# The University of British Columbia Food System Report (UBCFSP)

**Scenario 3A: "On-farm Wood Stands"**

**Implementing Sustainable production techniques and landscape management at the UBC Farm: A Hands-on Approach**

**Agsc 450**
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**Abstract**

The UBC Food Systems project is an integrated approach to studying the implications, and understanding the connections between what we eat, our community, and the environment. A hands-on component was crucial to developing the context for our research and to recognizing the role of forested lands in agricultural systems. They provide an alternative to traditional field cropping, while maintaining the carbon capacity of the soil and future timber. The UBC Farm, including its forested areas, are representative of the potential production and environmental services that well managed agroforestry systems can provide. The purpose of this project was to research the on farm wood stands located on the UBC Farm, with regards to increasing food production and mitigating environmental degradation caused by green house gas emissions. Through this project a short, midrange and long term land use strategy was outlined for the wood stands, which can be further expanded upon in the future. Non-timber forest products, such as oyster mushrooms, were explored as an option for increasing food sovereignty within the UBC Food System.

## Introduction

It is apparent that the global carbon cycle is undergoing changes due to an imbalance between carbon sequestered in natural bodies and carbon released through human activities (IPPC, 2001). The current food system which relies heavily on transporting food goods far distances, thus adding to carbon emissions, is in many ways environmentally unsustainable.

Simply maintaining atmospheric CO2 concentrations at current levels is a daunting task that requires a thorough examination and fundamental reworking of our current production systems. The University of British Columbia Food System Project

(UBCFSP) is one such attempt. Globally, the disturbance brought about through land use change is the most significant source of carbon emissions (Bellarby et al, 2008).

Human survival is intimately tied to agriculture and thus the disturbances associated with crop production. To counteract the disruptive nature of cultivation we must ask ourselves how can a variety of landscape elements be incorporated in such a way as to reduce or eliminate the carbon emissions associated with on-farm activities? The close proximity of the UBC Farm to the University of British Columbia presents a perfect oppertunity to explore the implications of a an integrated agricultural and forested ecosystem for the environment and food system.

The UBC Farm has been under intense pressure from the UBC administration to replace the 24 hectare farm with housing development. This has led to disputes over what is considered to be part of the farm. The University had taken the stance that only those areas (6 ha or so) of land which were under intensive cultivation were truly part of the farm and important for future planning. The remaining forested areas were not considered to contribute significantly to the farm system for food production or other means. The purpose of our project was to articulate the role of the wood stands located on the UBC farm in a manner that serves to further develop the connections between food production and landscape design management. Our project centered on researching sustainable landscape management techniques, particularly with regards to incorporating the wood stands into areas of both food production and carbon sequestration.

## Problem Definition

Carbon emissions could be reduced by decreasing the burning of fossil fuels, or by accumulating carbon in vegetation and in stabilized terrestrial ecosystems. Agriculture accounts for 8% of total GHG emissions, which is part of the evaluation used to determine UBC's efforts at becoming carbon neutral (Environment Canada, 2007; EPA, 2007). The implementation of Agroforestry practices represents an opportunity to lower the total GHG emissions from food production at the UBC Farm.

Studies found that converting forests into different types of agroforestry results in a decreased carbon release, when compared to converting forests to croplands (Sanchez, 2000). Agroforestry is a sustainable alternative to conventional agriculture because it has the potential to help restore degraded soils (Dixon, 1995). Research shows that if agroforestry is integrated after slashing and burning, 35% of the original forest carbon stock can be regained (Maren et al., 2004). Agroforesty also has the potential to increase the amount of carbon stored within the soil in forested ecosystems.

By increasing organic inputs from crop residues and tree litter, the amount of soil organic matter persisting within the soil may be increased (Young, 1997). Soil organic carbon (SOC) represents the largest reservoir of carbon, and its carbon sink capacity is much higher than vegetative carbon store capacity (Oelbermann, 2004). Higher levels of soil organic matter (SOM) are proven to improve crop yield and stabilize soil carbon sink capacity. (Oelbermann, 2004)

Canada has great potential to reduce atmospheric CO2 from the agricultural practices by increasing and protecting SOM (Oelbermann, 2004). Growing trees and agricultural crops on the same land could help to conserve soil and improve crop productivity (Bene et al., 1977). As a result, the implementation of an agroforestry system can increase food production, while at the same time decreases the 8% total GHG emission from agriculture. The purpose of this project is to research the wood stands located on the UBC farm, and then to investigate connections between food production and long term wood stand management at UBC.

