UBC Social Ecological Economic Development Studies (SEEDS) Student Report

An Investigation into New SUB Rooftop Garden Irrigations Systems

Brianne Dahle

John Mollica

Hao Zhang

University of British Columbia

APSC 262

March 31, 2011

An Investigation into New SUB Rooftop Garden Irrigation Systems

Prepared by:

Brianne Dahle
John Mollica
Hao Zhang

Submitted to:
Dr. Dawn Mills

APSC 262

March 31, 2011

ABSTRACT

In attempt to obtain LEED Platinum+ rating, the highest rating for a green building within North America, a producing rooftop garden is to be integrated into the new Student Union Building on UBC campus. This report contains a summary of the selected crop, it's management and irrigation needs specific to this particular garden, as well as a brief suggestion to a monitoring system. However, its main focus is a comparative analysis of the considered irrigation systems to be implemented on the rooftop garden. This was done through a triple bottom line analysis, which not only looks at the economical impact of the system, but also assesses the environmental and social bearing.

The three systems in question were sprinkler irrigation, drip tape, and soaker hose. An example of the factors taken into account during the analysis would be the cost of the materials necessary for the installation or maintenance, the efficiency of the system with respect to water conservation, or the level of convenience it imposes for the staff.

Based on the information reviewed within this article, the recommendation arrived at was to implement the drip tape. Many aspects influenced this decision, such as the budget, limited amount of staff, life expectancy, and the scale specific to the design of the Student Union Building rooftop garden. In conclusion, the recommended irrigation system presented in this report was selected due to the installation and maintenance costs being low, its efficiency with water usage, and the fact that it has very little social impacts.

TABLE OF CONTENT

LIST OF ILLUSTRATIONS

GLOSSARY

Aggregate - Particles that cohere to each other stronger than to other surrounding particles

Closed-Loop System - A system in which some of its output is used as its input

Hydraulic Conductivity - A soil's ability to transmit water when submitted to a hydraulic gradient

Leaching - Removal of material by means of dissolving

Macropores - A pore with a width greater than approximately 50 nm

Methylene Blue - A chemical compound used as a redox indicator

Slaking - Disintegration of a material when exposed to air or liquid

Emitters - Small holes spaced evenly along a drip tape line, which drip water slowly. Attachments can be connected to emitters

LIST OF ABBREVIATIONS

UBC	- University of British Columbia
SUB	- Student Union Building
SWC	- Soil Water Content
Thou	-Thousandth of an Inch – Also known as a mil or a point
SDI	-Subsurface Drip Irrigation

1.0 INTRODUCTION

This report conducts a comparative analysis of irrigation methods that can be implemented for the new University of British Columbia (UBC) Student Union Building's (SUB's) rooftop garden, which is currently undergoing its design phase. The garden will be split into two portions – a smaller area for a social garden that can be used for the public to enjoy, and a larger area designed for crop production. Garden design specifications followed by crop variety and irrigation factors are introduced first to grant the reader an understanding of the project's scale. A triple-bottom-line analysis was conducted for three irrigation methods: sprinkler systems, soaker hoses, and drip tapes, in order to find the most feasible irrigation method (or methods) for the garden. Garden monitoring equipment to regulate efficient water flow will also be discussed in detail further into the report. Finding environmentally friendly tools to minimize water usage, and spending as little money as possible to maintain the garden was our primary goal.

2.0 THE NEW SUB ROOFTOP GARDEN

The new Student Union Building (SUB), in efforts to achieve the highest green building rating in North America, is incorporating a rooftop garden into the plans. The green rooftop garden parallels the sustainability goals regarding environmental, economical and social impacts. It will be a model of sustainable farming, food security and offer community education. This garden has the potential to provide educational opportunities not only within the community, but also into UBC courses, as it could serve as a topic for educational programs, workshops and research projects. As well as providing entrepreneurship opportunities to students and possible work-study positions, this form of urban agriculture will increase the environmental sustainability of the SUB operations. The produce will be distributed among various organizations, such as Sprouts, AMS Food and Beverage Services, AMS Farm Market and leftovers to be donated to Community Eats and Salvation Army.

