the basket

To remove the bale from the basket, the farmer secures the compactor blade to the basket by sliding two 2x6 boards through the basket frame on top of the blade and then lifting the basket off the tied bale by raising the forklift blades. If the bale does not slide out easily, two cinder blocks are placed underneath opposite sides of the compactor after it is lifted part way up so that the tractor can then push down on the bale from inside the frame, thereby pushing the bale out the bottom end of the basket.

Step 5 - Moving the bale

Once the compactor is completely lifted off, the bale can then be push over onto a 40 in. by 48 in. pallet which allows the bale to be moved to a storage area and subsequently to loading onto a transport vehicle.

U-Pac Recycling Process

The U-Pac recycling model works as follows: U-Pac builds the basket compactors and sell them to farm groups or farmers for $500. U-Pac also supplies the buyer with a set of tags which identify the name of the farm/group. The farmer is instructed to attach a tag to each bale he produces. The tag performs two functions – to identify the source of bales so that accountability for quality can be maintained and to share revenue from each bale processed (within the Prince Edward County area).

Farmers often work in groups of 5 or 6 farmers, in proximity to the farm with the compactor, and bring their loose bale wrap to that farm for compacting.

When a total of 40 bales in an area are ready for pick up, U-Pac uses a local hauler with a 48 ft. flatbed trailer to collect the bales.

U-Pac is interested in providing services to farms in Northern Ontario and for arranging haulage of baled plastic to Tri-County Plastics. Costing would be volume dependent, but U-Pac would seek to make the transaction a zero cost, if possible to support the sustainability of the initiative. U-Pac has pointed out that transportation costs for moving materials from Northern Ontario locations to the Tri-County plant are much higher than for moving material from Eastern Ontario sites.

LDPE Silage Bags and Silage/Bunker Covers

While LDPE silage bags and silage/bunker covers are not currently recycled in Ontario, they are technically recyclable if they are cut up into sizes that can be readily baled. Lynn Leavitt of U-Pac advised that he has compacted cut up silage bags in one of his compactors to produce a 400 lb. bale. He stated that Tri-County Plastics could process the baled LDPE silage bags separately from the LLDPE bale wrap. It may also be possible to process the two types of plastic together when the plastic lumber production line is installed.

PP Baling Twine

I-90 Reprocessors Inc, Albert Lea, MN

I-90 Reprocessing LLC in Albert Lea, Minnesota recycles PP baling twine. I-90 is a spinoff of the Bridon Cordage operations which has historically operated one of the few PP twine recycling program in the United States. In 2016, Bridon Cordage, a manufacturer of PP baling twine, shuttered its recycling operations and sold the equipment to a startup, I -90 Reprocessors Inc. Since that time, I-90 has been receiving loads of baled PP twine from across Canada and the United States and converting it into highly sought-after PP resin. I-90 only processes twine and does not handle net wrap or PP woven bags due to contamination and preprocessing difficulties of the bags. I-90 does offer a payment of approximately, $0.15/lb (US$) for acceptable twine, however, that price is for material delivered to their Minnesota plant.

HDPE Containers

The vast majority of HDPE containers generated by farms in Northern Ontario are pesticide and fertilizer jugs with some sanitation containers. Since these containers are already collected and recycled under a CleanFARMS program or through the Blue Box system, Envise did not explore alternative recycling options for them. Farmers have noted that several Northern Ontario Districts with significant farming activity (e.g. Rainy River, Thunder Bay, Manitoulin, Algoma) do not have convenient access to a CleanFARMS collection depot. Increasing recovery rates will require better access to collection services by farmers across all Districts.

3.5.3. Resource Recovery Opportunities

Plastic products and packaging that are not recoverable through traditional mechanical recycling systems can be diverted from landfill through resource recovery technologies. These unrecycled materials can be directed to recovery facilities which convert the plastics either back into basic chemical components (including syngas) or waxes, or, can recover the energy value from the materials in the form of fuel, heat and electricity.

PP Feed Bags and Net Wrap

PP animal feed bags and net wrap are currently not viably recyclable because of the feed bags' potential for contamination, by animal medications and non-recyclable nylon stitching, and used net wrap has typically had a high contamination rate of organics and debris. These characteristics lower the recovery rate of the materials and increases the by-product disposal requirements and cost. However, these items could still see their resource value recovered through modern technologies.

