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# PLASTIC WASTE AND ITS REMOVAL BY LICENSED HORTICULTURAL FIRMS IN GEORGIA, USA

Key words: USA, Georgia, horticulture firms, recycling, plastic waste, survey, employee behavior

ABSTRACT. The purpose of the study was the investigation of horticultural firm behavior regarding plastic waste recycling and the constraints and incentives to increase the volume of recycled plastics. Licensed horticultural firms in Georgia recycle plastic waste such as plastic pots, trays, and multipacks to varying degrees. The survey involved horticultural firms licensed by the Georgia Department of Agriculture to conduct business in Georgia. A total of 2,194 firms were contacted and 299 completed the questionnaire. The scope of the survey was larger than a survey conducted in 2013. The survey response summary revealed that the majority of firms recycled at least one half of the used plastic pots. Results show that constraints to recycling include the sorting, storage, and cleaning of plastic waste. The share of respondents agreeing that those factors limit plastic recycling was 59%, 56%, and 69%, respectively. Lower waste pickup fees in exchange for plastic recycling would increase the volume of recycled plastic waste in the horticultural sector.

## INTRODUCTION

Plastic is ubiquitous. Its use results from properties such as light weight, moisture imperviousness, flexibility and low cost [Duchin, Lange 1998]. The demand for materials with these properties led to the development of various types of plastics used in countless products. The efficacy of plastic materials varies and oftentimes is very short, causing the user to replace them with new material. The same properties that encourage the use of plastic contribute to problems with its disposal. Plastics have low biodegradability [for example, Agamuthu, Faizura 2005] and have been recognized as pollutants, risking soil and water contamination. Uncontrolled burning of plastics also adversely affects air quality.

Uncontrolled disposal of plastics has led to regulations aimed at reducing possible environmental degradation and effects on human health. For example, the European Union (EU) strictly regulates plastic disposal in its solid waste management policy. However, disposal of plastics is part of solid waste management and its organization and scope varies across countries [for example Pacheco et al. 2012, p. 142].

Plastic waste originating from sparsely populated areas poses a particular challenge. Scattered locations of these wastes include horticultural producers and commercial landscapers. In contrast to pan-national regulations in the EU [EC 2020], the handling of used plastics in the United States is subject to local and state regulations. In the state of Georgia, handling plastics used in horticulture and landscape sectors varies from county to county. Each local government regulates the disposal of plastic according to social and economic conditions as well as the supporting infrastructure. This preliminary study explores general attitudes toward recycling plastic materials used in the production, distribution, and planting of horticultural plants by licensed companies in Georgia. The number of companies and amount of used plastic materials is only a fraction of the total amount used by households, the commercial sector, and government institutions in the state, but learning about the fate of plastic waste and possible constraints to recycling will provide insights applicable in developing pathways to limit plastic waste disposal in landfills. By reducing the plastic volume in landfills, the risk of environmental pollution decreases, while the landfill lifetime extends, thereby benefitting local government budgets and residents. Linking plastic waste recycling with personal characteristics of respondents provides information useful in seeking ways to increase recycling among licensed horticultural firms in Georgia.

The use of plastic pots, trays, liners, greenhouse covers, and other materials is common in horticulture. Also, different materials are made of various types of plastics, including low-density polyethylene (LDPE), high-density polyethylene (HDPE), polypropylene (PP), and high impact polystyrene (PS). Despite the development and availability of several types of biodegradable containers [Dennis et al. 2010, Zhang et al. 2019] their use has been very limited. In Georgia, the majority of surveyed landscape maintenance companies lack knowledge about the benefits of using biodegradable containers and very few actually used them [Harris et al. 2020]. Plastic containers and other plastic products remain commonly used by horticultural firms. Retail outlets continue to use plastic containers and trays for horticultural products such as ornamental plants as well as vegetables as they are easy to handle and transport, and minimize plant damage. Landscape companies find plastic pots easy to use at planting sites. Although some consumers have favorable attitudes towards biodegradable containers [Yue et al. 2010], their cost, increased fragility compared to plastic, and the risk of damage to plants seems to limit their use. Yet the broad use of biodegradable containers would prevent the need for further handling of at least some types of horticultural plastic waste.

## PREVIOUS STUDIES ON HORTICULTURAL PLASTIC WASTE REUSE, RECYCLING, AND DISPOSAL

Plastics are petroleum-derived products and their cost is tightly linked to the price of oil. A substantial decrease of oil prices in recent years led to a decrease in prices of recycled plastics and resembles the situation of the late 1990s [Subramanian 2000]. Recent oil price decreases have forced counties in Georgia to change the types of plastics accepted in household solid waste recycling bins since a decrease in demand for recycled plastics has

limited re-selling options. Households also mix recyclables with other waste and re-sorting at solid waste stations adds to handling costs. Household recycling behavior, including recycling plastics, has identified gender and labor participation [Matsumoto 2011] as well as age and income [Jakus et al. 1996, 1997] as factors affecting participation in recycling.