2.1 GARDEN DESIGN

With an expected life expectancy of 100 years, the SUB is designed to consist of two major sections. One is a smaller Social Garden focusing more on aesthetics and architecture and containing only edible flowers, herbs, select perennial fruits and non-edible vegetation, and the other being a Production Garden. The Social Garden is to be only 242m^2 in size, where as 1040m^2 has been dedicated for the Production Garden. Crops to be grown in the Production Garden have been selected based on numerous factors determining which would grow most successfully in the Vancouver region. With an average annual rainfall in Vancouver of 1,244mm, and only 24% of it during the months of April – October, an approximate 717mm of additional water is required for many of the selected crops. The options for watering systems currently being considered consist of over-head sprinklers, drip irrigation and hand watering. The garden management, however, is limited to one or two paid coordinators, and an independent system with a timer would be most beneficial. In addition, a reservoir collecting rainwater will be stored in the SUB basement.

2.2 CROP SELECTION AND MANAGEMENT

Crop selection is one of the most important steps to the success of the SUB rooftop garden. It determines how we will prepare the soil, what type of fertilizer we will purchase, and what kind of irrigation system we will use. For the production garden, a list of potential crops that will be grown with associated yield and income estimation has been created. (see Appendix A). The decisions are mainly based on the interests of potential food purchasers including Sprouts and AMS F&BS. Sprouts want the crops that are available during the school year and provide variety to the crops from the UBC farm. AMS F&BS indicates its interest in greens, herbs, berries, and certain specialty items, i.e. tomatillos. To meet the customers' expectation, a feasibility study has been done by interviewing the local garden managers and regional seed catalogues. It shows that the crops selected in the list can be grown in 30 cm deep soils under the local climate condition. Experts also suggested that a high diversity of crops would help maintain the nutrient capacity of the soil and reduce the risk of plant disease. Therefore, space efficiency, growing period and produce value have been taken into account when making the decision.

The selection of potential crops for the social garden has also been outlined. (see Appendix B) by the design team. The design team suggested that the garden should have herbs, edible flowers and perennial fruits, because these plants can be grown in containers and provide visual levels in the vegetation. This suggestion is also based on the assumption of an intensive gardening, with 50% of the space being cultivated.

The idea of season extension will be applied in the garden as an important part of the crop management.

3.0 FEASIBILITY ANALYSIS OF IRRIGATION SYSTEM

In order to provide sufficient water to the crops in the new SUB rooftop garden with consideration of potential impacts, an irrigation system must be carefully designed, installed and maintained. Therefore, a feasibility assessment of different types of irrigation system is necessary.

3.1 INTRODUCTION

Drip tape, sprinkler and soaker hose are the three most popular irrigation methods being used in the world. This assessment analyzes the feasibility of each system in terms of economical impact, environmental impact and social impact, also called triple-bottom-line analysis.

3.2 TRIPLE-BOTTOM-LINE ANALYSIS

3.2.1 Drip Tape Irrigation

Drip tape systems are flat tubing lines, which expand to a round cylindrical tube when water is run through it. Drip tape is attached to a main hose line from holes punched at spaced intervals. Each drip connection is called a branch, which combines to create a comprehensive watering network throughout a large target area. The drip tape waters its surrounding area with emitters, which are holes in the drip tapeline that allow for low-pressure water to flow freely – which drips. Attachments, such as tubing lines with valves, are used to carry water to hard-to-reach places where a drip end-piece is attached to control the flow of water. Drip tape systems make for a highly controlled network of watering to take place. A complete drip irrigation system diagram is shown below.