GreenMantra Technologies, Brantford, ON

GreenMantra Technologies is an Ontario based company that produces high-value synthetic polymer additives, waxes, and other chemicals from recycled waste plastics. The company upcycles post-consumer plastics into synthetic polymers and other specialty materials. GreenMantra products are used in asphalt shingles, asphalt paving, polymer processing and adhesives, inks and coatings. GreenMantra has not tested agricultural plastics specifically but has worked with LDPE film and has a proven system for converting this material.

Emerald Energy from Waste Inc.

Ontario has one MOECC licensed energy from waste (EFW) facility that could accept PP bags and net wrap – the Emerald EFW Facility in Brampton. Emerald EFW is a gasification facility that combusts gasses from the superheating of non-recycled municipal solid waste and industrial, commercial and institutional wastes. The heat from the combustion process is used to create steam, which is directed to a turbine to produce electricity or to a neighbouring paper mill for use in the production of recycled paper products.

The current tipping fees at Emerald Waste range from $140 to $160 per tonne, depending on the quantities and types of waste delivered.

Given the high cost of energy recovery for PP feed bags and net wrap, an extended producer responsibility program (either voluntary or mandated) likely would be required to operationalize this option.

Cogent Energy Systems, Merrifield, VA

Cogent Energy Systems, a US technology company with roots in Canada, has designed a proven system which utilizes an ultra-high-temperature gasifier that efficiently converts 1-4 tons per day of virtually any type of carbonaceous feedstock, such as biomass or agricultural solid waste, into an extremely clean synthesis gas composed primarily of carbon monoxide and hydrogen. This system can act as a distributed power system which is independently powered and can operate off the grid in remote areas or contribute power back to the grid when operating in a connected arrangement. The robust design allows it to handle a diversified array of agricultural wastes, both clean and dirty. Due to the small-scale nature of the equipment, installation could be done at any permitted facility. The caveat for direct application to agricultural processing is capital cost per unit in addition to the material preprocessing and size reduction requirement for shredding the plastic to homogenize the feedstock mixture.

3.5.4. Landfilling Options

Municipal waste management officials in twelve Northern Ontario Districts were consulted to assess and identify opportunities, constraints and restrictions in regards to the disposal of plastic farm waste at municipal landfill sites. Officials confirmed that agricultural plastic waste generated by farms in Northern Ontario that is not burned on-farm has historically been exclusively disposed of in local municipal and township landfills. Some landfills charge a tipping fee per load while others provide tipping privileges to local property owners for an annual fee.

In the previous 12 to 24 months, some communities in Northern Ontario (e.g. Armstrong Township, Town of Fort Francis) have introduced landfill bans on plastic bale wrap and silage bags while others are considering plans to ban these products in the near future (e.g. Temiskaming Shores).

As the remaining capacity in municipal and township landfills continues to be consumed and communities seek to extend the life of their existing landfill capacity, it is expected that more communities will adopt bans on recyclable material such as bale wrap and silage bags from landfill disposal. Consequently, while not all community landfills currently prohibit agricultural plastic disposal, it is expected that most to all of them will in the short to mid-term. The continued landfilling of plastic waste generated by farms is not a sustainable end-of-life management option for this material and should be viewed as a very short-term option until cost effective recycling and energy recovery options are developed and operational.

4.0 Collection Framework for End-of-Life Management

4.1. Fundamentals for a Sustainable Agricultural Plastics Recovery Collection System

In the design of any materials recovery system, a number of shared objectives among stakeholders are necessary to generate the highest volumes of collected materials, at the lowest cost, at the highest quality and with the least effort. How priorities are established among these objectives depends heavily on who you are as a stakeholder: IFOs (industry funding organizations representing producers) seek the cheapest methods, regulators want the highest volumes, recyclers want the cleanest material and users prefer the greatest ease of access.