## Vision Statement and Identification of Value Assumptions

**Vision Statement for a Sustainable UBC Food System**

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, whereby:

**1.** Food is locally grown, produced and processed.

**2.** Waste must be recycled or composted locally

**3.** Food is ethnically diverse, affordable, safe and nutritious

**4.** Providers and educators promote awareness among consumers about cultivation, processing, ingredients and nutrition

**5.** Food brings people together and enhances community

**6.** Is produced by socially, ecologically conscious producers

**7.** Providers and growers pay and receive fair prices

The Vision Statement for a Sustainable UBC Food System provides 7 goals to build, protect, and maintain a sustainable food system. These goals were established through taking into consideration environmental and social equities. We are a diverse group of Agroecology, FNH, and GRS students with varying paradigms; from weak anthropocentric to ecologically responsible food citizens, we were able to provide critical reflections of the Vision Statement.

The intentions of the goals are good in nature, however, as a whole, we felt that the 7 goals were highly unattainable and far too idealistic. They are also human-centered and human-driven, and are taken from the perspective of the consumer and producer, while environmental implications remained vague. There is no indication of intent to conserve soil or the environment through practices other than recycling and composting. However, based on our value assumptions, it is understandable that in the context of the farm the decisions will stem from ecological humanism because cultivation is a human activity, and thus our values will inevitable be inclined towards making decisions with human needs at the forefront. Therefore, an anthropocentric view will be the most regarded.

The first goal states that food in all aspects should be locally available to consumers. This statement essentially implies that locality is the only issue, but what is not being taken into consideration are the reverberations and impacts that are included in “locality”. The goal of producing ethnically diverse food can negate the vision for ecological sustainability, because often culturally defined foods are specific to their immediate climatic parameters. Therefore, culturally appropriate foods can usurp the concentration on local production.

Nevertheless, ecological sustainable food should stem from all levels including consumers, producers, waste management, and transporters, and not just from the base level of production, as implied in goals 4 and 6. However, we do agree with goal 4, in that education should be central in creating social equity, and it is vital in moving towards a sustainable food system. In addition, we feel that the anthropocentric view supports a privileged perspective and thus fails to consider the terminology and true meaning of social equity, food sovereignty, and local food system. The goals do not consider the realistic elements that would play a vital role in achieving a sustainable system, most notably the socio-economic aspects.

## Methodology

Our group's assignment was to thin a section of the UBC Farm’s wood stands and to discover practical uses for the harvested timber and remaining stands. In addition, one of the goals of our research was to discover ways of increasing carbon sequestering within the UBC campus.

As half of our group is from the Nutritional Sciences Majors who had very little knowledge about agroforestry, we began our research by having those that had some knowledge about agroforestry and agroecology explaining the basic ideas behind the importance of thinning a wood stand. After we were certain that every member of the group had an understanding of the task at hand and the importance of wood stand thinning, we were able to divide our tasks and perform more specific research into our given topics. Some of our research included reasons for thinning wood stands, byproducts of logs, marketable crops that can be grown on the wood stands as well as sustainable practices for thinning wood stands.

A major component of our investigation involved collaborating with Tim Carter and Mark Bomford from the UBC farm. This collaboration was critical to our understanding of the role of the chosen wood stand and the management requirements for increasing its productivity at the UBC Farm. Communicating with Tim and Mark gave us a better understanding of what our work would mean for the farm. Dr. Worral shed some light on the thinning process and helped focus our research findings.

The findings and discussion detailed in this report are the result of personal communications with UBC Farm staff, forestry expert, and review of relevant literature.

## Findings and Discussion

The wood stand itself is a long term fiber crop, but given that the land is not secured by tenure we must find innovative ways to incorporate the wood stand into the short and medium term future of the farm. Short term goals can focus on agroforestry crop production, while a medium term goal would be to increase the amount of soil organic matter by increasing leaf litter and root mass within the stand by means of understory development.

### *Long Term – Wood Carbon Sequestration*

The UBC Farm wood stand has the benefit of increasing the sustainability of the operation by acting as a carbon sink. Trees uptake carbon dioxide from the atmosphere through respiration and use it to create energy. This contributes to the sustainability of the UBC food system by potentially offsetting the carbon dioxide emitted from various sources at UBC.