Horticultural firms use a limited variety of plastic materials, but in large volume, making it potentially easier to manage recycling. Reuse, the preferred plastic waste handling method, is not feasible in horticulture due to the risk of pathogens infecting new plants, while sterilization is complicated by a lack of standardization of plastic materials. The economically infeasible reuse of horticultural plastics shifts the focus to recycling. Reuse has been advocated for local voluntary organizations supporting botanical gardens and other public landscapes.

Recycling horticultural plastic waste occurs, but is not without problems. The light weight of plastic as well as the shape of plastic materials (e.g. containers, trays, and greenhouse covers) results in bulkiness, posing a storage challenge between waste pickups [Meng et al. 2015]. Additionally, placing in storage areas involves labor allocated away from production. Time-cost and lack of storage space also affects household behavior in voluntary recycling [Jakus et al. 1996, 1997]. Sorting plastic waste by type is viewed as a constraint by environmental horticultural firms in Georgia [Meng et al. 2015], while the bulky and lightweight nature of that waste poses a challenge in transportation, thereby discouraging frequent collection. Reducing the amount of plastic waste requires additional labor by the horticultural firm engaged in plant production.

Once horticultural plastic waste is collected, it may be contaminated by soil particles, peat, or other substances that require removal prior to grinding to obtain a tradable product. Recycled ground plastics can be used in new products but are often not of the required quality [Al-Salem et al. 2009]. For example, the addition of recycled horticultural plastic in manufacturing new plastic pots is limited because it compromises its structural integrity and the addition of recycled plastic to some products is regulated to assure their performance [Poduška et al. 2019], although some experimental films with possible uses in horticulture have been developed from recycled greenhouse and low-tunnel covers [Picuno et al. 2012]. Recycled horticultural plastics are more likely to be used in non-horticultural products and the search for the valorization of horticultural plastic waste is on-going. In some instances, plastic waste, regardless of its origin, is incinerated in specialized power and heat generating plants since plastics are energy-dense [Bujak 2015]

The last option to handle horticultural plastic waste is disposal in landfills. Consumers often purchase plants in plastic pots or multipacks placed on plastic trays and discard the containers in accordance with the local solid waste management guidelines. Currently, those plastics are often placed in solid waste bins and end up in landfills. Incineration of plastic waste, practiced in some countries [Geyer et al. 2017], is very limited in Georgia because of the high construction and operation costs of suitable incinerators and legal disputes regarding the location of such facilities. Though the volume of horticultural plastic waste is dwarfed by consumer-generated plastic waste, it still generates a large volume of waste annually [EC 2020]. Efforts to expand recycling among licensed horticultural firms would lower environmental risks at local levels and make a meaningful contribution globally.

## RESEARCH METHODS

The applied character of this preliminary study and a lack of recent data on the behavior of horticultural firms in the United States and Georgia in particular require the collection of data before the use of descriptive statistical methods to identify self-reported choices in handling plastic waste. To implement a survey, a request was sent to the Georgia State Department of Agriculture to obtain the list of licensed horticultural firms permitted to conduct business. The list consisted of 2,149 firms. The provided list excluded large chain stores with horticultural product sections. National chain stores, due to their internal structure and centralized headquarters management, could be expected to handle plastic waste differently from small and medium size Georgia-based companies. The current study differs in scope from an earlier study conducted in Georgia [Meng et al. 2015] that was limited to members of the "green industry" association rather than firms registered and licensed by the Department of Agriculture. Members of the association were fewer and included some firms or individuals not engaged in horticultural production, distribution, or use of potted plants and plastics in landscapes.

The study distinguishes horticultural firms from farms, which also use plastics in various ways. For example, farms with animal husbandry prepare and store corn and grass sileage in large plastic bags [Briassoulis et al. 2013]. Some large vegetable or strawberry farms use plastic as mulch to conserve moisture, reduce weed competition, regulate soil temperature, and improve vegetable or fruit quality. Those types of plastic use are outside the scope of the study which concentrates on the use of plastic pots, trays, liners, multipacks, and other plastic materials used in the production, retailing, and installation of ornamental plants and vegetables.

Summary frequencies of selected respondent personal characteristics to the survey show the role of possible constraints to recycling or incentives to increase recycling. The selection of personal characteristics is guided by earlier studies of voluntary consumer waste recycling by members of the "green industry" association in Georgia. Additionally, the application of the test on differences between each characteristic (i.e., age, education, and gender) and selected opinions provides specific details that could be of interest to local waste management authorities and environmental management entities.