Selecting the Critical Drivers of a Best Practice System

When establishing a collection program for agricultural plastics, the key driver to achieving efficiency is to reduce the amount of commercial handling and transportation required to get the material to its final destination. Select criteria to sustainably achieve this are as follows:

Quality - Minimize contamination, e.g. separate incompatible plastics, organic matter (crop residues), and inert matter (soil, rocks and debris). Once plastic farm items have completed their useful life, they must be kept as clean and dry as possible. The easiest way to do this is to take small quantity materials such as silage/bale wrap, twine and net wrap and hang the plastic, indoors, for a full day post use. This will allow the contaminants and moisture to dry and allow for further cleaning by shaking off loose debris. Materials should then be segregated and stored in barns in large bulk bags or bundles to ensure that they stay clean and dry. Twine can be tied in bundles approximately three feet long, while net wrap can be placed loosely in the bulk bag. Feed bags should be compressed and folded in three foot lengths to ensure that the bales produced from the bulkier plastics are bound by as many twine cords as possible and retain their structural integrity.

Silage and bunker cover can also be air dried, folded and stored out of the elements to ensure the quality is maintained for recycling.

Access – Ensure that users have convenient access, preferably, within previously established patterns of travel, and that drop off and delivery is efficient.

In a farmer survey conducted by Envise, 105 respondents advised that they were on average, 13 km from their nearest landfill, however would drive up to 34 km on average to deliver their plastic to a collection depot. Respondents did rank their preferred locations to deliver recyclable materials as follows:

- landfill
- transfer station
- chemical supply dealer
- farm equipment dealer

The landfill ranking reflects a location that is close to the user, commonly visited, familiar and is similar to the current practice of managing the agricultural plastics.

Handling – Minimize the handling required to get the highest volumes of material from the generator.

It is expensive and time consuming to ship loose, light loads of plastic anywhere, when the available alternative is compacting, densifying and shipping heavier loads. By creating large volumes, densely packed bales of plastic at the point of generation, or close to it, farmers will minimize the number of trips to the drop off location and optimize the quality of the supply. The alternative could be a failed system as was observed several years ago at a municipal depot in Southern Ontario. This pile was highly contaminated with organics, debris, other plastics and moisture and took the contractor four days to bale onsite.

Figure 8 – Failed Southern Ontario Bale Wrap Collection Site

Bales manufactured using the U-Pac system can compress upwards of 500 hay bales worth of plastic into a single 1000 lb. bale ready for market. These bales can be produced in the farmers' yard and stored under cover or in a barn, pending the scheduled collection blitz in the area. Farmers can separately bale film, twine, and combined net wrap and bags in order to maximize the bale quality and minimize their handling of plastics.

Basket compactors provided by U-Pac could be located at decentralized locations and made available for loan to farmers. Twice per year, in the Spring and in the Fall, collection sites could operate a drop-off event to consolidate the finished bales and have the farmers deliver them to their local transfer station, prior to shipping by the consolidation site partner to a centralized location in each district. Once the local bale consolidation event is complete, an appropriate contractor would pick up and deliver loads of bales to the end destinations. To simplify proceedings, different materials could be staggered over different time periods. Further detail is included in the Cost Model section of this report.

Quantity – Maximizing the quantity of materials diverted from landfill will depend on designing an effective collection system which ensures that the needs of farmers are addressed, designing and implementing an effective communications campaign by engaging a broad community stakeholder group, and finally by gaining the support of farmers to commit to their responsibilities as stewards of the land and support a sustainable end-of-life for these farm generated plastics.

4.2. Collection Strategies for Agricultural Plastics

Based on the inventory of plastic waste developed in Task 1 and the potential end uses identified in Task 2, Envise developed a conceptual cost model for diverting selected plastic products and packaging from landfill disposal.

The plastic products and packaging selected for cost modelling were the items identified in the Task 1 inventory that were not already included in an existing diversion or recovery program. Therefore, LLDPE bale wrap, LDPE silage bags and PP baling twine were modelled based on delivery to recycling end uses. PP feed bags and PP net wrap were modelled based on delivery to an energy recovery end-of-life destination. HDPE pesticide and fertilizer containers plus PP seed bags were not modelled because they are already covered by CleanFARMS EPR programs.

The highest level of user convenience would be a collection system which hires a contractor to perform on farm pickups of loose plastic, sort the plastics, clean the plastics and deliver the plastics for recovery. It is reasonable to assume that this door to door service would involve excessive handling and be very expensive and inefficient.

The critical factor in the cost model is the assumption about how plastic is collected. Two different collection approaches were given high level consideration for modelling purposes.