Carbon in a natural ecosystem is stored in soil, litter and the biomass of the tree. It is also stored in Forest Product Stock (FPS), which accounts for post harvest materials and their subsequent carbon losses by use, decomposition, burning, and oxidization. Carbon sequestration refers to the accumulation of carbon in plant biomass through afforestation, reforestation and restoration of degraded lands, through the use of silvicultural techniques to enhance growth rates and through the implementation of agroforestry practices on agricultural land (Montagnini & Nair, 2004). The latter two are of interest to the UBC farm wood stand scenario. Tree thinning, a silvicultural practice, increases the amount of light and available nutrients, enhancing the growth rate of the remaining trees (Montagnini & Nair, 2004). As more nutrients and light are available, increased biomass storage can result from the implementation of agroforestry practices. The addition of shrub and herb species to the understory would in effect increase marketable crops produced in situ and enhance the amount of carbon stored within the wood stand.

Carbon sequestration is viewed primarily as a long-term approach to climate change mitigation, and its applicability to agricultural lands is widely recognized as important (Montagnini & Nair, 2004). When tree stands are young, the trees add more biomass than they lose and the wood stand increases carbon storage (see Figure 1) (Ontario Ministry of Environment & Ministry of Natural Resources, 2001). However, as the stand matures, growth and losses become balanced, thus the trees are no longer sequestering carbon, whereas the carbon in litter and soil continues to increase (Ontario Ministry of Environment & Ministry of Natural Resources, 2001). The greatest limitation to carbon sequestration is found to be based on the quality and nature of the site (soil fertility), tree species and their age as well as interactions with nitrogen deposition (Ontario Ministry of Environment & Ministry of Natural Resources, 2001, Montagnini & Nair, 2004). Thus it is important that litter fall and brush remain onsite post thinning to maintain adequate ground cover and to serve as a source for nutrient deposition. Other management practices to increase carbon stock include the extension of the harvest cycle length. Extending the rotation length of harvest will add to the standing carbon of a wood stand and will result in larger timber that can be used for longer-lived wood products (i.e. structural timbers) (Brown et al, 2004)

Estimates of temperate area capacity for carbon storage based on a tree-stem biomass to carbon content of 1:2 indicates that potentially 63 Mg of carbon be stored per hectare (Montagnini & Nair, 2004). Further carbon storage can occur through the conversion of forest biomass to durable wood products, which enables carbon to be stored in FPS. Finally, the production of timber from wood stands can reduce the pressure on natural forests due to commercial timber harvesting.

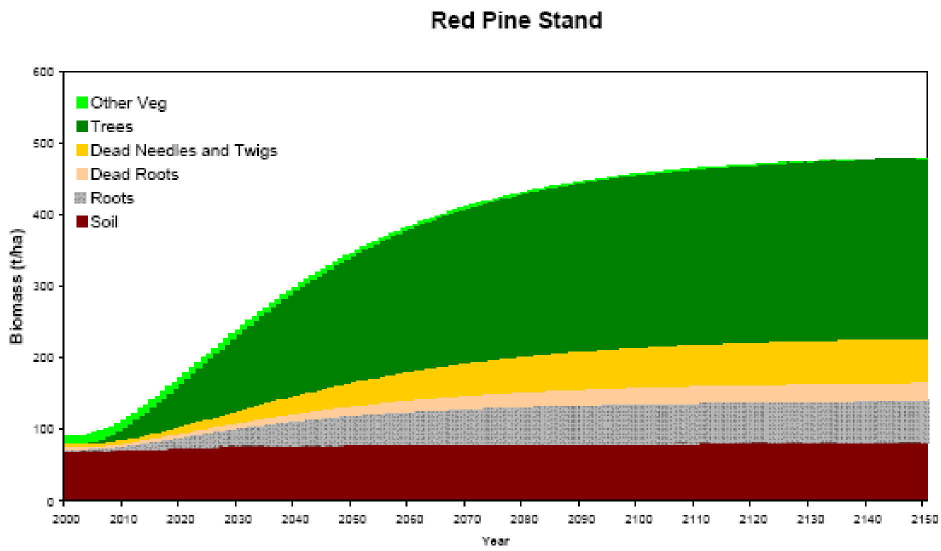


**Figure 1: Typical biomass profile for a Red Pine stand in Ontario, Canada (Ontario Ministry of Environment & Ministry of Natural Resources, 2001).**

### *Medium Term – Soil Carbon Sequestration*

The Kyoto Protocol is an international treaty agreed upon in 1997 which requires participating countries to cut greenhouse gas emissions to negotiated targets in an effort to curb global warming. Canada is required to reduce emissions to 6% below 1990 levels during the 2008-2012 commitment period (UN, 1998). Canada's emissions in 2012 are estimated to be 764 million tonnes of carbon dioxide equivalents, which is 33% above Canada's Kyoto Protocol target of 575 million tones (Ontario Ministry of Environment & Ministry of Natural Resources, 2001).

