UBC Social Ecological Economic Development Studies (SEEDS) Student Report

Design, Vegetation, and Management Plan for the New UBC AMS Student Union Building Rooftop Garden

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A UBC SEEDS Project

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Abstract

A desire for the incorporation of a rooftop garden into the new Student Union Building (SUB) at the University of British Columbia (UBC), Vancouver has been expressed by the students and AMS, and aligns with the environmental, social, and economic sustainability goals of the new SUB project. Qualitative research involved interviews with rooftop gardens in the region, and at other post secondary institutions to elicit best practices. Community Based Research was conducted, including interviews and meetings with stakeholders and potential partners, including Sprouts, AMS Food and Beverage Services, the UBC Botanical Gardens, and the UBC Farm, to help define the goal of the garden as a model of sustainable farming that contributes to food security and education of the community. Plans for container gardening of herbs, edible flowers, some perennial fruits, and non-edible vegetation in the 242 m^2 Social Garden were created. Recommended plans for the 1040 m^2 Production Garden include a green roof with 30 cm of soil and a drip irrigation system, and supervised open access. Other recommended design elements are a greenhouse, shed, apiary, composting area, and a washing and sorting station. Based on selected crops, an estimated 965 kg of food will be produced, corresponding to an annual income of $7,800. Distribution of produce will be primarily through Sprouts, AMS Food and Beverage Services, and an AMS Farm Market, with potential to contribute to the UBC Farm distribution system. Leftover food can be donated to Community Eats and the Salvation Army. Garden management may consist of a Rooftop Garden Advisory Committee, and 1 or 2 paid coordinator positions that together work a total of 40 h/week in the growing season and 20 h/week the rest of the year. If restructuring will allow, 2 student work-study positions would lower salary costs. The AMS Sustainability Coordinator, a Sprouts Board of Directors Rooftop Garden Liaison, and volunteers could support this position. Potential sources of funding and resources for the garden, in addition to crop income and cost recovery mechanisms are AMS subsidy or grants and donations. This garden has much potential in the long-term to develop new initiatives and educational programming, including workshops, inclusion in UBC courses, and research projects, however phase implementation should first focus on key functioning elements of the garden. This involves step implementation of costly infrastructure, and the deferring of expensive and labour intensive projects, crops, and distribution options until financial and management aspects of the garden are stable.

1.0 Introduction

1.1 Role of a Rooftop Garden in the New SUB

At the University of British Columbia, Vancouver, a new SUB is being designed, with construction scheduled from late 2011 to fall 2014. This undertaking is being driven by the Alma Mater Society (AMS), UBC's student government, in partnership with the University of British Columbia and Dialog + BH architects. The vision of the new SUB is to create a "unique destination that serves as a dynamic gathering place for students to interact and grow a vibrant student community on the Vancouver UBC Campus"[1].

[1] UBS Alma Mater Society (2010). My New SUB. Retrieved December 3, 2010 from www. mynewsub.com

Consultations with UBC faculty, staff, and students revealed that their primary concern for the new SUB was that it should be environmentally, socially, and economically sustainable[2]. There was also an overwhelming response that the preferred location for a student lounge was a rooftop garden.

Based on these responses, the sustainability goal of the new SUB design team is to create a LEED Platinum + building (the highest green building rating in North America), with considerations for the Living Building Challenge. Among the other goals are to enhance:

- Student empowerment by providing opportunities for students to take on leadership roles
- Community by creating more opportunities for student interaction and engagement
- Student development by providing more opportunities for skill building and work experience
- Environmental sustainability of operations in the SUB
- Economic sustainability by providing entrepreneurship opportunities for students and expanding the AMS business

The rooftop garden also aligns with UBC's reputation as a global leader in sustainability, and the institution's many initiatives, including adopting a Sustainable Development Policy[3]. A rooftop garden can help realize these objectives; Rooftop gardens are a form of urban agriculture, and when combined with green roof technology, they can enhance the social, environmental, and economic sustainability of a building and its users[4]. A summary of potential benefits is provided in Table 1.

