UBC Social Ecological Economic Development Studies (SEEDS) Student Report

Sustainable alternatives to traditional plastics and conventional plastic waste management in the agricultural setting of the UBC Farm

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University of British Columbia

AGSC 450

April 8, 2009

AGSC 450 - University of British Columbia Food System Project

Implementing sustainability production techniques
and landscape management at the UBC Farm

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Abstract

The use of plastics in agriculture, or plasticulture, is a comparatively recent phenomenon, with numerous associated benefits and is used globally to enhance agricultural production. Despite the production benefits of agricultural plastics, sustainable waste management is a considerable challenge, but an important goal for the UBC farm. The objectives of this project were to determine the primary plastics used in agriculture, to establish the main issues concerning the management of plastic waste, and to identify potential alternatives and solutions regarding these challenges. To fulfill these goals, a thorough literature search was conducted, as well as extensive communication with various people affiliated with the recycling industry. The plastics primarily used at the UBC farm include drip tape, plastic mulch, and greenhouse films. It was determined that there are several waste management alternatives for these plastics that are commonly implemented in agriculture, including biodegradable plastics, incineration, and recycling. Recycling was identified as potentially being the most environmentally sustainable alternative to plastic waste management. However, due to a poor market for recycled products and a general reluctance by the recycling industry to refine agricultural plastics, recycling is not a plausible alternative at this time. More research and an initiation of open communication between the agricultural and recycling sectors is necessary to make recycling feasible for everyone involved.

Introduction

University of British Columbia Food System Project (UBCFSP) is the foundation of the Agricultural Sciences 450 course (AGSC 450). The community-based research, integral to the course, is an excellent opportunity for students to apply the knowledge they have accumulated through their studies at UBC. For the UBCFSP 2008/09, we, the eight members of Team 22, were assigned the hands-on scenario: "Implementing sustainability production techniques and landscape management at the UBC Farm″ with a focus on agricultural plastics. Our goal was to investigate the potential alternative methods of managing agricultural plastics in order to decrease the ecological footprint of the UBC farm, thus ultimately helping to develop a more efficient and sustainable food system at the production level.

Going back to the Origin: Plasticulture

One of the primary objectives in agriculture is to enhance the growth of produce, which involves protection from an assortment of variables such as harsh climate and temperature differences. Before plastics were introduced in agriculture in the sixteenth century, the first glass greenhouse was invented in the United Kingdom to achieve these goals (Keveren, 1973). Over recent years, innovation and development have led to the use of transparent and translucent plastics as an alternative to glass, making plastic an integral resource in modern farming.

Plasticulture, the practice of using plastics in agriculture, is currently used on a global scale. Approximately 21 billion square feet of land around the world is covered by high tunnels, which are simplified growing systems that enhance crop growth, yield and quality (Mullins, 2003), and plastic greenhouses (Wittwer, 1993). The foremost functions of plastics in agriculture currently are:

- To eliminate the effect of extreme weather, especially temperature, rainfall, and wind from damaging crops and reducing marketable yields (Orzolek, 2004)
- To be able to harvest earlier by increasing the average growing degree days (Mullins, 2003)
- To rely less on herbicides and pesticides (Mullins, 2003)
- To create more efficient water conservation (Mullins, 2003)

The primary ways in which plastics are implemented in agriculture include drip tape, plastic mulch and greenhouse film. All three of these strategies are currently in use at the UBC farm to modify the abiotic environment, thus optimizing growing conditions for maximum production.

Problem Definition

Plastics are an integral part of modern agriculture and it is virtually impossible to grow food with adequate capacity without their help today (Orzolek, 2004). There are, however, environmental consequences. Although plastics' resistance to peroxidation, water, and microorganisms make it desirable and durable to implement in agriculture (Scott, 2000), these technical advantages which make plastic polymers useful have also created an issue that was never considered when plasticulture was first introduced: waste management. The UBC farm is currently facing this dilemma.