Carbon sequestration in agricultural soils is not recognized within the Kyoto Protocol. Unlike reforestation, agricultural soils are not factored into a county's emission budget. The transient nature of agricultural soils as carbon sinks due to their frequent disturbance as well as the difficulty in quantifying the CO2 sequestered are the main arguments against their inclusion within the protocol (Forge, 2001). The addition of long lived landscape features such as wood stands into the design of the UBC farm allows for areas that can be permanently classified as "carbon sinks" assuming they are managed properly.

Soil is an important component of the global carbon balance. Brady and Weil (2004) state that at any given time there is ~2400 Pg ($10^{15}$) of carbon stored within soil profiles as soil organic matter, which includes the surface litter horizons of forest soils. Management decisions that increase net primary productivity and the amount of plant material returning to the soil have the potential to increase the soil carbon stores (Montagnini & Nair, 2004). Soil organic matter (SOM) is synonymous with all the organic constituents found within a soil which includes all living biomass, dead plant material and organisms as well as stable organic compounds collectively called humus (Brady & Weil, 2004). In essence, all organic matter contains carbon hence its role in carbon sequestration. Not all organic matter entering the soil remains there permanently; it can be re-released to the atmosphere during decomposition by soil organisms.

The wood stand is situated within the Coastal Western Hemlock biogeoclimatic zone, submontane very wet maritime variant (CWHvm1) (BC Ministry of Forest, 2009). Conditions found within the wood stand are less than ideal for decomposition as it is carried out under cool, wet climatic conditions for much of the year. Limited biological activity in the soil is common. Acidophilic fungi and low-activity invertebrates are the primary decomposers of plant residues. (Krzic & Curran, nd). A thick litter layer may develop under these conditions where carbon to nitrogen (C/N) ratios are always greater than 20 and pH is generally acidic (Krzic & Curran, nd). For comparison, C/N ratios in the surface layer (Ap horizon) of agricultural soils are typically between 8:1 and 15:1 (Brady and Weil, 2004). If we are to regard the woodlot as a potential carbon sink, one of our goals must be to increase the amount of organic matter within the soil. Adding structural diversity to the wood stand by turning it into an agroforestry production unit can increase the amount of litterfall and root biomass, both sources of soil carbon.

***Short Term – Biodiversity and Marketable Crops***

The UBC Farm wood stands have the potential to contribute to the UBC food system; the practice of cultivating edible wild varieties of mushrooms as well as berries for food production is growing (The BC Forest Association, 2004). Maintaining and actively managing on farm wood stands not only contributes to biodiversity and ecosystem health, but can also increase farm revenue from marketable products.

Non-Timber Forest Products (NTFPs) are emerging as an economically viable area of forest stewardship (Cocksedge and Schroeder, 2006). Although small in relative size these forest stands could produce: edible mushrooms, floral greenery, berries, seasonal bows and timber for on and off farm use (Gunter, 2004).

Ecologically the presence of linear structures such as a wood stand within a cultivated farm system provides important habitat areas for a variety of species through structural diversity (Kandtelhardt et al. 2003). Increased biodiversity both floral and faunal contributes to overall ecosystem health and function (Hallman, R. and others. 2001). In an organic system like the UBC Farm the total system's health is crucial in ensuring continual high yields of crops. As the crops grown on the Farm are integral to the UBC Food system, it can be deduced that so too are the wood stands.

More directly these wood stands can become centers for food production. Our research focused on mushroom production for its health benefits as a food source, economic returns, as well their ecological services. In particular the Oyster mushroom will be discussed as it is widely consumed worldwide for multiple reasons including: their ease to cultivate, and low start up cost. There are a wide range of species available under different climatic conditions, and there can be year-round production of the mushrooms using different varieties for different seasons (Chang & Miles, 2004). For the purpose of this paper research was focused on a case study of Oyster mushroom cultivation and its potential for contributing to the UBC food system.

