UBC Social Ecological Economic Development Studies (SEEDS) Student Report

Implementing sustainable production techniques at the UBC Farm: The UBC Farm as a living laboratory

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University of British Columbia

AGSC 450

April 10, 2009

AGSC 450, Winter 2009

UBC FOOD SYSTEM PROJECT

Scenario 3A:

Implementing sustainable production techniques at the UBC Farm: The UBC Farm as a living laboratory

Biofuels and Energy Crops

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Part I

Abstract

As part of the UBC Food System Project (UBCFS) our group helped research and establish biofuel demonstration plots at the UBC Farm for canola, a first-generation biofuel, and miscanthus, a second-generation biofuel. Our research compares and contrasts these two crops in terms of growing capabilities and processing technologies, and contextualizes this information as it relates to the UBC Farm. After analyzing the soil and climate conditions of the UBC Farm, we deduced that both crops can potentially have all of their nutritional and climate requirements met once issues regarding adequate nitrogen for canola, and sufficient drainage for miscanthus are addressed. We believe that producing, processing and utilizing canola and its end product (biodiesel) is feasible within the boundaries of the UBC campus. On the other hand, miscanthus will serve better as a tool for education and research because of the relatively expensive technology that is required to extract its ethanol. Based on these findings and conclusions, our group provided a set of general recommendations to the UBC Farm and specific recommendations for the 2010 AGSC 450 students. They concern areas of research and interviews that we didn't have the time or resources to complete. All of our recommendations support the notion that UBC has the potential to attain its goal of becoming a leader in sustainability, and can be an exemplar of a self-reliant food system.

Introduction

Our group is part of a microcosm of other AGSC 450 groups who are all working towards helping UBC achieve a more sustainable food system. The UBCFSP is founded on a collaborative network of community stakeholders and partners, and relies on community-based action research as the primary source of data collection. The purpose of our specific scenario was to discuss biofuels in the context of mitigating climate change by reducing the emissions of greenhouse gases (GHGs) associated with fossil fuels currently utilized at the UBC Farm.

Our group focused our research as per recommendations offered by Mark Bomford, Program Coordinator for the Centre for Sustainable Food Systems at the UBC Farm (see Appendix A). Bomford desired that we focus our research on both canola and miscanthus: two crops that are representative of biofuels yet very contrasting. We will examine the feasibility of producing, processing and utilizing these two crops at the UBC farm to obtain biodiesel from canola and ethanol from miscanthus. In addition, our group will discuss the hands-on work activities performed at the UBC Farm. Appropriate signage for the both the canola and miscanthus plots was also designed by our group and is presented as colourful mockups (see Appendix B). The purpose of our recommendations is to help the Farm to achieve its goal of being "carbon neutral", as per the University's 2010 Carbon Neutral pledge.

Problem Definition

Scenario 3A, which addresses the problem of GHG emissions at the on-farm production level, is one part of a multitude of AGSC 450 scenarios that are all working towards a more sustainable and secure food system on UBC campus. The AGSC 450 group scenarios address issues at the production, processing, procurement, preparation, distribution, consumption and waste management levels of the UBC Food System. The UBC Food System represents a food system microcosm, where successful strategies employed on campus not only help UBC attain it's goal of being Carbon Neutral by 2010, but also serves as "real-world" research for adaptable, and sustainable methods that can help foster a healthy and long-lived planet.

All scenarios provided for the purpose of AGSC 450 acknowledge that every meal we eat has the potential to mitigate climate change. The problem that our scenario addresses is relevant because current research has found that on-farm production of food contributes 8% of total GHG emissions in Canada (AGSC 450 Teaching team, 2009). In response to these alarming findings, the Centre for Sustainable Food Systems (CSFS) at the UBC Farm in conjunction with the 100-Mile Diet Society, have enlisted in the "Changing the Food System to Change the Climate Project". This two-year project explores how sustainable agricultural techniques can reduce the GHGs associated with on-farm production. Decreasing CO_2 emissions at the UBC Farm by substituting conventional fossil fuel use with biofuels grown and processed at the Farm would reduce its GHG output and potentially increase its carbon sequestering capabilities (AGSC 450 Teaching team, 2009).

Vision statement and Identification of Value Assumptions

The AGSC 450 Teaching team provided a "Vision Statement" for a sustainable UBC food system, which states: "the overarching goal of a sustainable food system is to protect and enhance the diversity and quality of the ecosystem and to improve social equity". As a whole, our group agrees that the seven guiding principles are reflective of a sustainable food system, but we also believe that they are unrealistic and represent a utopian society devoid of laws, policies, and regulations concerning food. We propose changes to three existing principles and suggest the addition of a new one.

We believe it is impossible to produce all foods locally, especially when ethnic foods are considered. Certain constraints such as climate and cost would make producing foreign crops more difficult and at times unfeasible. We wondered what the term "local" encompasses. Does "local" refer to a campus, municipality, city, region or province? Depending on how far the geographical boundaries of that local region extend, we believe that food providers within one region must establish relationships with external food providers to ensure a food secure region. We based this belief on the concept of a food system that is self-reliant rather than self-sufficient. “Self-reliance implies reduction of dependence on other places, but does not deny the desirability or necessity of external trade relationships” (Kloppenburg, Hendrickson, &

Stevenson, 1996, p. 38). We believe this concept of self-reliance, along with a definition of "local", should be incorporated into principle #1.

In addition, we recognized that principle #2 only advocates the recycling or composting of waste, but not the reduction or reuse of it. As children, most of us were taught the "three Rs": reduce, reuse, recycle. Our primary strategies should be to reduce and reuse, with recycling as the last resort.