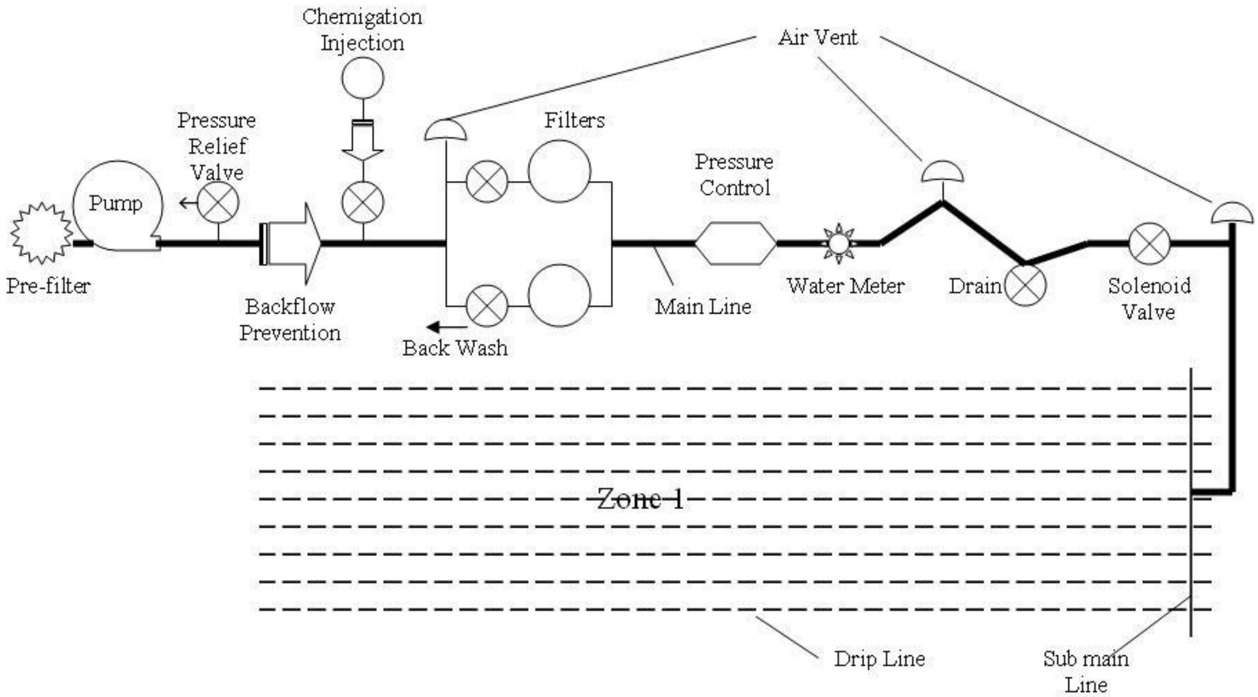

Figure 1. A comprehensive drip irrigation system

3.2.1.1 Environmental Impact

Most drip tapes are made from polyethylene or metallic materials. Polyethylene is a more realistic investment because it resists corrosion and mineral buildup, as opposed to other drip tapes made with steel or aluminum. Polyethylene is not biodegradable, and so turnover would need to be minimized. There are options to purchase one season-old drip tape to reduce polyethylene consumption, although repair and maintenance work would be much higher.

3.2.1.2 Economical Impact

There are a number of varieties of drip tape to choose from, and many suppliers. Attributes that will affect the cost of the tape are the width of the pipe, the thickness of the pipe wall, the distance between emitter perforations, the allowable water flow through the pipe, and the water pressure limit the pipe can withstand. More expensive piping will have a smaller distance between emitter perforations, have a thicker pipe wall, and be able to manage higher water pressure levels consistently (Southern Drip Irrigation, 2009, pg 6). The deciding factor which altered the decision for the 100 year price estimate was the re-useability of the thick, more expensive pipe. With thicker pipe walls, they are less likely to break down or become damaged by pests. On average, piping with a full inch in diameter and a wall thickness of 25 thou lasts at least two seasons longer than ½ inch diameter and a wall thickness of at least 10 thou. The larger pipes are meant for long term Subsurface Drip Irrigation (SDI), and when they are buried they can last in a conservative range of 3 to 5 years, whereas the smaller ones tend to break down within the first 3 years. A conservative estimate places thick drip tape to be twice as economically feasible as ½ tape. The rooftop garden's social area is estimated to be $242m^2$ and the production area is estimated to be $1242m^2$, so using a basic guideline that 200 feet of drip tape can cover an area of $1000ft^2$, the amount of tape to cover the entire rooftop would be roughly 1400 ft of drip tape. Buying drip tape from a company called QueenGil will run up initial costs for 3 years worth of drip tape at $115.50. Purchasing the tape along with drip tape attachments, tools, and a filter increases starting costs to $246.30. Assuming that drip tape, attachments, tools, and a filter will be fully replaced every three years, the financial projection for a 100 year period for simple drip tape irrigation system is $8210.00. Other products not mentioned could be an automated timer system, and a water pressure regulator gauge.