Disposal of plastics once they have reached the end of their useful life is a serious logistical issue in agricultural production. Many of the current disposal solutions involve either burning the plastic or dumping it into landfills, with limited access to local recycling (Stevens, Khan, Brown, Hochmuth, Splittstoesser, & Granberry, 1991). Landfills are being used up at an alarming and expensive rate, as dumping is currently the most common method used to manage the waste associated with agricultural plastic and film use worldwide (Clarke, 2001). These activities, if not regulated, have the potential to greatly contribute to a more serious issue, which is climate change.

The purpose of our project is to provide the UBC farm with the best solution to manage their agricultural plastic wastes while minimizing the negative effects on the environment. Our hands-on experience helped to enhance our understanding and perspective of waste management issues as part of the food system. This practical experience was also an opportunity to acknowledge the significance of completing an ethical food cycle as part of being responsible global citizens.

Vision Statement

Collectively, we agree with the principles stated in the "Vision Statement for a Sustainable UBC Food System," and recognize that waste management at the production level plays a significant role in the sustainability of a food system. The second principle, "waste must be recycled or composted locally" is the primary focus of the agricultural waste management project. Although most of the ethics outlined in the vision statement fundamentally focus on the production and consumption of food, we appreciate the concerns paid to the completion of the food cycle. In order to sustain these seven statements, it is essential that the needs of the food system are met, including the provision of adequate local food, the enhancement of community education and awareness, as well as environmentally conscious management of wastes. Our research concerning the management of agricultural plastic use is an integral component of the vision statement, as it investigates potentially more sustainable waste handling strategies, which has a significant impact on the food cycle.

Methodology

Initial Literary Research

For the purpose of familiarizing ourselves with the general topic of plastic-use in farming, our team initially conducted a background research. Due to the broad nature of the issue, we first agreed on the key aspects of the topic and then assigned each member to a specific area of research. Information was gathered concerning advantages of plastic-use in agriculture, potential negative effects of its use in the field on soil and wildlife, and the effects on the environment if disposed of improperly. Furthermore, our team investigated recycling facilities and processes currently in place, as well as non-plastic alternatives that are presently available around the world. To ensure reliability of researched information, the primary sources used were published journal articles and printed material, in addition to industry initiative websites such as Environment and Plastic Industry Council established by the Canadian Plastics Industry Association.

Communication with the UBC Farm

Informal Interview

In-class research consisted of two short interviews with Tim Carter, Production Coordinator of the UBC farm. During the initial interview, our team raised a series of questions that had been brainstormed prior to the meeting, based on our original research; these included questions surrounding current priorities of the UBC farm regarding recycling, aspects of plastic-management on which to focus, and realistic goals for our project, given the allotted time. The second interview expanded on the previous issues as we discussed specific companies that offer plastic alternatives and also addressed the problematic role that coyotes play in the field by damaging potentially recyclable or reusable plastic drip tapes.

Field Work

To gain a better understanding of how plastics, such as mulches and irrigation drip tape are used in agriculture, three hours of field work were performed. Following a thorough tour of the farm, Mr. Carter demonstrated our duties for the day. Our main tasks were to retrieve the used drip tape that remained from the previous farming season and to fold them in accordion style for reuse or proper disposal. The tapes that measured longer than 30 paces were saved for later use, whereas the shorter lengths and those that were gnawed or punctured by coyotes were put aside to be disposed of. Many of the tubes only displayed teeth marks on the edges and thus were simply clipped off at these ends. The plastic connectors for the tubes, which are fairly expensive, were also collected for later use.

At the end of our field work session, our team held a final discussion with Mr. Carter to confirm the main priorities of the farm and to verify key information he hopes to obtain from reviewing our project. His main concern was to find a recycling company or companies that would readily accept agricultural plastics. Along with this, he was interested in finding more information about the requirements set forth by these companies regarding the size, grade, cleanliness, and quantity of the plastics that would be accepted. He also highlighted the problem of coyotes causing damage to potentially recyclable drip tape and asked us to review any literature that would offer explanations as to why they like to chew on plastics. Finally, Mr. Carter asked us to research plastic alternatives that are currently available for farming and the advantages and disadvantages of their use.

