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Attitudes to the recovery and recycling of agricultural plastics waste: A case study of Nova Scotia, Canada

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ABSTRACT

Agricultural plastics waste (APW) is produced in different quantities and at widely distributed geographic locations and timeframes, and is often contaminated and/or physically degraded. Only a handful of jurisdictions have developed successful APW recycling programs through legislation or voluntary initiatives. The purpose of this study is to identify key barriers to implementing effective, accessible APW recycling programs. Using Nova Scotia (NS) (Canada) as a case study, we identified types of plastic and commodity groups that merit special attention, operational considerations that influence program development and implementation, and farmer attitudes regarding both the importance of APW recycling and the enabling conditions necessary to encourage their participation. Data were collected using a mail-out survey to NS farmers. Findings indicate that the farming community of NS has a positive predisposition to environmentally responsible disposal of APW, and were willing to introduce on-farm activities to prepare APW for collection. However, respondents were also frustrated with the existing lack of services/support for APW management and were opposed to any program that requires their participation in 'off-site' activities such as transporting materials to a central depot. The broader findings indicate that APW collection and recycling programs that are able to comprehensively address most barriers to an APW program will require a co-management structure funded by both the farming community and stakeholders from within the plastics industry.

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1. Introduction

Plastics, or synthetic polymers, are usually derived from petrochemicals and require energy (often fossil-fuel based) for their production. Approximately 4% of world oil and gas production is converted to plastics and the production process for plastics consumes the energy equivalent to an additional 3–4% (Al-Salem et al., 2009). Industrial scale production of plastics began in the 1940s and has grown at an estimated rate of 10% per year since that time, with global production increasing from 1.3 million tonnes in 1950 to 300 million tonnes in 2014 (Plastics Europe, 2015; Panda et al., 2010; Al-Salem et al., 2009). While amounts vary depending on jurisdiction, the use of plastics for packaging represents upwards of 40% of plastics demand—much of it for single-use packaging (Plastics Europe, 2015; Brems et al., 2012; Al-Salem et al., 2010). Many plastics are discarded in the environment or landfill because they are not easily recycled or do not generate profit when recycled. Brems et al. (2012) consider at length the reasons why certain plastics are difficult to recycle, including the high costs associated with transportation, storage, sorting, and processing, and the difficulties of implementing collection programs. Difficult to recycle plastics are often contaminated and structurally degraded low-density polyethylene films (LDPE), clam-shell packaging (usually made with poly-vinyl chloride), polystyrene and other plastics that are mixed together with other waste streams. Additionally, the necessary economies of scale necessary to profitably recycle these plastics are often such that operations are located in the developing world and are not easily established in the jurisdictions where much of the plastics waste is generated. In 2013, Canada and the United States recovered 450,000 t of low-value plastics (primarily film) for recycling (74% increase since 2005) but nearly 60% of these recovered plastics were shipped overseas (American Chemistry Council, 2015). China has become the primary recipient of the low-value plastics, importing 70% of the globally traded recovered plastics in 2012 (Brems et al., 2012).

Agricultural plastics are a category of low-value, post-consumer plastics waste, which in many jurisdictions have largely been ignored by recyclers. The estimates of agricultural plastics used

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and agricultural waste plastics generated in the literature vary widely; they range from 2 to 6.5 million tonnes of APW generated globally per year (Scarascia-Mugnozza et al., 2012; Briassoulis et al., 2013a). Plastics have become an integral part of many agricultural operations, including horticultural mulch films, bale and silage plastic, and fertilizer storage. Some of these major uses allow for an extended growing season, reduced water use, and reduced herbicide and pesticide use (Picuno et al., 2012). Plastics used in livestock production improve the quality and storage life of feed. Diversion of these plastics is a challenge for many governments and waste management researchers (IFFPG, 2015; PolieCO, 2015; Urvinnslusjodur, 2015; Briassoulis et al., 2010; Levitan and Barros, 2003). APW diversion programs that exist in Europe are managed through the co-operation of governments and academic researchers (Award Project, 2015; AgroChePack, 2013). Programs and networks that recover and recycle plastics waste in jurisdictions of Europe have been active since at least 1989 (Gront Punkt Norge AS, 2015; Birch Farm Plastics, n.d.) and have recently been buttressed by the 2011 establishment of an APW working group in the European Association of Plastics Recycling & Recovery Organizations (epro), however, 45.2% of APW in Europe was sent to landfill in 2012 (epro, 2012).