3.2.1.3 Social Impact

Drip tape irrigation is highly flexible, and can be customized to fit different area layouts. If drip tape irrigation is in place and the rooftop garden layout were to be altered dramatically, new lines would need to be used. Minor layout changes can be solved simply and easily with proper use of drip tape attachments.

Depending on plant selection, drip tape can be buried in soil to water the garden deeply. This allows for the drip tape system to be hidden from view, creating the illusion that the plants are self-sustaining.

3.2.2 Sprinkler Irrigation

As a method of irrigation, sprinkler systems are used globally. The technique is to resemble rain as the water falls onto the desired area and then infiltrate the soil. The efficiency of the system is influenced by numerous factors such as "the water distribution model of the sprinkler, the layout and spacing between sprinklers, and wind" (Romero, J. et al, 2006, pg 445).

3.2.2.1 Environmental Impact

One of the more commonly known environmental impacts of sprinkler irrigation is the leaching of fertilizer if over watered. However, this is more commonly an issue with large-scale farming and would likely not be an issue with an isolated soil system on a rooftop.

When compared to the drip irrigation method, the continuity of macropores present in the soil with sprinkler irrigation is much lower. A field study used methylene blue to demonstrate that "continuous macropores …[were present] up to a depth of 20-25 cm from the soil surface in the field… where the drip system was in use" (Crescimanno, G. 2006, pg 117). It was assumed that this was the soils original structure. In contrast, the depth at which the macropores terminated in the field irrigated by sprinklers ranged from 5-10 cm from the surface. It was thought that the impact of the water on the surface could induce slaking of the aggregate within the soil, as well as erosion of the fine clay particles into the pore space filling the macropores. This directly influences the hydraulic conductivity of the soil (Crescimanno, G. 2006, pg 117). Therefore, if the sprinkler method causes a drop in hydraulic conductivity, it could be said that the drip method is more efficient for irrigating deeper-rooted plants.

In addition, the materials used in the sprinkler system can be recycled in most areas.

3.2.2.2 Economical Impact

An economic comparison of four systems using different types of piping was conducted using Polyethylene (PE), Aluminum (Al), Polyvinyl Chloride (PVC) on the surface, and below the surface (PVCb). Figures 1, 2 and 3 are images of the piping.

Figure 2. Polyethylene Pipes

Figure 3. Aluminum Pipes

Figure 4. Polyvinyl Chloride Pipes

Annual water application costs, labor, maintenance, energy and hydraulic performance were some of the parameters considered. Generally, a sprinkler layout consists of a sub-main with lateral lines branching off where sprinklers are set up to distribute the water as seen in Figure 4. The results demonstrated that the water application cost drops when the spacing of the sprinkler layout is larger. The reasoning behind this is that even though the diameter is larger, (and therefore more expensive) the total length of pipe is less resulting in an overall lower cost (Romero, J. et al, 2006, pg 449). The study concluded that for a permanent sprinkler system, buried PVC pipes were the least expensive (Romero, J. et al, 2006, pg 451). It should also be noted that burying the pipes could add to the life expectancy of the pipe due to it being protected from potential environmental or physical damage such as solar radiation, temperature, freeze thaw action, or damage by tools (Romero, J. et al, 2006, pg 445).