## DATA

The collection of data about practices used by licensed horticultural firms in Georgia require the preparation and implementation of a questionnaire for use in the survey. A draft questionnaire was used in a pilot study before it was distributed online. The pilot study involved a sample of 30 licensed firms randomly selected from the available list. After observing that the respondents did not have difficulties in answering the questions, a letter of invitation to participate in the survey was sent to 2,149 licensed firms.

The survey was conducted through an online platform (Qualtrics) between November 2018 and April 2019. Among small and medium firms, a total of 299 responded to the invitation by completing the questionnaire. The response rate (13.9%) could be perceived as small, but it is not unusual for business firm surveys [for example, Julienti Abu Bakar,

Ahmad 2010]. Companies do not have the incentive to participate in research surveys and may view such participation as involving management or employee time that is spent on unproductive activities, implying costs. In absolute terms, the number of participating firms is fairly large and suggests that behavior with regard to plastic waste recycling is accurately reflected in the answers.

## SURVEY RESULTS

The examination of responses revealed that the firms did not provide answers to all questions. Such behavior, especially among business survey participants, is not uncommon. Therefore, the results include information about the number of firms sharing specific information. The majority of surveyed firms (49%) reported that their annual revenue in 2018 did not exceed USD 100,000, based on responses provided by 219 out of 299 participating firms. The small value of annual revenue implies that the firms employed a limited number of workers with the owner managing daily operations.

The firms engaged in recycling frequently used plastic materials. For example, the container-crop industry uses four billion plastic containers annually in the United States [Schrader 2013]. Plastic containers were recycled at a rate of 51% or higher by 64% of responding firms (Table 1). The reported plastic pot recycling lowers $CO_2$ emissions associated with the use of such pots in popular annual flower production [Koeser et al. 2014]. Plastic flats were recycled by 65% of firms at a similar rate as plastic pots. The share of firms recycling plastic inserts was smaller, 37%, but not all firms used them. The recycling rate reported by the surveyed firms is higher than in the 2013 survey.

Table 1. Percent of responding firms recycling three types of plastic waste

| Plastic waste | 50% or less | At least 51% |
|---|---|---|
| | % | |
| Plastic containers | 36.17 | 63.83 |
| Plastic flats | 34.34 | 65.38 |
| Plastic inserts | 62.68 | 37.32 |

Source: own research

In the previous study of Georgia environmental horticulture firms, the need for sorting various plastic waste and storing it between pickups was viewed as a disincentive to recycle. Results of the current survey of different types of horticultural firms coincide with the earlier study. Preliminary results revealed that nearly 59% of firms perceived sorting plastic waste at least as a slight constraint (Table 2). Sorting has been identified as a constraint to plastic waste recycling due to low benefits from economies of scale in sorting and limited demand for recycled material [Jang et al., 2020]. Sorting requirements also discourage households from recycling as it is associated with inconvenience [Jakus et al. 1997].

Similarly, 56% of responding firms viewed the need for storing plastic waste as a constraint in recycling. Storing was viewed as a constraint by about 46% of the "green industry" in the results of the 2013 survey in Georgia. Although summaries from the recent survey cannot be compared with those from 2013, more than one half of the companies participating in the former agreed that storage is a limitation. Many licensed horticultural firms may lack space they can dedicate to plastic waste storage as it awaits pickup by a

Table 2. Constraints limiting the recycling of plastic waste by surveyed licensed horticultural firms in Georgia

| Constraint perception | Sorting plastic waste from other waste | Cleaning plastic waste from soil residue | Storage on firm premises until pickup |
|---|---|---|---|
| | % | | |
| Not a constraint | 41.50 | 30.56 | 43.54 |
| Slight constraint | 37.41 | 29.86 | 27.89 |
| Constraint | 21.09 | 39.58 | 28.57 |
| Total | 100.00 | 100.00 | 100.00 |

Source: own research

recycling company. Since space represents a cost, firms tend to minimize space that is not used in a productive manner. In the case of households, having extra storage encouraged voluntary recycling [Jakus et al. 1997].

About 69% of firms agreed to various degrees that cleaning plastic waste of soil residue constrained recycling. That coincides with the results of earlier studies indicating that plastic waste contamination lowers the quality of plastic waste and limits its marketability [Blanco et al., 2018]. Also, about 45% of firms agreed that the recycling firm should pay for cleaning plastic waste of soil residue. Recycling by households also requires cleaning the recycled product including plastic waste and those who viewed recycling as a costly practice were willing to pay more to avoid recycling [Matsumoto 2011]. Such choices among households are consistent with the licensed horticultural firm view that they should be paid for plastic waste cleaning. Indeed, the difficulty of removing soil from some plastic waste from horticultural firms may prevent its recycling, leading to disposal at landfills or incineration.