We thought principle #7 was ambiguous. Some members of the group interpreted "growers" as any farmer who produces food, be it vegetables, grain, meat or milk, whereas "providers" were the food retailers. Others believed that dairy and cattle farmers were the "providers". Therefore, principle #7 could be amended to: "Fair wages are equitability distributed amongst all levels of the food system, and food providers receive fair prices and offer fair prices to consumers.

Lastly, we also recognized that these seven principles do not directly reflect the primary goal of our scenario, which is to reduce GHG emissions at the farm level. Even if food is produced locally, as principle #1 suggests it should be, it does not mean that the on-site emissions from farm equipment are any less than those from imported food. In order for our scenario to have a stronger connection to the seven principles that provide the foundation for the UBCFSP, we believe it deserves to be directly addressed as a new principle.

Part II

Methodology

Objectives

Our main task is to provide hands-on assistance with the continued implementation of "Changing the Food System to Change the Climate Project," while at the same time increasing our first-hand knowledge of the climate-change issues at hand. Our specific group objective is to discuss biofuels and energy crops, including planting practices, the importance of biofuels as alternatives to fossil fuels, and UBC’s role in establishing biofuel demonstration plots to exemplify production and use of renewable energy in agriculture.

Research Methods

We conducted our research based on a review of relevant literature, interviews, and our own accumulated knowledge as fourth year students in the Faculty of Land and Food Systems (LFS). The first aspect of our research involved collecting background information on the physiology, growing capabilities, growing requirements, and energy outputs of canola and miscanthus. In addition, we collected data on the advantages and disadvantages of using canola and miscanthus as biofuels, and their potential to mitigate climate change. This general literature review was done mainly through online research, as it provided a relatively simple and effective way to access general facts and up-to-date scientific articles and statistics. To make sure our research was relevant to climate and growing conditions at the UBC Farm, we spoke with Bomford about the UBC Farm's soil type and its suitability to planting these crops.

We conducted a great deal of our research through interviews, meetings, and informal conversations with noted experts in the field. The most valuable meeting we had was with Bomford. We also consulted Professor Art Bomke, noted Soil Scientist in the Faculty of Land, Food, and Systems, and Andrea Morgan, a student conducting directed studies on miscanthus, and caretaker of the UBC miscanthus plot. Conversations with Bomford and Andrea Morgan provided us with very useful information on the applications and practical purposes of growing canola and miscanthus at the UBC Farm. Bomford also contextualized the actual purpose and importance of the biofuel plots as a way of demonstrating the production and use of renewable energy in agriculture. As one of the program coordinators for UBC Farm, Bomford was able to provide detailed information, and clarify the purpose of the UBC’s biofuel plots; he also proved extremely accessible to our group.

As part of this project, we were required to conduct our own fieldwork as well, such as assisting in preparing the miscanthus demonstration plot. This final practical engagement provided us with a hands-on way to actually assist with the “Changing the Food System to Change the Climate Project.” At the same time, our fieldwork offered one of the most creative and reliable ways to increase our first-hand knowledge of climate-change issues and possible solutions at hand.

Variables to Consider

As part of any research study, it is important to question the credibility of research methods, data, and sources. We strove to gather data from only the most reliable sources we could find, by paying particular attention to how web pages were credited, whether or not they were university-affiliated, and the date that the website was last updated.

As for our interviews and meetings, we can trust the reliability of information on biofuels and their importance to UBC Farm, provided by Bomford and Professor Bomke, as they are both noted experts in their respective fields. However, there is the concern of information simplification; as eminent experts in their fields with vast sources of knowledge, both Bomford and Professor Bomke might have simplified their comments during interviews in an effort to make their answers more understandable to us. Another point to raise is the fact that Bomford, prior LFS student, and Professor Bomke, current LFS professor, were the only sources of expert information we pursued. This could point to a source of bias in how we conducted our study.

Our hands-on experience working on UBC Farm provided an important source of information as well. During our visit, we looked at other educational signs posted around the farm to get a better idea of how to create our own. However, certain outside environmental factors, including unexpected snow, affected our proposed fieldwork, resulting in our contribution of fewer hours to weeding canola and planting miscanthus. In addition, it is important to note that the work we conducted on the farm did not provide any tangible data. Rather, we took the opportunity to work on the plots as a way to further our holistic understanding of agricultural production of the biofuels we studied.

Findings

Canola

Canola was developed in the 1970s by Canadian plant scientists who were looking for a crop that would yield a healthy and edible oil (MCGA, 2008). Canola is used as a cooking oil, livestock feed, a rotational crop, and more recently as a biofuel. It is the most important oilseed crop of the world; its production has grown much faster than any other source of edible vegetable oil (Shahidi, 1990). It is a member of the genus Brassica, and as a member of the *crucifer* family, it can easily be identified by the four yellow flower petals that form the shape of a cross (MCGA, 2008). The yellow flower produces seed pods that are five centimeters in length and each pod contains 20 to 30 round seeds which can be crushed to extract canola oil. The canola plant can grow from one to two meters in height (MCGA, 2008). It is a cool-season crop and is mostly produced in Alberta, Saskatchewan, Manitoba, and British Columbia (Shahidi, 2008). It takes 3.5 months for the seed to germinate from the time of planting depending on moisture, fertility, and temperature (MCGA, 2008).

Ideally, canola should be grown on fertile, well-drained soils that have minimal weeds (Shahidi, 1990). Canola should not be grown in fields that have a high residue of herbicides, especially those which canola is susceptible to (e.g. triazine, imadazolinones). Furthermore, a high density of weed species or planting with another *Brassica* crop is not recommended, as this may deplete the soil of nutrients. Wet soil should also be avoided, since canola cannot survive in saturated soil conditions for long periods of time (Shahidi, 1990).