Communication with Existing Recycling Companies

Having seen the plastics that are used at the UBC farm and received guidance from Mr. Carter, our team was prepared to look into the existing recycling companies and to investigate the types of plastics being used at the farm by contacting agricultural plastic manufacturers. With the main objective of finding a company that accepts all the agricultural plastics used by the UBC farm, we first had to distinguish the plastic recycling numbers and determine how those plastics are being collected. Due to Mr. Carter's uncertainty regarding the specific material of the plastics used on the farm (including the plastic numbers), a few manufacturers, such as Netafim, ToroAg, and T-Tape were contacted to obtain information on each of the following plastic equipment types: drip tape, unwoven plastic sheet mulch, irrigation pipes and fittings, and woven groundcover. Meanwhile, Christian Beaudrie, Outreach Coordinator for UBC Waste Management, was contacted to obtain specific information regarding the types of plastics that are collected by the UBC Waste Management and the requirements that must be met before the plastics are accepted. It was established that UBC Waste Management sends all of the collected plastics to Metro Waste Paper Recovery where they are sorted and transferred to different recyclers (Beaudrie, March 18, 2009). A series of phone calls and emails were then sent dispatched to various recycling depots and we reached the Recycling Council of BC at the upstream of recycling system in BC. Their website provided helpful information for seeking specific recyclers in BC. After contacting some of the recyclers and being told that they declined agricultural plastics, our team asked for detailed explanations as to why that is the case and for measures that may be taken in order to increase the likelihood that they will be accepted.

Jill Ackerman was another valuable contact. She is a well-known figure in the plastic-recycling industry for having launched a pilot project on Vancouver Island, collecting agricultural plastics from Victoria to Sidney for recycling (Ackerman, 2008). She is an excellent source of information on recycling and was able to connect us with several other contacts in the industry.

Findings and Discussion

Agricultural plastics

The UBC farm uses a significant amount of agricultural plastics to create a more productive and effective production system. Currently, there are three different categories of agricultural plastics used at the farm with various distinct purposes and objectives:

1. Drip Tape

Drip tape is collapsible, thin-walled, water-emitting hose which is used in commercial agricultural production (Lamm & Ayars, 2007). The tubes are normally composed of polyethylene, which is the same thermoplastic commonly used in plastic shopping bags (Peacock, 2000). There are various basic drip distribution systems that allow for slow water discharge using strategies such as: tiny orifices, low pressure, and outlets with flow resistance (Jensen & Malter, 1995). The UBC farm uses the drip tape that is of the flow resistance type, which reduces water flow to slow a trickle or a drip (Figure 1). At the farm, the drip tape is most often used on the 200 plus varieties of row crops, like the vegetables and fruits in the Market Garden. The tape is black with 100-375 microns thick emitter holes that are spaced at 20-60 cm intervals (Jensen & Malter, 1995).

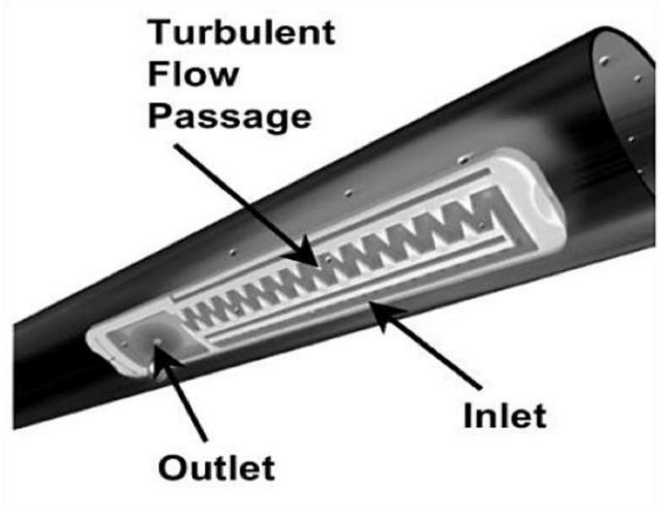

Figure 1. Model of plastic emitter used in drip tape (Lamm & Ayars, 2007).