The *Pleurotus* mushroom is commonly called the oyster mushroom and it has been used as for medicinal and food purposes, and continues to play a role in the commercial market (Chang & Miles, 2004). Inoculated alder logs will begin producing after 6 to 18 months and continues seasonally with the right combination of temperature and moisture. The mushrooms reach maturity within an average of 10-15 days, and in the summer can take as little as 4 days (Craig and Miles, 2004). On average, three harvests can be gained per log per year. This cycle can continue for up to six years on the same logs, but the fifth year is generally poor (Craig and Miles, 2004). The mushrooms could be sold at $12.00/lb fresh (Pacific Rim Mushrooms, 2007). Opportunities for trial crops are only limited by start up resources. Forestland also benefits from cultivating saprophytic species like *Pleurotus ostreatos,* because they occupy ecological niches of parasitic fungi, thereby effectively curbing the spread of disease vectors (Stamets, 2000).

As a food source oyster mushrooms contribute to the total productivity of the wood stands. They could be sold at the farmers market, as well as utilized by AMS food outlets. The following table gives a nutritional analysis of 100g fresh Oyster Mushroom (Adapted from Kurtzman, 2005).

| | Units | Oyster Mushroom Profile/ 100g fresh weight |
|---|---|---|
| Energy | kcal | 35 |
| Protein | gram | 3.31 |
| Fiber | gram | 2.3 |
| Calcium | mg | 3 |
| Potassium | mg | 420 |
| Selenium | mcg | 2.6 |
| Sodium | mg | 18 |
| Niacin | mg | 4.956 |
| Vitamin B-6 | mg | 0.11 |
| Vitamin C | mg | 0 |
| Na | mg | 1 |
| K | mg | 296 |
| Calcium | mg | 0.1 |
| Fe | mg | 0.43 |
| P | mg | 111 |

**Table 1. Nutrient Content of Oyster Mushrooms.**

This is just one example of the potential cultivatable crops for the UBC Farm. Other options include, but are not limited to: shitakes, morels, huckleberries, salal berries, salmon berries and elderberries for making jams, as well as floral greenery.

## Recommendations for UBC Key Partners

Based on our findings and discussion we focused our recommendations for key UBC partners on implementing agroecological principles to enhance wood stand productivity and services, both through increasing management practices and expanding education.

The UBC farm may seek out an agroecology or forestry course focusing on soil management; students would collect samples and perform the lab work in order to investigate and propose methods that maximizes the carbon sequestration capacity of the wood stand from the soil aspect. The course “Field and Laboratory Methods in Soil Science” (AGRO 403) stands out as the ideal partnership. In subsequent years, if an agroforestry system is developed, soil organic carbon can be monitored and compared to the reference levels that were first recorded. However, as carbon sequestration requires land management practices to remain constant over time the implications for our findings hinges on the future of the farm.

Besides its role in carbon sequestration, the wood stand should also be recognized for its potential for generating revenue for the UBC farm. Potential revenue generating crops include fruiting mushrooms in spring and fall; berries (such as elder berries, salmon berries, salal berries and huckleberries) in summer; and bows and evergreen decorations (such as cedar, fir and salal for floral arrangements) during the winter. All of these suggested species are popular and marketable crops, which have the potential to be sold at the UBC Farmer's Market. Therefore, creating an agroforestry system is not only environmentally sustainable, but it can also be a source of income and will increase the area of cultivatable land on the farm.

The wood stand scenario is a complex topic, which would benefit from an interdisciplinary approach to further define its ecological and economic value. Other faculties beyond Land and Food Systems, such as the faculty of Science, Forestry, and Commerce should be involved in developing a management strategy. We strongly encourage collaboration and further partnership between faculties to truly explore the full potential of the wood stands for the environment, as well as its role in food production. Topics such as carbon sequestration, as related to the environmental sustainability, and potential carbon credits for the UBC farm are some examples for further research options.

## Recommendations for Future AGSC 450 Groups

As this is the first year that the AGSC 450 teaching team has launched a hands-on Farm scenario to the UBCFSP, resources from previous groups were rather limited. One of the biggest challenges our group faced initially was developing connections between our varied disciplinary background to the wood stand case in a relevant and food-centered manner. Therefore, we recommend future colleagues to establish interdisciplinary connections before investigating the greater context; this will help define the thesis.