Table 1: Benefits of green roofs and urban agriculture[5]

Component	Function	Benefits		
		Environmental	Economic	Social
Green Roof	Protects rooftop from damage and extends the life of rooftop	3	3	
	Reduces energy needed to cool the building in the summer and heat the building in the winter	3	3	
	Reduce carbon footprint by reduction of fossil fuels	3	3	
	Storm water reduction	3		
	Reduces the urban heat island effect	3		
	Improves air quality and acoustics	3		3
Urban Agriculture	Increasing the self-reliance of the campus to produce, process and distribute nutritious food (i.e. promotes food security)	3	3	3
	Local production of marketable crops	3	3	

[2] LFS 450 Group 8 Report, 2010.

[3] UBC Board of Governors (2005). *Sustainable Development Policy 5*. Vancouver: University of British Columbia.

[4] International Living Building Institute (2010). *Living Building Challenge 2.0*. Seattle: International Living Building Institute; Weston Solutions Inc. (2007). Fact Sheet: GreenGrid and LEED Certification. Michigan:Weston Solutions.

[5] Centre for the Advancement of Green Roof Technology. An Introduction to Green Roofs [presentation]. Vancouver: Green Roof Research Centre; Sidewalk Sprouts (1999). Benefits of Urban Agriculture. Retrieved December 4, 2010, from http://sidewalksprouts.wordpress.com/ua/benefits/

	Aesthetically pleasing			3
	Act as a venue for social interactions			3
	Makes an unused space productive	3	3	3
	Educational opportunities for teaching, learning and research			3
	Create employment opportunities		3	3
	Promotes biodiversity	3		

1.2 Project Background

In the winter term of 2010, two groups of students in the Faculty of Land and Food Systems course LFS 450: Land, Food and Community III were tasked with creating a design and working management plan for the new SUB rooftop garden. Their goal was to create a proposal for a garden that will be an icon of sustainability and act as a catalyst for innovation and future projects at UBC and in the Greater Vancouver Area. The result of their work was a broad overview of potential options for layout, production, distribution, management, crop selection, waste management, business operation, and educational opportunities of a garden.

1.3 Project Intent

Based on the initial research of the LFS 450 students, the aim of this project was to further develop plans for the new SUB rooftop garden. More specifically, to:

- Identify and review other buildings that have established notable rooftop gardens and focus on eliciting best practices from gardens where produce is sold and used in food outlets.
- Verify and revise existing layout plans.
- Select crops for the garden with consideration of climate, growing season, soil depth requirements, and the products desired by potential purchasers.
- Plan a crop rotation for the selected crops in order to maintain the soil's nutrient capacity.
- Estimate the potential crop output quantities from the garden and the corresponding income.
- Create options and recommendations for the human resources required for garden operation and distribution of the food produced.
- Consider plans for implementation of the garden in phases.

2. 0 Methodology

2.1 Theoretical Framework

The theoretical approach to this project was to obtain data through qualitative Community Based Research (CBR). CBR is research on a topic of practical relevance to

a community that is carried out in a community setting[6]. It involves collaboration between community partners and researchers who share control of the research agenda through involvement in research design, implementation, and dissemination of results. The goal is to develop an action-oriented process and achieve results that are useful for making positive change in the community.

2.2 Key Partners and Stakeholders

AMS: The UBC AMS is providing a portion of the funding for the project. The new SUB will be the central hub for AMS operations and work to serve the student body that the AMS represents.

AMS Food and Beverage Services (AMS F&BS): AMS F&BS is a potential purchaser of food produced by the rooftop gardens and runs catering services and food outlets in the SUB.

Sprouts: Sprouts is a student-run natural food coop and restaurant in the SUB that functions under the AMS. They are a potential purchaser, and there are many possibilities for collaboration on initiatives.

UBC Farm: The UBC Farm is an agricultural operation model on campus that best practices can be taken from. The objectives of the rooftop garden and UBC Farm are similar, and the farm is a valuable source of knowledge and information. There is great potential for collaboration and cooperation between the Farm and rooftop garden.

UBC Botanical Gardens: The Botanical Gardens have a large infrastructure base, as well as knowledge on horticultural and gardening practices that can be a potential resource.