The main objective of drip tape application is to increase crop yield. This is achieved as both water and fertilizer can be applied on a timely basis. Application of water using this technique uses less water than furrow or flood irrigation (Jensen & Malter, 1995), and less energy, pressure and labour as compared to surface sprinkler systems (Humphrey & Mussen, 1995). The disadvantages, however, of a drip irrigation system are the initial cost and the disposal (Humphrey & Mussen, 1995). Other issues associated with drip tape use include clogging, poor uniformity of water delivery, risk of animals chewing on the tape, and rupture during the mechanical weeding process (Humphrey & Mussen, 1995).

2. Plastic Mulch

Plastic mulch is a product commonly used in agricultural operations to suppress weeds and conserve water. When drip irrigation is installed under plastic mulch, higher crop yields can be achieved (Jensen & Malter, 1995). The chemical composition and pigmentation of the plastic film are critical factors in determining the mulch’s durability, strength, resistance to aging, and its ability to retain heat within the soil (Jensen & Malter, 1995). Plastic mulch also prevents weed growth and rapid heating of crops while selectively improving lighting (Stevens *et al.*, 1991). For example, the black films can be used during cold weather to provide increased heating for seed germination and thus, an earlier planting is achievable in the local climatic season (Stevens *et al*., 1991). On the other hand, the clear films reflect some of the sunlight rays, thus cool the soil during hot summer weathers to prevent scorching the plants.

As with drip tape, there are issues concerning plastic mulch removal and disposal. The black films generally used as plastic mulch are non-degradable, and thus accumulate in the field, which could potentially interfere with planting operations as the residues may clog the machinery (Stevens *et al*., 1991). The common methods of mulch removal include discing, burning, and physical removal (Stevens *et al*., 1991). Discing involves burying the used plastic in the soil as the disc harrow turns and loosens the soil (Stevens, *et al.*, 1991). The method is not recommended for the black film that is used at the UBC farm due to the risk of plastic particles building up in the soil. Burning of plastic films is laborious, with a risk of emitting toxic fumes, and violates the environment protection laws in many countries (Stevens *et al*., 1991). Dumping is the least intensive option, however, it is not sustainable and many landfills no longer accept plastic mulch wastes (Stevens *et al*., 1991). Currently, the UBC Farms has resorted to storing the plastic mulch, and other plastic wastes, until an affordable, local, and sustainable alternative option to dumping arises.

3. Greenhouse film

Greenhouse films are implemented in order to maintain warmer temperatures within greenhouses by trapping the heat from the light rays that enter through the film. Numerous parameters influence the useful lifetime of polyethylene greenhouse films, in general however, the films have a very short life span without the addition of light stabilizers (Hamid, 2000). Some of these parameters include polymer type, film thickness, climate conditions and crop types (Hamid, 2000).

As with other agricultural plastics, the primary waste management strategy for greenhouse films is dumping. Substitutes for discarding the plastics to landfills include recycling the degraded films and potentially burning the films as an alternative energy source. In a trial conducted by the Central Termica Litroral de Almeria, greenhouse film was tested as a fuel-substitute in coal-fired power plants (Paolo La Manita, 2002). It was found that greenhouse film is a competent substitute for coal as it maintains comparable thermal efficiency without the emission of harmful wastes into the environment (Paolo La Manita, 2002).