Minimum temperature for growth of canola is about 0°C. The crop will germinate at a soil temperatures of about 5°C but its optimum soil temperature is around 10°C.The crop is tolerant to saline conditions and a soil pH as low as 5.5. Canola requires approximately 16 to 18 inches of water through its growing season (Oplinger, Hardman, Gritton, Doll, & Kelling,1989).

Canola can be developed for both spring and winter annuals. For spring canola, early seeding is necessary to reduce damage from flea beetles and improve seed yields (Shahidi, 1990). Winter canola is usually seeded six weeks before the first anticipated hard frost. The seedlings then go dormant in winter and new leaf tissue is generated in early spring (Weber, Myers, & Minor, 1993). Production of canola requires sufficient quantities of nitrogen, phosphorous, potassium, and sulfur to supply essential plant nutrients (Shahidi, 1990). It requires 100-200 kg of nitrogen/hectare, and 10-20 kg of sulfur/hectare (Hoveland, Odom, Haaland, & Alison, 1981).

Canola is the primary source of biodiesel, which is the fastest growing alternative fuel in Europe. In Canada, biodiesel remains in the early stages of market development. It is produced using a mechanism called trans-esterification. After the oil is extracted from the canola seed, the triglycerides are reacted with an alcohol in the presence of an alkaline catalyst. One of the products of this reaction is methyl ester, otherwise known as biodiesel (Energy System Research Unit, n.d.)

Biodiesel can be used as a substitute for conventional diesel or as an additive. In both pure and blended forms, biodiesel has been shown to reduce the emissions of air toxins such as carbon dioxide, particulate matter, carbon monoxide, black smoke from vehicles as well as hydrocarbons. When comparing regular diesel with pure biodiesel, pure biodiesel produces a 73% decrease in the lifecycle of CO_2, a 51% reduction in methane emissions, a 67% decrease in unburned hydrocarbons, a 48% decrease in carbon monoxide, a 47% reduction in particulate matter and a 100% reduction in sulfur oxide emissions. Its low level of iodine also contributes to less residual engine deposits (Western Economic Diversification Canada, 2004).

Miscanthus

Miscanthus x giganteus is a sterile hybrid of *M. sinensis* and *M. sacchariflorus*, and is commonly known as "giant Chinese silver grass" (Living Countryside, 2009). It is one of the most productive grasses known as it has the ability to tolerate cool temperatures and maintain photosynthetic activity even in the colder months of October (Yates, 2008). It is a perennial plant which can grow more than 3.5 meters in height and its dry weight can reach 25 tonnes/hectare in one growing season. In addition, it is a GHG-neutral crop because of its good carbon sequestrating properties. The amount of carbon dioxide absorbed by the plant during growth is the same as the amount released when used as a biofuel (Living Countryside, 2009). This is important in respect to the farm's goal of becoming "carbon neutral", as per the University's 2010 Carbon Neutral pledge.

The growth and development of miscanthus are influenced greatly by climate. Miscanthus crops have optimum growth in areas with mild temperatures and high water activity. Miscanthus grass originates from the tropical and subtropical parts of southeastern Asia, where they have suitable climates for growth: warm temperatures and heavy rainfalls that are well distributed. Ambient temperatures also regulate the length of the growing season (Christian & Haase, 2001).

Miscanthus is capable of tolerating a wide range of soil types. The most favourable soil for the crop is medium soils like sandy or silty loam. It should have good air movement, with high water-holding capacity and organic matter content (Christian & Haase, 2001). However, Miscanthus has also shown reasonable yield on a wide range of soils, from sands to high organic matter soils (Department for Environment Food and Rural Affairs [DEFRA], 2007). The soil pH should be maintained around pH 5.5 to 7.5 (DEFRA, 2007) and nutrients such as nitrogen and phosphorus are required but only in low levels (Lewandowski, Scurlock, Lindvall, & Christou, 2003). Fertilizers can be applied to miscanthus plots but are usually for soils with a low nutrient content (Lewandowski et al., 2003). The maximum amount of nitrogen and phosphorus fertilizer application is up to 50-70 kg/hectare/year and 5-17 kg/hectare, respectively (Lewandowski et al., 2003).

Miscanthus species use a C4 photosynthetic pathway. C4 plants are more efficient in their light, water and nitrogen usage than C3 plants, such as canola. The numbers C4 and C3 indicate the number of carbon atoms in the molecule used in photosynthesis (Yates, 2008). C4 plants are the most efficient in converting sunlight energy to biomass energy (Heaton et al., 2004). They have four extra steps in their metabolic pathways and have four extra proteins than C3 plants, which are more concentrated in miscanthus grown in cooler temperatures; therefore, these extra proteins are thought to be related to tolerance of low temperatures (Yates, 2008).

Miscanthus' rapid growth and highly favourable energy balance of low input and high yield characteristics have led to its popularity as a potential biofuel in Europe since the 1980's (Heaton et al., 2004). Unlike canola, miscanthus yields ethanol, not biodiesel. It is considered to be a more efficient biofuel than other plants because it generates 2.5 more ethanol than corn does (Hay & Forage Grower, 2008). One disadvantage is that the cellulosic ethanol technology that is required to extract the ethanol from miscanthus is still expensive and not yet available at an industrial level. This process pre-treats the miscanthus with a dilute acid to remove hemicellulose and lignin components, thereby exposing the biomass to enzymes and releasing sugars that can then be fermented into ethanol (Lawford & Rousseau, 2003).