New SUB Rooftop Garden Committee: This committee is a collection of relevant stakeholders that is helping guide the development and design process. Members include representatives from AMS F&BS, the new SUB design team, the AMS, Sprouts, the UBC Farm, and SEEDS (the program through which this project is being facilitated),

2.3 Steps Taken

The first steps of the project involved reviewing relevant documents, including the 2010 LFS 450 reports, information on the SUB design process, as well as background literature on rooftop gardens, green roofs, and urban agriculture. Next, other buildings with notable rooftop gardens, as well as non-rooftop gardens, from which experiences, lessons, and best practices could be reported were identified. Interview were conducted with: local gardens, to gain information on growing conditions and gardening best practices; rooftop gardens, to research specific rooftop garden best practices; and gardens in other post secondary institutions, which could act as funding and management models.

[6] Centre for Community Based Research. What is Community Based Research? Retrieved December 4, 2010, from http://www.communitybasedresearch.ca/Page/View/CBR_definition.html

Interviews were done with mangers of the:

- Rooftop garden on the YWCA, Vancouver
- Rooftop garden on the Fairmont Waterfront, Vancouver
- Land and Food System (LFS) Orchard Garden, UBC
- Community garden at the UBC Botanical Gardens
- UBC Farm
- Rooftop "Sky Garden" at the University of Toronto, Ontario
- Rooftop Garden at Trent University, Peterborough, Ontario
- McGill University rooftop garden, Quebec

In addition, information from an LFS 450 interview of the District Main rooftop garden, Vancouver was incorporated. An extensive qualitative survey was developed as a template for guiding interview questions (Appendix A).

Based on findings from these interviews, discussions were had with potential purchasers and managing partners regarding what crops to grow, how to manage the garden (potential roles and contributions of partners), and options for food distribution. Interviews were done with:

- Sprouts
- UBC Botanical Gardens
- UBC Farm
- AMS F&BS
- AMS Sustainability Coordinator

Throughout the term, research was guided by input from the SUB Thematic Design Workshops, the Rooftop Garden Committee, and suggestions from Liska Richer (SEEDS) and Art Bomke (supervisor of the directed studies project).

From the research, interviews and stakeholder communications, best practices and responses to the research questions were developed. Communications build on the relationships developed with project partners, stakeholders, and other garden managers, as well as additional background research were used to fill in research gaps. Specific actions methods for the different research areas are outlined below:

Layout and Design

The existing Program Area for the rooftop garden was updated based on changes in SUB design plans. Verifications (and corresponding alterations) were made based on experiences from other gardens, and further research into the space requirements of the various components.

Crops and Crop Management

Crops were selected based on what can be successfully grown in the region (from local interviews and regional seed catalogues), what can feasibly be grown on a rooftop (with respect to rooting depths, management requirements, crop return period, and space efficiency), the relative income value of crops, and crops desired by potential purchasers. This included consideration of popular market items in the province. Crop area, based on a suggested crop rotation, was combined with data on yields and price data from the UBC Farm and BC Farmers markets to estimate total crop yield and associated income.

A suggested crop rotation was created based on rotations at the UBC Farm and other successful organic agriculture operations. This was combined with information on management best practices to start the creation of a management guide, containing resource materials for garden coordinators.

Human and Financial Resources

Different management scenarios and requirements for paid staff were compiled from other gardens. Based on the relative size of the rooftop garden, recommendations for human resource needs were made. Based on the contributions potential partners were willing to make, options for management were outlined. Sample job descriptions were made, and reviewed by the appropriate stakeholders.

While creation of a budget and economic model for the rooftop garden was beyond the scope of this project, garden management models are largely dependent on available funding. A list of potential funding sources was compiled based on the financial models of other gardens, and specific funding options available at UBC.

Phase Implementation

As the project proceeded, stakeholders' suggestions that would be difficult to implement initially, but have potential for implementation in the long-term were noted. Similarly, some options based on initial budget limitations were identified, and methods devised for plans to be adaptable to future changes, because many aspects of the project cannot be formalized at this point in time.