Alternatives to Traditional Agricultural Plastics

Biodegradable plastics are a potentially more sustainable alternative to the traditional plastics used in modern agriculture. There are numerous benefits associated with the use of biodegradable plastics as compared with polyethylene based plastics¸ such as a reduced impact on the environment. This section outlines two categories of alternative plastics including the benefits and challenges associated with these traditional polymer substitutes.

One alternative to traditional plastic is synthetic biodegradable polymer. An ideal degradable plastic polymer is one that completely deteriorates into carbon dioxide, water, minerals, and biomass, which does not negatively impact the environment or release any toxic by-products (Kyrikou & Briassoulis, 2007). There are numerous benefits associated with the use of these synthetic biodegradable plastics in agriculture. Biodegradable polymers provide all of the advantages of traditional plastics, in addition to reduced labour and environmental benefits as the plastics can be left to deteriorate in the field, and are no longer accumulating in landfills.

While the environmental benefits associated with biodegradable plastics seem obvious, there are potential complications in the degradation process. If the soil and abiotic properties are not ideal, the deterioration of the plastics may not proceed properly, resulting in contamination of the soil and pollution of the environment (Kyrikou & Briassoulis, 2007). Instead of degrading into inert and harmless particles, the plastics may leave residues that adulterate the soil (Kyrikou & Briassoulis, 2007). Products that have slow degradation rates are more likely to be toxic, and accumulate in the soil (Kyrikou & Briassoulis, 2007). Furthermore, even if the biodegradable plastics are effectively broken down, they essentially disintegrates into small pieces of plastic, which are likely to be left in the soil.

Plant starch-based plastics are another type of biodegradable polymers. This alternative to traditional plastic is a more sustainable option due to the inexpensive raw materials derived from renewable agricultural commodities. Vegetable-based plastics, however, are single-use products, which may potentially lead to increased consumption (Arévalo-Niño, Sandoval, Galan, Imam, Gordon & Greene, 1996). Although the starch-based degradable plastic may be environmentally friendly as an end product, the increased energy required in the manufacturing process results in the consumption of far more fossil fuels than are used in the production of traditional plastics (Arévalo-Niño, Sandoval, Galan, Imam, Gordon & Greene, 1996). In addition to the increased energy required to create these biodegradable plastics, there are issues concerning the agricultural practices used to produce the raw materials. It is likely that the corn used to manufacture starch-based plastics is cultivated in large monoculture operations, using herb- and pesticides that negatively impact the surrounding ecosystems (The Environment and Plastic Industry Council, 2009). Although biodegradable materials offer many environmental benefits, uncertainty remains regarding their sustainability.

The UBC farm has researched some of the companies that currently manufacture these plastic alternatives, and realized that most were located overseas (Carter, personal communication, March 11, 2009). Due to the undesirable environmental effects of the emissions related to traveling long distances would have on the environment, along with the previously mentioned barriers, not to mention its high cost, the UBC farm has yet to find an appropriate plastic alternative.

Waste Reduction and Recycling

Traditional Recycling

Recycling of used agricultural plastics may, at first, appear to be a relatively sustainable alternative to traditional waste management strategies. Plastic recycling, however, is an energy intensive process. Nearly one-third of the energy used in the manufacturing of polyethylene is invested in the processing operation (Scott, 1999). When the reprocessing energy associated with recycling plastic is added to the energy expended in transportation, cleaning of waste, and additive-use to create a serviceable product, the overall ecological benefits of recycling is frequently lost (Scott, 1999).

Agricultural plastics are often a combination of several different types of polymers, making them difficult to recycle (Scott, 1999).