UBC Farm Climate and Soil

When looking at the feasibility of growing canola and miscanthus on the UBC Farm, we must look at climate and soil characteristics as a means of determining if the crops are suited for the chosen environment. The soil at the UBC Farm is a Duric Humo-Ferric Podzol which is a type of Bose soil. It has a course texture with gravelly and residual stony deposits that occur 30cm to 160cm deep (Bomke, personal communication, March 2009). The soil has good to excessive drainage. Because of this, poor water holding capacity and nutrient retention can occur and subsequently lead to poor crop yields in plants that cannot adjust. Because the soil is a type of Podzol, it is acidic in nature and can cause nitrogen leaching (Lundstrom et al, 2000). Due to management interventions such as liming practices, compost application and cover cropping, the pH is approximately 6.5 with nitrogen availability continually increasing. In some areas of the Farm however, the pH is as low as 5.5. The UBC Farm experiences a typical west coast climate with warm rainy winters and relatively cool dry summers.

Discussion

Based on the soil and climate conditions of the UBC Farm, both canola and miscanthus will have all of their nutritional and climate requirements met. One problem that canola may face being grown at the Farm is its ability to acquire nitrogen. While available nitrogen levels are continuing to increase at the Farm through compost and winter cover cropping practices, the levels are still yet to be at optimal. Nitrogen deficiency in canola limits chlorophyll development and older leaves turn light green or yellow, wither, and fall off (Berlund, McKay, Knodel, 2007). This ultimately leads to a decreased flowering period and decreased seed production. This is the cardinal sign and if observed, management applications within the organic farming regulations such as manure, fish meal or blood bone meal applications should be performed.

One problem miscanthus may face being cultivated at the Farm is the soils ability to hold water. Because this crop requires large amounts of water and the soil at the UBC Farm drains water very well, it may not receive its water requirements from the soil and a type of irrigation system such as overhead or drip will likely be needed to meet the plants requirements (Ontario Ministry of Agriculture, Food and Rural Affairs [OMAFRA], 2007). However, where the crop is planted at the bottom of the hill at the Farm, there are some water drainage issues and thus the soil has an increased water holding capacity. This will aid in the plants growth and hopefully decrease the amount of irrigation required.

In the context of the UBC Farm, not only do the canola and miscanthus plots serve as educational demonstration sites for the production of biofuels, but they also work towards the Farm's ability to become carbon-neutral. Because the trans-esterification of canola is a relatively easy and inexpensive process, the UBC Farm could potentially produce its own biodiesel to run its farming equipment. Ultimately the Farm cannot produce enough biodiesel to sustain all of its fuel requirements; however, it is a step in the positive direction towards carbon neutrality.

Production of cellulosic ethanol biofuel from miscanthus unfortunately cannot be done on the Farm. The process requires considerable inputs and is very costly to perform. The Farm can still potentially utilize the miscanthus as a fuel for heating their buildings using a process called pyrolysis: a process that combusts biomass into fuel. This method still requires more development and research (Wikipedia, 2009c), but it is known to be more efficient than combusting wood for the same purposes because its "weed like characteristics" allow it to grow back fairly rapidly (Bomford, personal communication, March 2009).

In a global context, the first-generation of biofuels was hailed as the coming of cleaner, and greener energy; however, utilizing seeds and grains like canola for fuel diverts land away from producing food for animals and humans. This subsequently raises food prices and demand, thereby creating a more insecure food system. A 2007 study reported that biofuels from grains and oilseeds had already driven up food prices by $14 billion over the last year (Tokgoz, Elobeid, Fabiosa, Hayes, Babcock, & Yu, 2007). Some perceive the first-generation of biofuels as a failure (Bomford, personal communication, March 9, 2009).

Utilizing second-generation biofuels appears to be more promising. It does not rely on food crops for energy production, but rather on waste that would have otherwise been a disposal problem, such as stalks of wheat, corn or wood. In the case of miscanthus, it utilizes a hardy high-yield crop that provides a greater energy return in comparison to first-generation biofuels (Bomford, personal communication, March 9, 2009; Wikipedia, 2009b). However, as previously stated, it still needs more research and development.

Recommendations

Our recommendations to the UBC Farm stem from our findings extracted from our meeting with Bomford, our field work, our collection of biofuel research and our accumulated knowledge as AGSC 450 students. The following recommendations reflect our opinions on how biofuel technology can benefit the UBC Farm, the UBC food system and the neighboring community. These recommendations will help the Faculty of Land and Food Systems reach the UBCFSP goal for UBC to become a leader in sustainability and an exemplar of a self-reliant food system.

The first part of our recommendations outlines five general recommendations for the UBC Farm. The second part is specific recommendations for the 2010 AGSC 450 students; their purpose is to fulfill the five previously stated recommendations for the Farm.

Part 1: General recommendations for the UBC Farm

- Continue to establish biofuel demonstration plots for both canola and miscanthus
- Pursue a system for producing, processing and utilizing canola within the boundaries of the UBC campus.
- Establish relationships with:
    - The Department of Chemical and Biological Engineering for the purpose of the trans-esterification of canola
    - The Dean of Forestry for the purpose of taking advantage of his knowledge on cellulosic ethanol technology
- Create connections with various UBC courses that could use the demonstration plots as tools for education or research.
- Incorporate biofuel education into the UBC Farm field trips that are offered for elementary and secondary school classes.