Plastic waste sorting, storing, and cleaning requires labor. But the firms are generally small as indicated by annual revenues and small firms have limited labor resources. Almost half of the surveyed firms viewed the labor requirements to handle plastic waste at least as a slight constraint, a noticeably lower share than those naming other constraints discussed in this study. The average employee number in the 2013 survey was 22, but the average size was influenced by a few particularly large firms.

The views expressed by surveyed firms were consistent with the above described tendencies. Specifically, about 59% of firms "somewhat agreed" or "agreed" that relaxing the requirement of sorting waste by plastic type would increase participation in voluntary recycling. However, the largest share (more than 67% of responding firms) agreed to varying extents (48% "strongly agreed") that they should not be charged for the pickup of plastic waste that the recycling firm re-sells. In the 2013 survey, 47% of firms agreed that an incentive to recycle plastics was their belief that such behavior led to minimizing their waste disposal fees. Currently, with the shrinking demand for recycled plastic, revenues from the sale of recyclables may not be sufficient to cover the costs of collection and processing (for example, sorting by type) plastic waste and prevent free pickups at the company location.

Voluntary recycling, including plastic recycling, has been associated with individual personnel characteristics. Age, education, and gender are commonly identified as relevant factors influencing recycling [Jakus et al. 1997] and plastic recycling in particular [Matsumoto 2011]. In the case of plastic waste recycling by horticultural firms in Georgia, education was negatively related to the plastic recycling decision. The result was explained by the average number of years of formal education received by the respondent as being below a college degree [Meng et al. 2015]. In the current survey about 55% of respondents received at least 16 years of education, implying that the majority had a college degree. A high level of education is likely to eliminate the lack of information about the desirability of recycling and the potential damage to the environment from discarding plastic waste. Additionally, respondents who admitted discarding plastic with their household recyclables at least once a week accounted for 70% of those choosing to provide an answer to that question.

## CONCLUSIONS

Horticultural firms commonly use plastic products in the production and installation of plants in the landscape. Plastic waste generated by those firms cannot be re-used, but can be recycled rather than being disposed at landfills. Recycling has been hampered by lower oil prices in recent years, making recycled plastic materials less competitive and limiting their use. Still, learning about recycling rates of various products and constraints to recycling among licensed horticultural firms in Georgia provides new knowledge useful in managing waste disposal and educating the industry to increase the share of plastic waste that is recycled.

The survey results indicated that a relatively high share of plastic pots and trays is recycled. The summary revealed by this preliminary analysis indicates the sorting and storage of plastic waste waiting for pickup remain the major constraints in recycling. Cleaning soil particles from plastic waste is also viewed as a constraint, yet without cleaning the value and quality of recycled plastic waste is greatly diminished. Space and labor are allocated primarily to productive uses and plastic waste handling forces the reallocation of those resources.

Future studies may overcome some of the weaknesses of this preliminary study by expanding the detailed list of various plastic materials used by licensed horticultural firms. A broader geographical scope and alternative survey methods could be applied to increase the response rate. It also seems worthwhile to periodically repeat the survey with focus on plastic waste recycling to gauge changes in recycling behavior and verify the relative importance of identified constraints.

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## ODPADY TWORZYW SZTUCZNYCH I ICH USUWANIE PRZEZ LICENCJONOWANE FIRMY OGRODNICZE W STANIE GEORGIA W USA

Słowa kluczowe: USA, Georgia, firmy ogrodnicze, materiały plastikowe, recycling, badania ankietowe, zachowania pracowników

ABSTRAKT

Licencjonowane firmy ogrodnicze recyklingują zużyte materiały plastikowe, w tym m.in. doniczki, tace i wkładki używane w procesie produkcji. Celem badań było zidentyfikowanie zachowań pracowników firm ogrodniczych, dotyczących recyklingu plastiku oraz poznanie motywów i ich opinii na temat ograniczeń i bodźców do zwiększenia ilości recyklingowanego plastiku. Badaniami objęto licencjonowane firmy, znajdujące się na liście Departamentu Rolnictwa Stanu Georgia w USA. Przeprowadzono badania ankietowe wśród 2194 podmiotów ogrodniczych uprawnionych do prowadzenia takiej działalności. Badania te miały większy zasięg niż te przeprowadzone w 2015 roku. Sumaryczne wyniki z ankiet pokazały, że większość firm oddaje do recyklingu co najmniej połowę zużytych doniczek plastikowych. Stwierdzono, że sortowanie, przechowywanie i czyszczenie zużytego plastiku w firmach ogrodniczych ogranicza w dużej mierze recycling tego materiału. Udział respondentów, którzy uważali te wymagania za ograniczenia wyniósł odpowiednio 59, 56 i 69%. Zapewnienie niższych opłat za odbiór i wywóz śmieci, w zamian za oddane do recyklingu plastikowe materiały, na pewno zwiększyłoby wolumen odzyskiwanego materiału.

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