3. 0 Results and Discussion

Detailed results of interviews conducted throughout the term with garden managers and potential partners are available in Appendices B and C, respectively. References made to any of the gardens are based on personal communication as described in the interview summary notes.

3.1 Garden Objectives

Objectives of other rooftop gardens identified during interviews were: to be an educational tool for management practices, food security, and urban agriculture, as well as to contribute to social responsibility by providing food donations and producing high quality, fresh, nutritious food[7]. A goal of the LFS Orchard garden was to act as a miniature model of an agriculture operation. In order to be a farm model that incorporates the sustainability wishes expressed by students during design workshops, the social, environmental, and economic pillars of sustainability must be incorporated. Conversations with the SUB Rooftop Garden Committee and the Thematic Design Workshops have identified educational opportunities as aligning with the educational

[7] Sarah Brunelle, Alternatives (McGill University), Personal Communication, October 8, 2010; Carissa Murphy, YWCA, Personal Communication, September 27, 2010.

goals at the university. Furthermore, there is potential for the garden to become a recruitment selling point for the institution, similar to Trent University.

3.2 Garden Design

Layout

As of November 8, 2010, 1,040 m^2 (11, 190 square feet) were allotted to the Production Garden area, and 242 m^2 (2,600 square feet) were allotted to the Social Garden. Appendix D shows the tentative dimensions and layout of the new SUB rooftop, including garden space.

The Social Garden will be on level 2 of the building, and this role of this garden (as indicated by the SUB design team) will be low labour gardening, consisting mainly of herbs, edible flowers, certain perennials fruits, and non-edible plants that contribute to the aesthetics and architecture[8]. Options for garden design include raised beds and container gardening. While raised beds are easier to manage for more intensive cultivation, containers can be better integrated with seating areas, and can be arranged around other features of the space[9]. In addition, containers can be moved, adding an element of flexibility, are less weedy, and (depending on the roof infrastructure) light weight options exist.

The main Production Garden will be on the top floor (level 5). Table 2 shows the existing Program Area, based on previous SUB designs options.

Table 2 Existing rooftop garden Program Area[10]

Component	Area (m2)	Area (square feet)
Greenhouse	372	4,000
Composting System	45	480
Water Reservoir System	9	100
Garden Research Area	45	480
Beehives	19	200
Crops	604	6,500
Shed	45	480
Central Art Display	11	120
	1,148	1,2360

Having a greenhouse (as indicated in the existing Program Area) is beneficial for season extension, and the ability to save money by growing seedlings[11]. It serves to demonstrate all components of an agricultural operation for educational purposes, and is more convenient for staff when located on-site[12]. Greenhouses can also be heated using a building heat recovery system. The use of hoop houses or cold frames, however, will

[8] Rooftop Garden Committee meeting, November 1, 2010.

[9] Sarah Brunelle, Alternatives (McGill University), Personal Communication, October 8, 2010.

[10] LFS 450 Group 8 Report, 2010.

[11] Sarah Brunelle, Alternatives (McGill University), Personal Communication, October 8, 2010.

[12] Jay Baker-French, LFS Orchard Garden, Personal Communication, September 28, 2010.

minimize greenhouse needs, and for the size of the garden, a hobby-style greenhouse (approximately 3.5 m by 3 m) would be sufficient for seedling growth, although greenhouse-dependent mixed farms exist[13]. An example is Eliot Coleman's in Maine in which greenhouses occupy a quarter of the growing area. Large greenhouses, however, require additional infrastructure, such as fans and shade cloths, if they are to be used during the summer months. A slightly larger than a hobby-style greenhouse could potentially provide extra space, such as shelter for tours, meetings, and other groups during Vancouver's rainy winter months[14].

Composting systems in the researched gardens were generally small-scale, backyard composters. For example, the YWCA had a four-bin system that used up approximately 5 m^2, indicating that a fairly extensive composting system could be implemented in a smaller space than in the existing Program Area.