Part 2: Specific Recommendations for 2010 AGSC 450 students

Research based

- The University of Illinois is at the forefront of farm biofuel production and is exploring how high quality plant biomass can be produced and utilized. We recommend next year's group contact the University of Illinois to find out their applications, methods and techniques used to establish a successful bioenergy crop, specifically miscanthus.
- Prepare a cost analysis on the feasibility of using the Farm's canola as a biofuel. Then, search and apply for funding to support the bioenergy crop production and processing at the Farm. With canola production at the UBC Farm being so small scale, it currently costs more to grow a tank of diesel then to purchase one, which is not economically feasible. Funding will be necessary for this project to be completed. Capital will also be needed to purchase start-up equipment such as a canola press.

Key informants to meet with and interview

- We would like to emphasize that all members of the future AGSC 450 group assigned to this scenario should attend scheduled meetings with Bomford, Art Bomke and if possible, Andrea Morgan before beginning their research. All were key informants to our group's understanding and development of this project.
- Meet with the Chemical and Biological Engineering Department, which has a pilot plant for the trans-esterification of canola. Find out the feasibility of the Farm's canola being processed on campus.
- Jack Saddler, Dean of the Faculty of Forestry, is undergoing research in bioenergy, specifically, the bioconversion of lignocellulosic residues to ethanol. We propose the next group meet with him and create a summary of his research

Future hands-on work

- Some of the group members could be facilitators for one of the Farm's field trips; it could include a short and informative presentation suitable for children on how biofuels contribute to the global health of our planet.

Conclusion

Canola and miscanthus are two crops that are representative of the expanding biofuel industry but are very contrasting. Whereas canola is classified as a controversial first-generation biofuel that produces biodiesel on an industrial scale, miscanthus is a second-generation biofuel that produces ethanol using relatively expensive technology. Both strive to reduce emissions of GHGs, but miscanthus seems to be more promising because of its superior energy efficiency and because it utilizes non-food crops and therefore is more publicly and politically accepted.

The primary goal of our project was to understand how canola and miscanthus could be best utilized on a small-scale at the UBC Farm. Within the context of the UBCFSP, establishing a canola plot at the UBC Farm has the potential to mitigate climate change by reducing GHG emissions of farming equipment. If financial resources are available and a successful partnership is established with the Faculty of Biological and Chemical Engineering, it will be possible to create a self-sustaining alternative energy system within the boundaries of the UBC campus to fuel the UBC Farm equipment. We perceive the canola plot to be a locally minded initiative that will create a more self-reliant, sustainable food system on the UBC campus. Establishing a miscanthus plot, on the other hand, is a more globally minded initiative that will provide education and research opportunities beyond the UBC campus. At this point it is unrealistic to think of utilizing it as a biofuel at the UBC Farm, but the potential for pyrolysis should be explored, as should the University of Illinois biofuel endeavors.

Part III: Field Work

Meeting with Bomford

The first time we spoke with Bomford was when he attended the breakout session during one of our AGSC 450 classes early in the semester. Some of the main topics he proposed that our group focus on included: 1) How can canola and miscanthus best be used at the UBC Farm? 2) Is there an alternative supplier of miscanthus who could supply it earllier in the season than Blue Stem nursery? 3) Can we formulate well-researched suggestions on how to improve the canola crop at the UBC Farm?

Our first group meeting at the Farm was scheduled for the early morning of March 9th, which turned out to be a morning very white with snow. Despite these less than friendly farming conditions everyone from our group still showed up ready to work. As we soon came to realize that these conditions were not conducive to trimming the canola or prepping the miscanthus plot as per our initial agenda, we ended up meeting with Bomford for what turned out to to be an invaluable group discussion and integral part in the development of this paper. Our original intention was to gain a greater understanding of the purpose of our research, and to make sure our objectives and goals for this project aligned with Bomford's desired outcome. We left the Farm that day with a lot more information and understanding than we had anticipated. We couldn't put enough stress enough on how important it was that we all ended up attending that meeting. We had originally intended for only 2-3 of our group members to speak with Bomford. It was a blessing in disguise that the weather that day was not conducive to hands-on work.

Overall, we gained knowledge about the goals, limitations and barriers to growing, processing and utilizing canola and Miscanthus at the UBC Farm. We learned about key players in the UBC community that would help fulfill the goals of the biofuel demonstration plots (see Recommendations for more information). Bomford also communicated the Farm's need for demonstration plot signs: a task that became an important part of our field work and something tangible we could offer the UBC Farm (see Appendix B). We also realized that there had been lack of communication since our first meeting with Bomford. Without us knowing, another supplier for Miscanthus had already been found: Kato's Nursery Ltd. in Abbotsford, BC. Had we set the task of finding an alternate supplier as one of our priorities, it could have taken away valuable time from our project.

Hands-on farm work

A few weeks after the meeting with Bomford, and after much rescheduling, six of our eight group members met at the Farm. It was a beautiful sunny afternoon and we were much more eager to get our hands dirty. Our efforts were directed solely to the miscanthus plot; we unfortunately did not have an opportunity to work directly with the canola crop.

Specific tasks included aligning and digging a portion of the perimeter of the miscanthus plot, removing large rocks from the soil, and taking biological waste material and delivering it to the compost up the hill - and might we add that the wheelbarrows were very heavy! Some of our group members picked up shovels, engaged their muscles and dug a grid one foot wide by one foot deep while the rest of us stretched our legs and got our hands dirty by picking up rocks. One glitch along the way worth noting took place during the aligning of the plot as we veered off track a few times creating a less than perfect grid for our miscanthus. Lastly, to our disappointment we were not able to plant the miscanthus like originally hoped as the ground was too wet from the incessant rain in the days previous. After 2 hours of fieldwork on the Farm, it was agreed by everyone that our contribution, yet small, was a very rewarding and enjoyable experience.