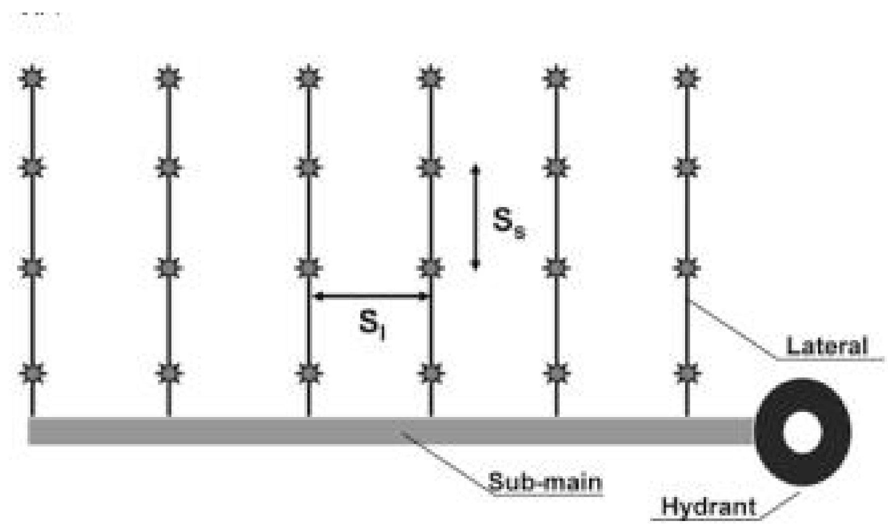

Figure 5. General Sprinkler Layout

Source: Montero Martı´nez, J., Martı´nez, R. S., & Tarjuelo Martı´n-Benito, J. M. (2004), pg 106.

3.2.2.3 Social Impact

A study on the performance of a sprinkler system on a golf course discusses the factors that contribute to water losses during the irrigation process. Some of these factors include climate variables, such as humidity, temperature and wind. It was determined that the affects of the temperature and humidity are significant to the losses during the day time due to the low humidity and high temperature. An increase in temperature results in an increase in loss due to evaporation. However, evaporation losses are inversely related to humidity. In conclusion, the average efficiency of nighttime irrigation was greater than daytime irrigation by 5% and is therefore suggested that the "best time for irrigation is during the early morning … or late night hours" (Latif., M., 2008, pg 452) . This would be impractical if the system was monitored by the staff, but could be done if the system was automatic. If it were possible to implement nighttime irrigation, it would be useful in the case that maintenance or weeding were required, the sprinklers would not turn on during the task.

3.2.3 Soaker Hose Irrigation

Soaker hoses are round rubber or plastic hoses with perforations which allow water to slowly seep out of them into the ground. Usually a timer is used to control the flow of water in the hose.

3.2.3.1 Environmental Impact

Although rain will be collected and used to water the plants, it does not seem to be sufficient. A great amount of water from other sources will be consumed. With soaker hose irrigation, that amount can be reduced significantly, because water is delivered directly to the root zone. Soaker hoses are made of car tires, so they are reusable and recyclable.

3.2.3.2 Economical Impact

Soaker hoses are very cheap. The currently available ½ inch hose costs about $35 per 100 ft with a 7-year guarantee. Unlike the sprinkler irrigation system, soaker hoses are very easy to be installed, maintained and removed, so the labor cost is very low, but extra cleanup work is needed for reuse. Soaker hose doesn't involve spray, so it means leaf diseases are kept in check. The disadvantage is that for a large area needs to be watered, it requires a lot of hoses which can bring up the cost.

3.2.3.3 Social Impact

Since soaker hose irrigation system doesn't require a fixed structure of pipeline, it saves space and gives the gardener more flexibilities to choose the crops they want to grow. The rooftop garden is also designed to be a research facility. People can use soaker hoses to ensure that the plants get the right amount of water and eventually optimize the result of their research. The down side is that once the hose is damaged and leaks, it usually can only be replaced instead of repaired.