Our group started the investigation of the wood stand's role in carbon sequestration and its potential for growing marketable NTFPs. These findings can be expanded into specific species of extensive agroforestry crops; namely those that require minimal management or capital, or those which have the greatest potential for generating economic revenue for the UBC farm. In order to do so, we suggest conducting consumer surveys to determine the current demand for various crops. Some important factors to consider include the cost-benefit relationship between possible revenue, labour investment, and the profitable market price with consideration to existing competition.

Nevertheless, maximizing profit is not the only criteria for choosing the most suitable crops to grow in the wood stand. Future groups should bear in mind that the ideal marketable crops should also have some benefit to the wood stand itself, such as enhanced nutrient interactions between the crops and the trees. The BC Agroforestry Handbook is an excellent resource to refer to on how to construct a survey for this purpose.

Finally, we strongly suggest future groups working on the wood stand scenario to increase communication and knowledge sharing with the faculty of Forestry as early as possible. Potential candidates include Dr. Tom Sullivan, Dr. John Worral, and Dr. Cindy Prescott who may provide excellent resources for future colleagues. Students can also connect with owners of successful wood stands in BC to create a support and information network.

## **Field Work**

Our field work consisted of six hours spent within the wood stands performing various tasks including: sawing down trees, marking trees for cutting, de-limbing the logs, relocating cut down trunks and removing invasive species such as Holly and blackberry. We spent our first hour exploring the Yellow Cedar and Douglas Fir wood stands and locating all of the marked trees. We then divided up the tasks and began a rotation so that each member had an opportunity to try all of the different aspects involved in wood stand thinning.

During our first three hour shift we were joined by Tim Carter and Dr. John Worral who helped us get started with our work, educating us about the proper (and most efficient) ways of thinning. John stayed for the duration of our first shift ensuring that work was flowing smoothly and helping those of us who had little experience working with saws and hatchets.

Upon arriving on the site to perform our field work, John Worral informed us of the ecological dangers of the interactions between invasive species and local fauna. He further explained the necessity of wood stand thinning in providing a better environment for the majority of the trees to reach their potential. On our last day on the farm, we helped John determine which trees should be tagged for removal, which further enhanced our knowledge about the wood stand. After sawing the trees, we carried them out of the forest where group members were waiting to de-limb them and cut them down to usable size. The remaining parts of the trees were grouped together for chipping or burning. The usable trunks were salvaged to be used for fence posts and other various items.

## **Group reflective paper**

Working on the farm has given us a better understanding of the significance of our chosen topic. Not only were we able to apply skills learned in class as well as through research, but through our experience we gained knowledge about each group member's strengths and weaknesses, which has further strengthened our bond as a team. Some of our members had very little knowledge about agroforestry and wood stand thinning and therefore relied on the knowledge of those students within the fields of agroecology and agroforestry for guidance. Learning from peers provides explanations in layman’s terms that can be understood by those with minimal knowledge about a certain idea.

Having John and Tim work closely with us benefited our whole group, especially to those of us who were very new to the idea of cutting down trees. It was insightful to gain information from them, because each had a different perspective about the wood stand. Tim saw the wood stand as more of an immediate resource asking what it could do for the farm right now. John had a more long term outlook, explaining that it was doing exactly what it was planted for: growing and producing a valuable timber product over time. He also provided insight on the intricacies of the forest habitat.

One of the main goals of our project is to increase carbon sequestration on the farm thereby decreasing UBC's ecological footprint. Although we implemented all of our thinning practices in a sustainable manner using hand saws and hatchets, some of us had questioned whether our decision of cutting down trees is counter-intuitive in increasing carbon sequestering. However, after much discussion within our group, we concluded that although thinning the wood stand decreases the number of trees, we are in fact giving the remaining trees the opportunity to thrive and therefore increasing the stands carbon sequestration.

## Conclusion

After thorough investigation and research, it is concluded that the wood stands at UBC farm provides many long-term and short-term applications which can be beneficial to promote sustainability and reduce carbon emissions. The wood stands also have the potential to be used for education, public outreach, growing marketable crops, and provide other interdisciplinary connections. Areas to also explore are the potential for carbon sequestration for GHG emissions reductions and connecting with other successful wood stand owners. Thus, with partnerships with UBC and continued research from future AGSC 450 students, the wood stand can be utilized to be more than just standing timber.

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