Option 1 - Private Waste Company Collection and Baling

In this option, private waste management companies are contracted to set out roll off containers or front-end bins at designated collection sites (such as local landfill sites or ag dealers). Farmers are instructed to place their loose plastic waste in the appropriate container. To effectively service the different Districts, it is estimated that at least four sites per District would be required. The hauler would collect the full bins and deliver them to a local recycling facility for baling. The bales would then be transported to recycling or energy recovery end markets.

Under this scenario, the baling costs at a rate of $90.00 per tonne over 180 estimated recoverable tonnes, would total approximately $16,200. However, it is the shipping to the baler that would be most expensive. These shipping costs of light, loosely packed plastics would average approximately $500 per bin, with three bins per site and four sites per District, transportation costs would be in the $90,000 range. This assumes only one pickup, per bin, per site. On this basis, the servicing costs to get the materials to the commercial baler could easily exceed $100,000.

Advantages – ease of use, ease of management

Disadvantages – high processing and handling costs, lower quality control, no user commitment, inefficient use of partner space at facilities

Option 2 - On-Farm Baling

In this option, basket compactors are purchased either by the Program Operator or directly by the farmers from U-Pac Agri Service (U-Pac) to enable them to bale their plastic waste on their farm. Farmers can bale their different streams of plastic throughout the year, either by themselves (if they have large enough volumes) or by getting together with neighboring farms to contribute smaller volumes of plastic to a finished bale. This approach can be undertaken for bale/silage wrap, PP Twine, net wrap and feed bags (combined) and silage/bunker cover.

When a tractor trailer load of bale/silage wrap and silage/bunker cover plastic in a District(s) is ready for collection, U-Pac contracts a haulage company to collect the bales and deliver them to Tri-County Plastics for recycling. Similarly, loads of net wrap/feed bag bales are transported to the Emerald EFW facility for recovery and loads of twine bales are transported to I-90 Reprocessors for recycling as is appropriate.

Lynn Leavitt of U-Pac indicated (as described in Section 3.2.2 above) that the Program Operator or farmer would be charged $500 for a basket compactor unit. Collection of baled LLDPE and LDPE plastic from consolidation points in Northern Ontario was expected to be at low to no additional charge. The size of the consolidated loads and travel distance will be key to the overall transportation economics.

It should be noted that the U-Pac option is dependent on a successful commissioning of the new washing and drying system at the Tri-County facility, which is currently underway, Tri-County is committed to making the stream recoverable, as other facilities have previously done.

Advantages – farmer investment in cost effective basket compactor equipment, efficient movement of compacted bales from farms to collection nodes, low demand on partners for hosting collection events and transshipping, quality control as each bale can be labelled with generator information. A solution to a farming challenge developed by a farmer – not imposed by government.

Disadvantages – requires effort by farmers to invest sweat equity to make the system sustainable, requires farmer cooperation and coordination to consolidate low volumes of plastic together to make full bales.

Based on the information obtained and discussions with contractors, the U-Pac option presented the greatest benefit and met the criteria for a best practice program.

Due to farmers baling plastic material on their farms, the U-Pac option should result in lower transportation costs, eliminate the cost for interim commercial hauling and commercial baling and would likely produce plastic bales with less contamination as compared to Option 1.

The U-Pac option can be more easily applied in Districts with high levels of hay acreage, since it does not rely on contracts with multiple waste management companies for haulage and baling services.

It should be noted that LLDPE bale wrap represents an estimated 70% of plastic waste generated by farms in Northern Ontario, so the U-Pac bale wrap program alone could yield significant benefits to the diversion challenges facing Northern Ontario farmers.

4.3. Cost Framework for a Northern Ontario Ag Plastic Collection Program

The first step in assessing the cost for an agricultural plastics collection system is to determine two critical factors, first the collection approach and second the estimated volume of materials to be collected. The last step is to determine the financial implications of the collection system.