Until recently, agricultural plastics from the Lower Mainland and Okanagan regions could be sent for processing and recycling in Abbotsford, BC. Polymere Group, run by Ryan Anderson, had washing and processing equipment sufficient to work with agricultural plastics (personal communication, March 30, 2009). Once processed, the plastics were sent next door to another facility for recycling (Anderson, personal communication, March 30, 2009). Unfortunately, due to the drop in the plastics market, these facilities were recently forced to close down, as the market was not large enough to support the lower grade plastics used in agriculture (Anderson, personal communication, March 30, 2009). It is less expensive for recyclers to process higher grade plastics such as water bottles and milk jugs, as they are easier to clean, are one-use-only, and have less exposure to contaminants (Anderson, personal communication, March 30, 2009). While recycling of these plastics continues, there is currently no recycling facility fully equipped to deal with agricultural plastics in the Lower Mainland.

The present condition of global recession adds a further challenge as it is not economically viable to recycle agricultural plastics when the end products cannot accommodate the labour cost. Therefore, due to the cost and astronomical energy levels related with recycling, alternative processes may be more environmentally and sustainably favourable.

Burning Incineration

Energy generation by incineration of plastics waste is a viable method for recovered waste polymers. The hydrocarbon polymers found in plastics can be used to replace fossil fuels, and thus reduce the carbon dioxide burden on the environment (Scott, 2000). The energy expenditure of plastic wastes is comparable to that of fossil fuel, and the thermal energy produced by polyethylene incineration is similar to that used in the manufacturing process, making it an efficient energy source (Scott, 2000). Additionally, hydrocarbon polymers produce only carbon dioxide and water and are consequently considered clean fuels.

One challenge to the incineration process is that agricultural plastic is usually contaminated by the soil and plant debris. Due to the fact that it is usually not economically viable for a recycling company to wash the plastic, it is rarely recycled (Garthe and Miller, 2004). A process developed in the US, however, can encapsulate the dirt and debris within and also increase the density of agricultural plastics. The plastic is heated and formed into pellets called Plastofuel, which can easily be stored, shipped, and used for fuel. Still, the burning of these pellets releases similar amounts of sulphur- and nitrogen-dioxide compounds into the atmosphere as burning coal (Garthe and Miller, 2004).

High temperature combustion of plastics is another technological innovation that may provide an alternative use for agricultural plastic waste. By heating similarly sized pellets to 1100ºC, they can be used as fuel to heat greenhouses and other agricultural buildings. This burning system, however, requires oil to initially heat up to adequate temperatures, and further testing must be completed (Garthe and Miller, 2004).

Incineration of plastic wastes also has tremendous potential for energy conversion, though it is usually done in the field with no reclaimed energy. Some types of agricultural plastic have nearly as much energy stored as straight fuel oil (Garthe and

Miller, 2004). However, burning plastics at low temperatures in open fields adds pollutants to the atmosphere which pose a risk to human health (Clarke & Fletcher, 2002; Levitan & Barros, 2003). Furthermore, the burning of pesticides poses another concern; when pesticide bags are burnt, pollutants from the residual pesticides enter the atmosphere (Lemieux, Lutes & Satoianni, 2004). Fortunately, the UBC farm does not use pesticides on its crops or on the plastic used for mulch cover.

Biological Recycling

Another alternative for plastic waste is biological recycling. This process involves the degradation of biodegradable plastics with the primary product being biomass. The resulting biomass can be used as a seed-bed for new crops (Scott, 2000). Biomass formation is beneficial for the environment as the carbon is retained, rather than being released into the environment (Scott, 2000).

Existing Recycling Infrastructure

Considerable effort has been paid to find a long-term recycling solution for the UBC farm. The current recycling infrastructure in place at UBC and the Lower Mainland is complex, and difficult to navigate. With the help of Christian Beaudrie, an Outreach Coordinator at UBC Waste Management, we were able to secure some information regarding specifics.

Through our communication with Mr. Beaudrie, it was determined that the company that provides recycling for UBC collects plastics labelled 1-7 (personal communication, March 18, 2009). From correspondence with various plastic recyclers and manufacturers, common agricultural plastic type classifications were ascertained. It was established that the UBC farm uses primarily plastics with identification numbers between 2 and 5, which are recyclable at several local facilities (Larry Munoz, personal communication, March 19, 2009). Technically these plastics could be processed at existing facilities. In reality, however, agricultural plastics are not widely accepted at recycling facilities due to a number of logistical reasons. Through communication with several recycling companies, we were able to determine the specific issues that cause facilities to turn down agricultural plastics.