Sign workshop

After speaking with Bomford and working hands-on at the UBC Farm, three members of our group met to discuss and create a template for the signage of the canola and *Miscanthus* demonstration plots. Two of the three group members attending the sign workshop had not participated in hands-on work at the Farm due to scheduling conflicts, whereas the third group member had; she was able to provide insight regarding the physical aspects of the plots, as well as creative suggestions based on the other signs she saw at the Farm. Throughout the entire creative process for designing the sign mock-up templates, the sign workshop members strived to make the sign relatable, easy to understand and interactive in order to appeal to the large variety of individuals who frequent the UBC Farm.

During the sign workshop it was decided that a general sign template would be created. This general template would be used for both the canola and miscanthus signs, and would be included in the final report as potential sign mock-ups that the UBC Farm could easily implement and adapt to suit their preferences. It was decided that each sign should be comprised of the following elements: Common name, latin name, general growth properties, current uses, goals for usage in the future, and according to each goal a definition of the terminology used. In addition, to make the signs interactive and relatable to the public visiting the Farm, a "Did You Know?" thought bubble was envisioned as an accompaniment to the main sign (see Appendix B).

Part IV: Group Reflections

Working on this AGSC 450 capstone project truly drove home the idea of being flexible when working with a real community. Flexibility was crucial in all of our community-based-research projects throughout the entire Land, Food, and Community series.

Throughout our time working on our project we had to take into consideration all sorts of variables: schedules of the collaborative partners, differing views of our partners, plant/seed procurement, planting times, and weather. These variables usually don’t play such a huge factor in other schoolwork. In other classes outside the Faculty of Land and Food Systems, we have worked on group projects but rarely in the context of community based research. We tend to find that individuals from other faculties are not accustomed to working on practical projects that are not as structured and don’t have theory as their primary focus. They have difficulty putting theory into a practical, community-based context. We feel these projects are a more accurate reflection of “real-life” than traditional academic projects we find in other faculties across campus; they demand collaboration, flexibility and creativity.

We appreciate being a part of a community-of-learners that work together to approach issues of sustainability with an interdisciplinary approach that understands the complexity of the inter-relations among all sectors of a system, particularly the food system. Frankly, we think this is one of the most valuable lessons taken from the AGSC series that will aid us in the future, when we work in the real community of Vancouver or beyond to deal with real-world issues. It is also rewarding to be part of an ongoing 8-year project. We felt satisfied and relieved knowing that everything we didn't have the time or resources to address in this year's work would be considered by next year's students as per our recommendations.

Another theme that was brought up was the value of the UBC Farm to UBC and its students. As a centre of research, it gives students the opportunity to experience hands-on work. Some of our group members had never worked on the Farm or even been to the Farm. Through their work they realized the value of the Farm, and the immense amount of time, energy and resources that has been invested in using it for food production, education and research. We particularly recognized the amount of teamwork and coordination that's necessary to keep the UBC Farm not only up and running, but actually expanding in what it offers both the UBC community and the community at large. With the amount of scheduling conflicts we had, we couldn't imagine how difficult it must be for Mark Bomford, program coordinator of the Farm, to create a system of coordinating volunteers, employees, researchers, students, visitors and field trips. When we visited the Farm we met such a diverse array of individuals and groups working on a multitude of projects. This must take an inordinate amount of organization, but they all collaborate and coincide to make up one of the most fascinating places of research on campus; a beautiful getaway that truly fosters community, one of the core values of our Faculty.

We really valued the hands-on component of our project. Visiting the Farm and talking with Bomford was so vital to our learning experience! We were excited to be part of his recommendation to create sign templates for the biofuel demonstration plots. We feel Mark is someone who truly realizes the value of hands-on learning. We loved that he wanted the signs we created to answer questions such as, "how much land is needed to fuel our car or feed out family?" He hoped that through such visual conceptualizations, students and other community members could better understand the headlines in the newspapers and the issues surrounding biofuels, land, food, and sustainability.

One roadblock that we encountered several times when we told others about our research was public resistance. Many people outright disagreed with the concept of biofuels for reasons associated with both ethics and sustainability. The large scale issues of efficiency, use of land, and use of food conjoined to bring a lot of criticism to our project when speaking with members of the faculty and even project leaders. However, there wasn't as much resistance to using the biofuels as research demonstration plots; for the mot part, they were strongly encouraged and supported by all stakeholders and community members in the context of the UBC Farm.

Within our own group, it was both an advantage and disadvantage that we all had the same perspective on biofuels, which was that we don't support them as monoculture crops produced on an industrial scale, but that we support them as education and research tools (especially the second generation!). We were also open to the idea of small-scale production of biodiesel from canola within the UBC campus boundaries. The fact that we all had the same perspective probably saved us time in deciding what direction we wanted to take this project, but it may have caused us to be too one-sided in our approach.

Overall, we feel proud and privileged to have taken part in an 8-year project that is working towards creating a campus that is truly sustainable and self-reliant. We hope our work this term has contributed to creating a campus that can be an example and model for other across universities across North America to follow.