4.3.1. Collection Approach

As stated previously, the collection system is based upon a volume reduction strategy that seeks to increase transportation efficiencies starting at the farm level. High level design elements are as follows:

a) A Program Operator is established to oversee the operations of the collection system.
   - This could be a consortium of stakeholders in Northern Ontario, an independent contractor or an experienced stewardship organization, such as CleanFARMS.

b) Collection partners are engaged to site the collection events and act as District Hubs.
   - The District Hubs, act as load consolidation points to which satellite transfer locations can send collected, completed bales.
   - This study is not prescriptive in defining who or where the hubs must be located but acknowledges that the needs of the farmers in the immediate communities must be served effectively by willing partners to ensure that all farmers have access to the basket compactors. These partners may change from District to District, but that is a function of how each community determines optimal access to the compactors.
   - This hub and spoke system drives efficiencies through lower handling costs for the program and provides farmers with convenient access to either landfills or transfer locations.

c) Basket compactors are provided, at no cost, to transfer node (sites) for loan to area farmers
   - Farmers can also be provided the opportunity to purchase compactors in order to further increase convenience.
   - There should be at least one compactor per transfer node, which is estimated to be equivalent to four compactors per district for a total of 48 basket compactors.

d) Farmers utilize the compactors as needed to manufacture bales of sorted plastics.
   - Farmers can group together to contribute plastic to a single bale or bale individually.

e) Periodically, based upon plastic types and estimated volumes, collection events are organized to move full loads of higher volume materials to end destinations.
   - For high volume material like bale wrap the events may be biannually, while for lower volume material such as for twine and feed bags, events may be once per year to ensure transportation efficiencies are maintained.
   - Plastic destined for EFW – net wrap and feed bags - would be shipped via LTL (less than truck load) carrier direct to the Emerald EFW facility in Brampton, while twine destined for recycling would be shipped in two loads; one from northwestern Ontario sites and one from northeastern Ontario sites, direct to I-90 Reprocessors in Minnesota.
   - Bale wrap would be collected biannually at load consolidation events, and based upon the estimated collectible volumes, would generate approximately four truckloads per year.

4.3.2. Estimated Collectable Volumes

The total annual volume of select agricultural plastic waste generated in Northern Ontario Districts is described in Table 8: District Summaries of Select Agricultural Plastic Waste.

Table 8: District Summaries of Select Agricultural Plastic Waste

Northern Ontario Estimated Annual Plastic Waste Production (in tonnes)	LDPE Film	LLDPE Film	PP Twine	PP Net Wrap	PP woven bags
Algoma	0.6	54.2	12.8	5.1	0.9
Cochrane	0.4	29.7	7.0	2.8	0.4
Greater Sudbury	0.1	8.9	2.1	0.8	0.3
Kenora	0.2	18.5	4.4	1.7	0.3
Manitoulin	0.6	48.7	11.5	4.5	0.9
Nipissing	0.5	44.5	10.5	4.2	1.3
Rainy River	1.1	94.5	22.2	8.8	1.4
Sudbury	0.4	33.3	7.8	3.1	0.7
Thunder Bay	0.5	38.8	9.1	3.6	1.1
Timiskaming	1.3	91.4	21.5	8.5	1.6
Muskoka	0.2	15.5	3.7	1.5	0.1
Parry Sound	0.4	40.7	9.6	3.8	0.6
Total	**6.2**	**518.8**	**122.0**	**48.5**	**9.5**

The above table includes all of the projected plastics generated in Northern Ontario. The following Table 9 – Collectable Agricultural Plastic Waste in Northern Ontario reflects the likely collectable volume which has been calculated based upon a conservative 25% collection rate.

Table 9 – Collectable Agricultural Plastic Waste in Northern Ontario

Northern Ontario Estimated Annual Plastic Waste Collection (in tonnes)	LDPE Film	LLDPE Film	PP Twine	PP Net Wrap	PP Woven Bags
Total Estimated Weight	6.2	518.8	122.0	48.5	9.5
Collection rate	25%	25%	25%	25%	25%
Estimated Collectable Weight (tonnes)	1.5	129.7	30.5	12.1	2.4
Average Bale Weight	182 KG	455 KG	455 KG	455 KG	455 KG
Estimated Number of Bales Collectable	9	285	67	27	5
Estimated Loads	**8**		**2**	**1**	

A typical dual axle, tractor trailer load capacity is 40 metric tonnes or 40,000 KG. Using this load weight as a standard, the estimated loads required to service Northern Ontario agricultural plastics on an annual basis is estimated to be a combined total of 11 full and partial loads.