In many jurisdictions, APW is discarded using one of four disposal methods, each with its own negative environmental consequence. These include: on-site burning of APW, on-site burial, disposal in municipal landfills, and illegal dumping (Scarascia-Mugnozza et al., 2008). Briassoulis et al. (2010) identifies negative repercussions of burning plastics in an open environment including the release of numerous harmful substances into the broader environment (water, soil and air). Bio-accumulation of these harmful substances in plant materials may occur if adjacent fields are contaminated. Burying APW contributes to degradation of soil quality characteristics, and can result in soil contamination, which poses possible threats to local ecosystems. Disposal of APW in terrestrial and aquatic environments also contributes to esthetic pollution, threats to domestic and wild animals, and the loss of material resources and energy; these issues are magnified when materials are disposed of illegally in unmanaged sites (Briassoulis et al., 2013a).

The most recent study of plastics waste in Nova Scotia estimated that 13.8% of plastics were diverted from landfill and sold to plastics recyclers in 2006 (Resource Recovery Fund Board, 2008). This is comparable to those European countries who lag behind the European average (26%) such as Malta (12%) and Cyprus (15%); however, the amount going to landfill was only 38%, due to the fact that 36% of plastics were burned for energy recovery (Plastics Europe, 2015). Therefore, much less plastics are going to landfill in Europe, and the average plastics mechanical recycling rate of 26% is still almost double the Nova Scotia plastics recycling rate.

Farm plastics generated in the Atlantic Canadian provinces, including New Brunswick, Nova Scotia, and Prince Edward Island have been estimated at 2124 t per year. Estimates suggested that Nova Scotia accounted for approximately 702 t per year of the total (CleanFARMS, 2012[1]). Low-density polyethylene (LDPE) is the predominant plastic used on farms with silage film and bale wrap accounting for about 80%, followed by row covers and mulch film at 8% (CleanFARMS, 2012). CleanFARMS reported that the majority of plastics waste generated on-farm are dumped, burned, or sent to landfill, a finding supported by data collected via the Nova Scotia Federation of Agriculture's *Environmental Farm Plan* (P. Brenton personal communication, December 22, 2014).

Beginning in the 1990s in North America the quantity of plastics waste on farms began to be documented in professional, government, and university reports. For example in 1997, a study completed by the Waste Management Institute at Cornell University found that waste management was the single most often cited issue with plastics use on farms. Moreover, 85% of the farmers surveyed ($n = 77$) said they would be interested in a recycling program if available, but would not be willing to pay for the program (Rollo, 1997). Another study completed in 2003 by Levitan and Barros, noted that the management of farm plastics had significantly lagged behind other plastic waste streams, in large part because it was legal to burn/bury agricultural plastics on-site. The study also found that the economics of a recycling program was not well understood due to the low-value and the technical challenges associated with contamination and degradation of the materials (Levitan and Barros, 2003).

At that time, there were a number of initiatives undertaken in various jurisdictions to try and address this issue. These included: an industry-sponsored network for collecting HDPE pesticide containers; an industry-sponsored program based in Ontario, Canada, that picks up, pays for, and re-processes polystyrene nursery flats and trays; a LDPE nursery film collection program in New Jersey accessible to out-of-state producers; a plastic lumber re-processing technology based in Prince Edward Island, Canada, capable of handling contaminated LDPE plastics used in dairying; and a plan at Penn State University to develop a plastic fuel nugget that can be burned for energy recovery (Levitan and Barros, 2003). More recently, Briassoulis et al. (2013b) have proposed technical specifications for the best economic and environmental valorisation of APW in the context of European agriculture and plastics management. There is little evidence in literature to suggest whether or not farmer attitudes or challenges are markedly different today than they were in the 1990s and early 2000s.

The purpose of this study is to investigate the attitudes in the agricultural sector toward recycling and disposal of APW in order to identify the current barriers toward implementation of a diversion and recycling program. The study takes a case study approach with a specific focus on Nova Scotia, Canada which has a strong legislative history of sustainable waste management, but yet does not have an ongoing management plan for the diversion of APW from the existing waste stream.

2. Materials and methods

2.1. Scope of the research

The scope of the paper is to evaluate bottlenecks and challenges to implementing plastics diversion and recycling programs from dispersed generators, such as in agricultural contexts. The first step was to conduct a literature review of existing APW recycling programs and challenges associated with managing geographically dispersed plastics waste streams. The next step was to evaluate attitudes toward plastics use, generation, and disposal options by targeted APW generators. The final step was to survey waste management groups, as well as industry and government representatives across Atlantic Canada to examine prevailing concerns related to implementation of APW diversion and recycling programs. This research used a mixed methods approach in order to determine how the attitudes of rural producers might impact development of an APW diversion and recycling program. Survey questions and research methodologies were reviewed and approved by Dalhousie University's Research Ethics Board.

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

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