Appendix A: Meeting minutes with Bomford

March 9, 2009

Big picture context

- Failure of first-generation of biofuels (corn/canola, biodiesel, ethanol)
  - Fossil fuel calories (negative energy balance; investing more energy than what is being generated)
- Potential of second-generation (miscanthus, cellulosic ethanol technology)
  - Carbon neutral (taking carbon out of the atmosphere and then re-releasing it)
- Potential concerns
  - Raise in food prices
  - Should arable, fertile land be used to grow biofuels instead of food?
  - Genetically modified
  - However, UBC Farm does not expect any significant resistance to using biofuel demonstration plots as a means for education and research

Background Information

Mark wants general background research on canola and miscanthus

- Include our previous background research (C4 vs C3)
- Both a source of biofuels but are very contrasting
- Canola (annual) and miscanthus (perennial)
- Miscanthus is quick-growing (weed-like) and has larger biomass than canola, grows to be 3 m high
- Miscanthus is not a heavy nitrogen feeder like corn

Background on UBC Farm

- Soil type
  - "sandy lome"; well drained sandy soil, area where the miscanthus will be planted has been sheet mulched
- climate

Application at the UBC Farm

- Main purposes of canola and miscanthus: education and research
- Not growing it to heat a building, run a tractor, etc; however, it is feasible that the Farm could extract ethanol from their canola to use as an energy source on the Farm

Canola

  - Biodiesel from canola could be a worthwhile endeavor
    - 2006 and 2007 crops on the farm were not successful; not well cared for; organization that established the plots walked away
    - Case study (successful): Scandanavia; have a similar climate to Vancouver
  - Canola oil press could be feasible for the farm to attain
  - Transforming the oil into biodiesel requires the grain in fermented and then distilled
  - Chemical and biological engineering department has a pilot plant for trans-esterification of canola

Miscanthus x gigantus

- Current supplier: Katos, Abbotsford
- Uses: compost, mulch, bedding for chickens, wind barrier (hedgerow)
- Previous production at farm was unsuccessful
  - We need to find out what should be done next time around: fertilizers? Nitrogen fixers?
    - Consider University of Illinois: http://news.illinois.edu/news/07/0201bp.html
    - Also consider Western Europe (DenMark, Germany, Britain)
- Not practical to use it as a biofuel on the farm; cellulosic biofuel technology only available on an industrial scale and the farm's equipment runs off of diesel anyway
- Best potential use: Pyrolysis (chemical decomposition of a condensed substance)
  - Would create a stabilized form of carbon instead of releasing it back into the atmosphere
- Good person to talk to: Dean of Forestry (he has extensively researched cellulosic ethanol production)
- University of Illinois: http://news.illinois.edu/news/07/0201bp.html

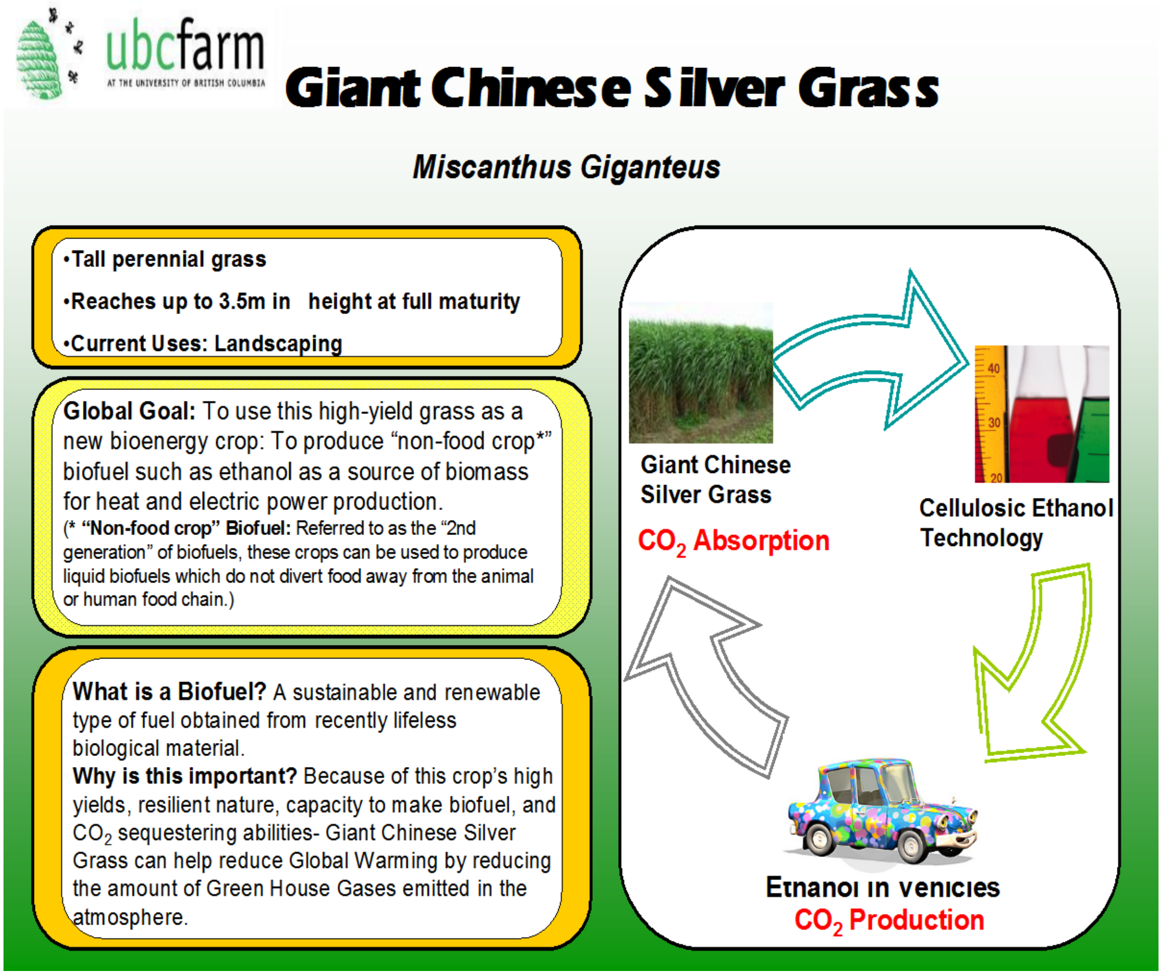
Barriers/Limitations:

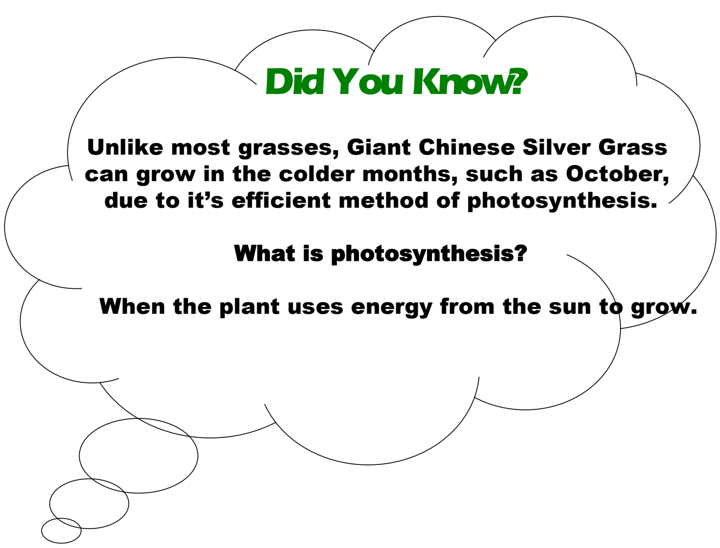
- Finances
  - Biofuels at the UBC Farm will not create a profit; at such small-scale production, it would cost the farm more to grow a tank of diesel than to buy it

Signage for biofuel demonstration plots

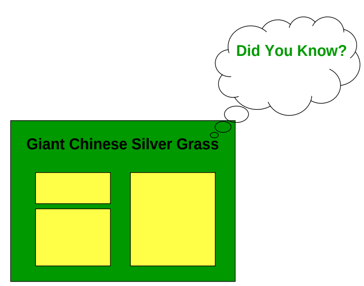
- Condense our information into meaningful, attention-grabbing information that can be posted on a sign in front of the demonstration plot
  - Idea for sign: "This 500 square foot plot of canola could fuel…"
    - Mark feels it would not be too difficult to get the biofuel demonstration plots subsidized

Appendix B: Sign templates for the UBC Farm





Layout of Sign



Canola

Brassica napus

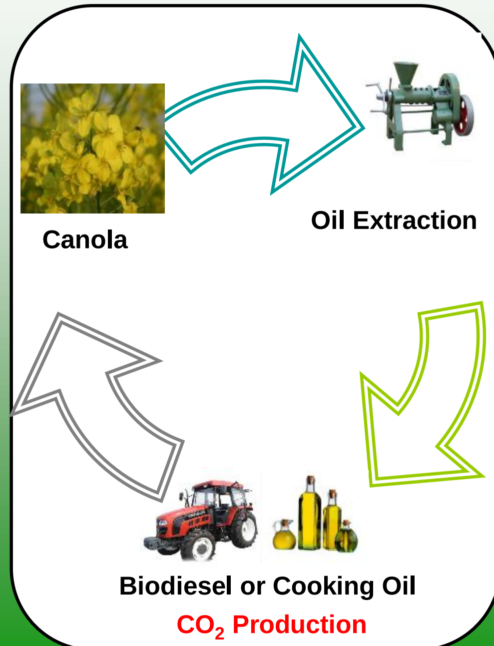
- Grows in Spring & Fall
- Current Uses:
  - Biodiesel
  - Cooking Oil
  - Livestock Feed
  - Improving Soil Erosion

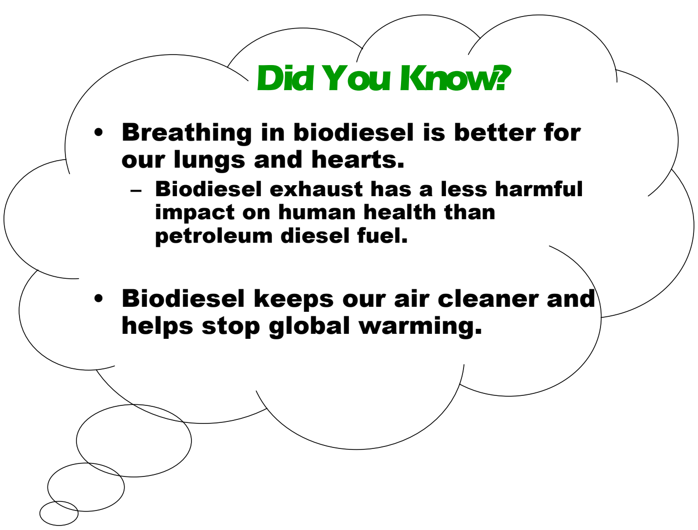
What is Biodiesel?

A clean burning alternative fuel produced from domestic renewable resources

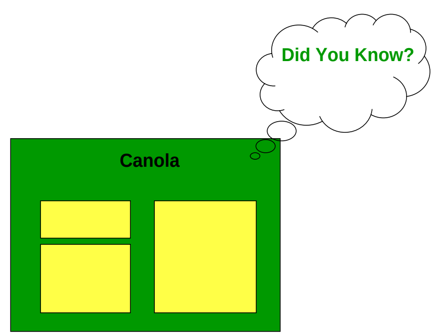
Current Uses of Biodiesel

- Fuel for diesel engine vehicles
- A heating fuel in domestic and commercial boilers





Layout of Sign



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