For the LDPE and LLDPE categories of plastic, the loads have been combined under the premise that the small quantities of LDPE can be added to a bale of the LLDPE and tagged for separation at the recycler. Due to the small quantities U-Pac has indicated that this cost savings approach would be acceptable.

4.3.3. Transportation Costs

Transportation costs are calculated using three different methodologies for each of the three-separate end of life destinations. Based upon pricing provided by commercial carriers and the collection contractor, plastic bale transportation costs would be as follows:

a) LDPE and LLDPE film – cost covered by revenue received by U-Pac
b) PP net wrap and feed bags - **$4,876 CDN**
    - This is calculated using a commercial LTL carrier, directly hauling bales into Emerald EFW in Brampton from consolidation points in Norther Ontario Districts.
c) PP twine – two routes were developed to limit the transboundary shipping surcharges that loads travelling to the US are subject to.
    - Route 1 – consolidated bales from Dryden and Rainy River into Thunder Bay at a cost of $1,825, which was then shipped as a single shipment to I-90 Reprocessors in Albert Lea, MN at a cost of $2,560 for a total route charge of **$4,385 CDN**.
    - Route 2 – consolidated bales from the remaining sites into Sault Ste Marie at a cost of $7,023, which was then shipped as a single load to I-90 at a cost of $3,420 for a total route charge of **$10,443 CDN**.
    - The total transportation cost to move the PP twine to I-90 is estimated at **$14,828 CDN.**

- The route consolidation points and collection nodes are shown in Figure 9 – Map of Twine Bale Load Consolidation Flows

Figure 9 – Map of Twine Bale Load Consolidation Flows

d) The total cost of transportation of all baled plastic to end of life destinations is **$19,704 CDN.**

4.3.4. End of Life Revenue and Tip Fees

End of life revenues and tip fees follow a similar pattern to the transportation costs in that they all follow a different structure. Revenues and fees are as follows:

a) LDPE and LLDPE – revenues are retained by U-Pac to cover transportation increased costs of the larger Northern Ontario service area.
b) PP net wrap and feed bags – this is charged on a per tonne basis at a rate of $140/tonne
   - Estimated annual total of 14.5 tonnes at $140/tonne = **$2,030 CDN** cost
c) PP twine – this is revenue paid at $0.15/lb US which is equivalent to $0.41/KG at an exchange rate of $1.2545 CDN to US$.
   - Estimated annual total of 30.5 tonnes at $0.41/KG = **$12,505 CDN** revenue
d) The total estimated annual net revenue for estimated waste volumes is **$10,475 CDN**.

4.3.5. Overhead Costs for Program Operations

The proposed approach to establishing an agricultural plastic collection system in Northern Ontario relies on the participation and engagement of the various stakeholders with an interest in improving the end-of-life management of agriculture plastics and keeping them out of landfills, on farm burials, and open burning piles. Key to this environmental partnership will be the communications and promotion of changes to ag plastic management practices, scheduling, and opportunities for collection. Typical program budgets for launching new diversion systems include substantial allowances for communications including media purchases, signs and advertising.

Under a broad partnership plan, the many stakeholders in Northern Ontario agriculture can leverage their communication channels to effectively reach all of the farming communities. Possible partners include:

- OMAFRA – Ontario Ministry of Agriculture, Food and Rural Affairs
- OFA – Ontario Federation of Agriculture
- NOSCIA – Northern Ontario Soil and Crop Improvement Association
- Various Ontario farmers associations such as:
    - Beef Farmers of Ontario
    - Dairy Farmers of Ontario
    - Chicken Farmers of Ontario
- Municipal governments
- Agricultural product retail dealers
- Agricultural product manufacturers and distributors

Assuming that the Program Operator function requires a part time, Program Manager to operate, and can be administered from an existing stakeholder organization, a possible overhead cost structure could appear as follows in Table 10 – Overhead Cost Estimate.

Table 10 – Overhead Cost Estimate

Expense	Amount
Insurance	$4,000
Communications	$5,000
Program Administration	$35,000
Travel	$10,000
Total Overhead Costs	$54,000

4.3.6. Capital Investment Requirements

The basic premise of the on-farm baling approach to collecting agricultural plastic for recycling is to empower farmers to clean, sort, and bale their agricultural plastics on the farm and play an active role in the diversion of these materials from landfill. To achieve this result, farmers must be equipped with the tools required to density their plastics for transport.