3.3 MONITORING SYSTEM

A smart irrigation system can be implemented by establishing a closed-loop feedback system, as shown in the flow-chat below.

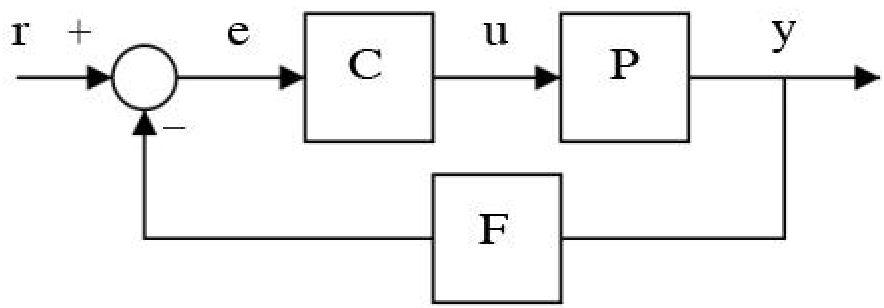

Figure 6. Closed-loop Feedback System

Source: Wikipedia – control theory

In the chat, ‘r’ represents the ideal status of the soil, and ‘F’ represents the monitoring device, which collects real data from soil. ‘C’ and ‘P’ represent the adjusting system which controls the watering devices. Once the system is established, it can automatically and constantly take care of the crops. The down side of the system is that it is too expensive since it requires a computer and control software.

The alternative solution is to use a monitor to measure the status of the soil and simply show the data on a LED screen, and then the gardener will decide what to do next. There are three common ways to show the status of soil including gravimetric SWC, volumetric SWC, and soil water potential. Gravimetric SWC refers to how much water in the soil on a weight basis. Volumetric SWC reports the moisture level of soil. The soil water potential is a measure of how tightly the soil holds the water.

4.0 RECOMMENDATION

Research conducted regarding each irrigation method's triple-bottom-line analysis made apparent several key variables which influenced the garden's development most: efficiency of water usage, projected economic expense over 100 years, environmental impact of product, and ease of installation and maintenance.

Regarding water efficiency for plant growth, we found drip tape to be an ideal choice for the garden when implemented correctly. The slow and careful release of water slightly above an area of interest, or buried underground to supply root networks is proven to reduce leeching effects in the soil, which promotes ideal soil composition for plant growth. A low-impact water flow also helps create an even distribution of nutrients in the soil, whereas high-impact watering sprinklers can easily disturb soil equilibrium. Soaker hoses run the same watering benefits as drip tape, but do not last as long. With proper maintenance, drip tape lines can run up to twice as long as the average soaker hose. When dealing with garden changes, a soaker hose lacks versatility when compared to a drip tape system. A drip system can branch easily, and minimizes tubing lengths to water an entire garden, while a soaker hose must run through every single area to supply moisture. From a financial perspective, a short term project may not see immediate financial benefits from a large drip tape system on account of initial cost, but averaged over 100 years, cost-benefit analysis favors drip tape. This is mainly due to the high resilience of the material, which allows for less frequent replacement. Maintenance, however, is higher for drip tape systems on account of the level of complexity a garden can have. Each drip line must be carefully examined for perforations, cleared of buildup, and roots must be trimmed during each maintenance period to keep a successful project. This can be seen as a setback, but environmentally and financially, drip tape is still deemed the most viable option. When crops are rotated and garden layouts change, this flexible system will be the easiest to optimally run a garden, and is by far the most beneficial.

LIST OF REFERENCES

Crescimanno, G.,De Santis, A., & Provenzano, G. (2006). Soil structure and bypass flow processes in a Vertisol under sprinkler and drip irrigation. *Geoderma*, 138(1-2), 110-118.