The primary reason agricultural plastics are not collected for recycling is due to cleanliness. Most recycling facilities will only accept plastics if they are clean or easily sanitized (Beaudrie, personal communication, March 18, 2009). The plastic recycle facilities that accept bottles and containers for food and beverage tend to reject agricultural plastics due to hygienic reasons (Beaudrie, personal communication, March 18, 2009). This is an obvious issue with agricultural plastics, as they are contaminated due to the nature of their function. The labour and costly resources such as water and energy involved to ensure the plastics are clean prior to recycling is an expense that falls on the producer.

The expenses associated with the actual recycling process are another cause for rejection of agricultural plastics from facilities. BTR Recycling, a recycling company based in Delta, is not willing to accept any agricultural plastics from UBC farm due to the labour costs associated with processing existing plastics to make something useful. Essentially, the cost of recycling plastics exceeds the profits obtained from the sellable product (Anderson, personal communication, March 30, 2009). This trend is likely, in part, due to the global economic recession. BTR Recycling may be willing to accept the agricultural plastics once the profits of selling recycled products increase (Anderson, personal communication, March 30, 2009).

The ease of recycling is another reason some facilities may not accept agricultural plastics. Pacific Mobile Depots (PMD), a recycling company based in Victoria, BC, will accept agricultural plastics as they are considered to be mixtures of plastic types. If the plastics are in fact a conglomerate of various plastic types, it becomes difficult to recycle them into their individual parts (Clarke, 2001). Additionally, PMD is not a solution for the UBC farm, as it conflicts with the sustainable UBC food system vision of locally recycled wastes.

Wildlife Interactions

Wildlife, coyotes in particular, pose a mechanical damage risk to agricultural plastics. Coyotes are notorious for chewing the ends of drip tape, often times causing damage that prevents the plastics from being reused (Carter, personal communication, March 11, 2009). Extensive research was carried out to obtain information in regards to why coyotes chew plastics. Unfortunately, it appears at this point that no concrete research has been conducted regarding this specific topic.

Recommendations

The more plastic that is maintained in working condition, the less need there is for recycling. As recycling of plastics can be difficult, waste reduction through reuse should be implemented when possible. There are multiple plastic types, and it was a challenge to identify the specific types used by the UBC farm. Therefore, it would be beneficial to research the various plastic types in more depth to, perhaps, find more suitable types for agriculture which may increase its lifespan and provide more durability. There may also be methods of plastic management that can help maintain its functional condition, such as altering the placement of drip tape or storage methods.

Another possible management solution is to use biodegradable plastics. We were unable to identify suitable alternatives for drip tape or containers, but a biodegradable substitute may be a possibility for plastic mulch or bags. If an affordable and effective biodegradable substitute can be found, that does not leave residues in the soil, it would decrease the amount of waste produced.

For any plastics that cannot be replaced or re-used, there are methods of recycling available. Due to the current recession, it may be difficult to find a plant that will currently accept agricultural plastics, but it is recommended that there be a continued liaison between the farm and local recycling depots to identify the conditions required to make the plastic acceptable. For example, since it was mentioned by Anderson that BTR Recycling may be willing to accept the agricultural plastics once the profits of selling recycled products increase (personal communication, March 30, 2009), it is recommended that the UBC farm keeps in close contact with this company. Keeping waste plastic clean and dry will mean that recyclers are more likely to take them. It is also extremely important to separate plastics by type, as any mixing can lead to the recycled products being useless. It may also be helpful to work with the local government to find sustainable methods of plastic management.