The U-Pac basket compactor is an ideal to solution to offer farmers. It is inexpensive, rugged and is a solution to a farming problem, solved by a farmer for farmers. The cost of a basket compactor is $500 and would require an allowance of $250 in shipping charges to deliver a unit to a farmer or staging location. Based upon the need to place these units in convenient proximity to users, an allowance of four basket compactors has been made on a per District basis. It is recognized that some basket compactors may be less utilized in lower production areas than in others, however, the key is to ensure that a high level of access is provided to all farmers in Northern Ontario. The capital expenditure (CAPEX) estimate for this system is outlined in Table 11 – Capital Expenditure Estimate.

Table 11 – Capital Expenditure Estimate

District	Number of Compactors	Cost Per Site
Algoma	4	$3,000
Cochrane	4	$3,000
Greater Sudbury	4	$3,000
Kenora	4	$3,000
Manitoulin	4	$3,000
Nipissing	4	$3,000
Rainy River	4	$3,000
Sudbury	4	$3,000
Thunder Bay	4	$3,000
Timiskaming	4	$3,000
Muskoka	4	$3,000
Parry Sound	4	$3,000
Total CAPEX	48	$36,000

4.3.7. Cost Framework Summary

The cost summary for the launch of an agricultural plastics collection system is summarized as follows, in Table 12 – Program Cost Framework Summary.

Table 12 – Program Cost Framework Summary

Financial Item	LDPE and LLDPE Film	PP Net Wrap and Feed Bags	PP Twine	Total
Transportation Costs	N/C	$4,876	$14,828	
Disposal Costs/(Revenue)		$2,030	($12,505)	
Net End-of-Life Cost		$6,906	$2,323	$9,229
Overhead Costs				$54,000
Annual Net Operational Costs				$63,229
Total CAPEX				$36,000
Total Capital requirement for First Year Setup and Operations				**$99,229**

5.0 Potential for an Extended Producer Responsibility Program

On June 1, 2016, the Ontario Legislature passed Bill 151, the Waste-Free Ontario Act, 2016 (WFOA). WFOA replaces the Waste Diversion Act, 2002 (WDA) with a new producer responsibility framework that makes producers individually responsible and accountable for their products and packaging at end of life. Under this regime, producers become directly accountable for recovering resources and reducing waste as required by regulation.

In all cases, the term “producers” refers to brand owners and first importers of products and packaging, not the generators of waste products and packaging (such as farmers).

WFOA also replaced the WDA oversight agency, Waste Diversion Ontario (WDO), with a new oversight agency called the Resource Productivity and Recovery Authority (RPRA). RPRA has been empowered with greater oversight and enforcement capabilities and is required it to act as a data clearinghouse for producer responsibility programs.

WFOA has two Schedules: Schedule 1 – The Resource Recovery and Circular Economy Act, 2016 (RRCEA) that sets out the new producer responsibility framework; and Schedule 2 – The Waste Diversion Transition Act, 2016 that sets out the operation of existing waste diversion programs, including the process for winding them up.

Under RRCEA, the Minister is responsible for developing a *Strategy for a Waste Free Ontario (the Strategy)* which describes how to build a system that puts valuable resources destined for landfill back into the economy. On February 28, 2017, the Minister released the final Strategy document after several months of consultation. The Province’s two primary goals in the Strategy are to achieve zero waste (the Province’s new long-term waste diversion goal) and to achieve zero greenhouse gas emissions from the waste sector. The Strategy, which has to be updated every five years, serves as the Province’s roadmap to shift Ontario towards a circular economy and towards a zero-waste future.

The Strategy sets out a series of milestones that the Ministry of the Environment and Climate Change (MOECC) intends to achieve:

2018 – Begin to implement the Food and Organic Waste Action Plan; begin to designate new materials under producer responsibility regulations (e.g. batteries, fluorescent bulbs and tubes, additional waste electrical and electronic equipment); develop and consult on disposal bans for food waste and materials under existing diversion programs; and develop and consult on amendments to the existing 3Rs regulations.

2019 – Begin to implement the amended 3Rs regulations to better address industrial, commercial and institutional (IC&I) waste.