Charlesworth, P. (2000) *Irrigation Insights No.1 Soil Water Monitoring* Retrieved from http://www.irrigationfutures.org.au/imagesDB/news/soilwatermonitoring2ed.pdf

Dalgliesh N. (2006) Measuring Soil Water for Better Farming Decisions. *FARMING AHEAD*, No.168

Jensen, L., Shock C. C., Flock R., Feibert, E., Shock, C. A., Pereira, A. (2005) Irrigation Monitoring Using Soil Water Tension. *Sustainable Agriculture Techniques.*

Kay, M. (1983) *Sprinkler Irrigation: Equipment and Practice*. London: Batsford Academic and Educational.

Latif, M., & Ahmad, F. (2008) Operational Analysis of Water Application of a Sprinkler Irrigation System Installed in a Golf Course: Case Study. *Journal of Irrigation and Drainage Engineering,* 134(4), 446-453.

Montero Martı´nez, J., Martı´nez, R. S., & Tarjuelo Martı´n-Benito, J. M. (2004). Analysis of water application cost with permanent set sprinkler irrigation systems. *Irrigation Science*. 23(3), 103-110.

Morris, M. (2006) *Soil Moisture Monitoring: Low-Cost Tools and Methods.* Retrieved from http://attra.ncat.org/attra-pub/soil_moisture.html

Romero, N. J. O., Martínez, J. M., Martínez, R. S., & Martín-Benito, J. M. T. (2006). Set Sprinkler Irrigation and Its Cost. *Journal of Irrigation and Drainage Engineering,* 132(5), 445-453.

Southern Drip Irrigation Methodology. (2009). *SDI-2009-Catalogue.* [Pricing Data]. Available from Name of source site: http://www.southerndrip.com/

APPENDIX A

Family	Crop	Yield (kg/m^2)	Price ($/kg)	Area (m^2)	Total Yield (kg)	Income ($)	Selection Rationale
Allums	Leeks	2.05	5.51	19	39.0	214.8	Sprouts wants; available into school year
	Garlic	0.38	26.46	19	7.3	193.2	Sprouts wants; available into school year
	Onions	3.68	3.31	19	69.8	230.9	Good value, Sprouts wants; available into school year
	Overwinter Onions	3.36	3.31	19	63.9	211.3	Good value, Sprouts wants; available into school year
Apiaceae	Parsnips	1.41	6.61	8.2	11.6	76.6	Sprouts wants; available into winter
	Carrots	2.66	7.17	8.2	21.8	156.1	High value; Sprouts wants; available into fall
	Florence Fennel	1.76	11.02	8.2	14.4	159.1	High value; Sprouts wants; available into fall
	Celery	4.48	7.72	8.2	36.8	283.7	High value
	Celriac	2.51	6.06	8.2	20.6	124.8	Good value, available into fall
Asteraceae	Lettuce	2.52	2.43	8.2	20.7	50.1	Sprouts wants; available into winter
	Artichokes	1.55	11.57	9.6	14.8	171.9	Good value
	Endive and Radicchio	1.51	7.72	8.2	12.4	95.7	Good value, Unique product
Chenopodic-aceae	Beets	2.22	6.61	8.2	18.2	120.4	Good value
	Sorrel	0.91	8.82	8.2	7.4	65.7	High value; AMS wants
	Spinach	1.45	13.23	16.4	23.7	313.7	High value
	Swiss Chard	1.68	11.02	8.2	13.8	152.0	High value; AMS wants
Early Cucurbits	Cucumbers	0.38	5.51	11.5	4.4	24.4	Popular market item
	Zucchini	1.11	6.61	11.5	12.8	84.6	Popular market item
	Summer Squash	1.11	6.61	11.5	12.8	84.6	Popular market item
Late Cucurbits	Pumpkins	3.37	3.31	11.5	38.8	128.3	Good value; Sprouts wants; available into fall
	Winter Squash	3.37	4.41	11.5	38.8	171.1	Good value; Sprouts wants; available into fall
Legumes	Bush beans	0.75	8.82	10	7.5	66.4	Efficient for intercropping
	Pole beans	0.78	8.82	10	7.8	69.2	Good value; popular market item
	Edamame	0.62	8.82	6.4	3.9	34.8	Unique product
	Peas	1.15	13.23	19	21.8	288.7	Good value, Sprouts wants; available into fall
Nightshades	Tomatillos	2.36	6.61	8	18.9	125.1	Good value; AMS wants
	Tomatoes	2.57	6.61	8	20.5	135.8	Good value; popular market item
	Tomatoes, Cherry	2.24	14.33	9.5	21.3	305.2	High value; good sale item with salad greens
	Peppers (sweet/spicy)	1.04	11.02	10	10.4	114.9	Good value; popular market item
	Eggplants	2.22	8.82	10	22.2	195.7	Good value; popular market item
	Potatoes	2.20	5.51	12	26.4	145.7	Good value; Sprouts wants; available into