Focus for Future Research

An important focus for future students as well as the farm could be maintaining the quality of the actual plastics already in use. A major problem is coyotes. Although we were unsuccessful with finding specific reasons as to why coyotes chew on plastics, other farmers have found that raising the drip tape about a foot or two above the ground greatly reduces the severity of the problem.(Carter, personal communication, March 11, 2009). Furthermore, burying the tape deeper, or perhaps covering it with certain mulches might cause the coyotes to ignore it. Other possibilities might be the creation of distractions to be placed around the perimeter of the farm. There may also be different types of plastic that are hardier or less attractive to coyotes. It may also be helpful for future students to further look into ways to deter coyotes from chewing the drip tape.

A beneficial task for future students would be to work with local companies and the local government to try to find solutions or methods that would make plastic management, especially recycling methods, more economical. There are possibilities of grants, as used by Jill Ackerman in her pilot project on Vancouver Island, as well as donations to make it more feasible. Those in the industry, including farmers and recycling companies, also need to be aware of the benefits to them. Otherwise, saving plastics for recycling may seem like more work than it is worth. Additionally, Polymere Group and Innovative Solutions may re-open or another facility may be able to adapt in order to continue the recycling services, should the market improve.

Conclusion

By encouraging students to add to an ever-growing body of knowledge, the UBCFSP has created and continues to create opportunities for participants to engage in truly meaningful projects that can have lasting effects. Agricultural plastics act as protection for crops and increase yields. Because they pose a problem with waste management, they are a problem on food production systems worldwide. Our group examined the most sustainable waste management options for plastics on a local scale at the UBC farm that would coincide with the vision statement. To determine potential management options for the farm's drip tape, plastic mulch, and greenhouse film, we contacted regional recycling facilities.

During this time of economic recession, it is difficult for plastics to be recycled economically, especially used agricultural types, which are difficult to be cleaned properly. Unfortunately, with the current economic crisis in full swing, most plastic recycling operations are not finding it profitable to recycle agricultural plastics. Many have had to close, and at present, there is no facility that will handle the agricultural plastic waste of the UBC Farm.

Reflection Paper

The UBCFSP has provided our group with many opportunities to learn from a variety of different sources. There were guest speakers that carried with them a wealth of knowledge in their fields. The teaching team has a unique blend of experience and backgrounds, making them the ultimate resource. Together they were able to handle any question related to the course, or otherwise, that arose throughout the semester. The UBC Farm workers were very capable with answering questions related to the functioning of the farm and what goes on there. They were very helpful with directing us around the farm and very generous for sharing their wisdom and intimate knowledge of the farm's inner workings. It was valuable experience for us to play the role of liaisons between the farm and potential recycling facilities. Of course, even within our group there was a great diversity of backgrounds with students from various programs, each passionate about something unique but complementary to our collective arrangement. All of these ‘teachers’ were able to answer our questions and alleviate much of our confusion. But their role was much greater than that. Through our interactions, our group was able to gain an appreciation for relying on the expertise of others and acceptance that, as a whole, we are better equipped to tackle problems that will arise not only in class, but in life following school.

There is a distinct difference between reading about something and actually witnessing it in real life. Our group had the opportunity to see plastic drip tape that was gnawed on and damaged by coyotes that inhabit the adjacent wooded ecosystem. Seeing this unfortunate damage allowed our group to feel sympathy for the farm workers and the coyotes whose fringe habitat puts them in direct contact with human life. We have read a lot over our years, and it is very helpful to live out what we have learned down at the farm- even if it is just for a few hours. The main themes of AGSC all relate to the livelihood of the farm. Without this experience, it would be difficult to imagine where some of our classroom learning would apply when we are living in an urban environment.

Not everyone in our group had been to the farm before, so the field work was a great way to connect with part of the UBC community that is unfortunately hidden behind condominiums. For this exposure, and because a functioning farm on campus is such a luxury, more field work should be organized around giving back to the farm; this project based around plastic management has allowed our team to accomplish this.

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