2020 – Achieve an interim goal of 30% waste diversion by 2020. Also, complete the transition of existing waste diversion programs (except the Blue Box Program); and designate additional materials under producer responsibility regulations. These additional materials will likely be mattresses, carpets and furniture since the Ontario government has committed to introduce producer responsibility programs for these products under an agreement reached by the Canadian Council for Ministers of the Environment (CCME).

2021 - Begin implementing disposal bans on materials under existing producer responsibility programs.

2022 – Release the first update of the Waste-Free Ontario Strategy and possibly implement a food waste disposal ban.

2023 – Complete transition of the Blue Box Program; and continue to designate additional materials under the producer responsibility regulations.

2025 – Continue to designate additional materials under producer responsibility regulations.

2030 – Achieve an interim goal of 50% waste diversion by 2030.

2050 – Achieve an interim goal of 80% waste diversion by 2050

Although these milestones are not all "set in stone", they do provide a roadmap for how the Province intends to proceed towards achieving zero waste.

The timelines shown above indicate that the earliest opportunity for farm plastics to be designated under a new producer responsibility regulation would be either 2023 or 2025. It will be important for the Ontario agricultural sector to make a strong case to the MOECC regarding the need for producer responsibility programs covering all plastic farm products and packaging. The advocacy effort needs to be supported by sound research on tonnages of plastic waste generated, the risks associated with continuing to dispose of farm plastics in local landfills and cost-effective options for waste diversion. This report provides most of the necessary background research for Northern Ontario.

The Ontario Federation of Agriculture (OFA) has played an active role in providing feedback and guidance to the MOECC on how WFOA regulations should be implemented in the agricultural sector. On January 15, 2018, the President of OFA, Keith Currie, wrote to Ian Drew at the MOECC Resource Recovery Policy Branch with comments on the draft Food and Organics Waste Framework. In the letter, Mr. Currie also made the following general recommendations regarding a producer responsibility framework:

- It is vital that the Waste Free Ontario Act and accompanying regulations expand recycling programs for pesticide and fertilizer containers, feed, seed and pesticide bags, plastic bale wrap and many other items used on the farm.

- A producer responsibility framework should recognize the barriers of rural, northern, and regional waste diversion costs for pick-up, drop-off, and collection, to determine the logistics of cost-effective recovery of waste resources, beyond the proposed targets based on community size, density and geographic distribution.
- A producer responsibility framework should recognize that there is no capacity for Agriculture to bear the responsibility for reduction, reuse or recovery of packaging used for the sale of farm production, and that responsibility should lie further along the distribution route. This strategy reconciles the mismatch between packaging for products originating outside the province with Ontario origin product packaging.

Previously, on January 20, 2016, Mr. Currie wrote to Marc Peverini, Senior Policy Analyst at the MOECC, with comments on the Strategy for a Waste-Free Ontario. Among several other recommendations were the following:

- The Waste-Free Ontario Strategy needs to assist industry initiatives, such as CleanFARMS, in implementing guidelines and programs, as opposed to imposing regulations.
- Expanding the collection of products for resource recovery and alternate uses should be encouraged and integrated within existing programs. This is a cost-effective approach of increasing services to rural Ontario (e.g. bale wrap collection).

These recommendations offer useful guidance for moving forward with a producer responsibility framework for waste plastic products and packaging generated by Ontario farms.

First, any recycling or resource recovery option for farm plastics must be cost-effective. If producers are obligated by regulation to establish expensive recycling systems, the cost will be passed on to farmers in the form of higher prices for farm products or possibly passed on directly through retail “eco fees” on farm products. The agricultural sector is unable to bear these additional costs.

Second, a producer responsibility framework for farm plastics must recognize the unique challenges of collecting and transporting plastic material from farms in rural and northern Ontario. Innovative solutions are required to overcome these obstacles.

Third, a producer responsibility framework for farm products and packaging should recognize existing producer-funded waste diversion initiatives (such as the CleanFARMs pesticide container and seed bag recycling programs) and find ways to build on these efforts rather than replace them.

The opportunities for plastic waste diversion described in this report are consistent with these guidelines and could form the basis for cost-effective producer responsibility programs covering a wide range of plastic waste generated by the Ontario agricultural sector.

Appendix A – Volume Calculations