							winter; UBC Farm has blight problems
Leafy Brassicaceae	Arugula	1.35	17.64	8.2	11.0	194.5	High value; AMS wants
	Mustards, Ruby Streaks	1.68	13.23	8.2	13.8	182.4	High value; AMS wants
	Mizuna	1.35	17.64	8.2	11.0	194.5	High value; AMS wants
	Rapini	1.68	11.02	8.2	13.8	152.0	High value; AMS wants
	Kale	1.82	13.23	8.2	15.0	197.9	High value; Sprouts wants; available into winter
	Pak Choi, Choi Sum	2.52	6.61	8.2	20.7	136.8	Good value; Sprouts wants; available into fall
	Collards	1.82	6.61	8.2	15.0	98.9	Sprouts wants; available into fall
Other Brassicaceae	Broccoli/	0.87	7.72	7.2	6.3	48.6	Sprouts wants; available into fall
	Brussel Sprouts	1.18	7.72	7.2	8.5	65.8	Sprouts wants; fall cropping an option
	Cabbage	3.58	4.41	7.2	25.7	113.5	Sprouts wants; available through winter
	Cauliflower	0.90	8.82	7.2	6.5	57.3	Sprouts wants; available into fall
	Kohlrabi	1.63	5.51	7.2	11.7	64.5	Sprouts wants; available into winter
	Radishes	0.84	8.82	7.2	6.1	53.4	Good value; available into fall
	Rutabagas	4.24	7.17	7.2	30.6	219.0	Good value, Sprouts wants; available into winter
	Turnips	4.24	6.61	7.2	30.6	202.1	Good value, Sprouts wants; available into fall
Perennial Fruits	Blueberries	1.36	16.53	12.5	13.6	224.2	High value; AMS wants; reduce wind (N-W)
	Strawberries	1.02	16.53	12.5	10.2	168.2.	High value; AMS wants
	Raspberries	1.25	16.53	12.5	12.5	207.02	High value; AMS wants; reduce wind (N-W)
	Blackberries	1.08	16.53	12.5	10.8	179.4	High value; AMS wants; reduce wind (N-W)
TOTAL				**509.4**	**965.1**	**7548.9**	

APPENDIX B

Vegetation	Yield (kg/m^2)	Price ($/kg)	Area (m^2)	Total Yield (kg)	Income ($)
Edible Flower	0.07	35.27	9	0.66	23.13
Calendula					
Nasturtium					
Bachelor button (Centaurea)					
Marigold					
Chrysanthemum					
Carnation, Dianthus spp.					
Day lily, Hemerocallis spp.					
Lilac, Syringa vulgaris					
Pansy					
Violet					
Chamomile					
Lavender					
Hedges	0	0	9.5	0	0
Figs	0.45	12.13	9	4.04	48.93
Currants	0.92	15.43	9	8.24	127.16
Herbs	0.22	30.86	9	2.02	62.27
Basil					
Bergamot					
Borage					
Chervil					
Chives					
Cilantro					
Dill					
Epazote					
Fennel					
Lemon Balm					
Lovage					
Oregano					
Parsley					
Mint					
Rosemary					
Sage					
Savory-Summer					
Savory-Winter					
Sweet marjoram					
Thyme					
Green onions					
		TOTAL	**45.5**	**14.95**	**261.48**