The beehives are still desired by the Rooftop Garden Committee. If the hives are facing off the edge of the roof, bee activities will be concentrated away from the garden, allowing for easier management for the beekeeper, and 2 m of buffer space for garden workers will be sufficient between the hives and nearby crops[15]. In addition, having a minimum of 3 hives is recommended for easier management by providing flexibility in moving frames among hives.

Design plans for rainwater collection now have the storage reservoir in the SUB basement, removing the need for it in the Program Area. The central art display has also been removed from the program area because it would take up valuable growing space, and would better serve the meditative goals of the Social Garden. Smaller art pieces and visual components, however can be incorporated into the space without requiring additional area.

Sheds are useful for storing tools and equipment for gardening and beekeeping. The LFS garden has an approximately 5 m^2 storage room, which they find to be somewhat limiting, however, because the main purpose is storage, a 45 m^2 as in the existing Program Area is likely larger than necessary; the District Main rooftop garden finds a much smaller shed sufficient.

Space for research area is designated as a separate space in the existing Program Area, however, integration of the research area into the crop production space allows for results that are based on soil that has undergone intensive cultivation and has a similar soil history to the rest of the garden[16]. This allows for findings to be applied to the rest of the garden. In addition, food produced in these projects is typically of appropriate quality for sale, and does not need to be kept separate.

The LFS 450 reports recommended container gardening for the productive area. Experiences at McGill have been that raised beds or a green roof completely covered in soil are a more productive use of space. The Fairmont finds raised beds more efficient for gardener workers. In addition, green roofs have more economic and environmental benefits for the building (as shown in Table 1), although considerations of leaks, the weight of the soil, precipitation inputs during wet Vancouver winters must be taken into

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[13] Mark Bomford, UBC Farm, Personal Communication, November 17, 2010)

[14] Art Bomke, Personal Communication, November 2010.

[15] Ann Carter, Master Beekeeper and President of the Central Interior Beekeepers Association, Personal Communication, December 16, 2010.

[16] Art Bomke, Personal Communication, November 2010.

account. The green roof at Trent, which is fully covered in soil, developed a leak after 15 years, and all the soil had to be moved aside in order to fix it. Between beds or rows, space is needed to walk, move produce with wheelbarrows, and carry out other management actions. In the LFS Orchard Garden, 30 to 40% of the space is cultivated, while in intensely cultivated gardens, roughly 50% of the space can be cultivated[17]. The YWCA has experienced difficulties in managing their garden due to a lack of walkways.

Because this project will be part of a new building, there is great potential to create a cutting edge rooftop garden, provided due care is taken in planning infrastructure needs and creating a garden that functions as a part of the building. Retrofitted elements of rooftop gardens are often difficult to implement and face many barriers. For example, the YWCA faced infrastructure problems and extra expenses in building their greywater system. Additional design considerations raised by garden managers during interviews included a service elevator that provides direct access from outside on the ground floor to the garden (without having to move materials through the building), and allotting space for washing and sorting produce in the Program Area[18]. It has been indicated that the architects will create a layout for the garden incorporating recommendations made in this report[19].

Access

Access to rooftop gardens can be limited. For example, the District Main Garden is only open to residents of the apartment building. Others, such as the YWCA, have open public access, but visitors must pass through the main lobby. For this reason, volunteers, fitness centre users, staff and building residents are the main users. At Trent University access is available only through tours or upon request, but visual access is provided from an overhead "Groundhog Walkway". The LFS Orchard Garden is completely open access, and has experienced occasional instances of vandalism.

Open access to the garden is important in promoting use, awareness and plays a role in the social and educational goals of the project[20]. However, for safety purposes, and because of drinking establishments nearby in the SUB and nighttime building users, there is the need for certain levels of security and supervision.

Water Resources

Watering systems used range from moveable overhead sprinklers, "underground" irrigation systems, drip irrigation, hand watering, and semi-hydroponic containers[21]. Semi hydroponic systems are not applicable to plans for the SUB rooftop garden, but drip systems were indicated to be optimal because they can be put on a timer for management

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[17] Mark Bomford, UBC Farm, Personal Communication, November 12, 2010.

[18] Carissa Murphy, YWCA, Personal Communication, September 27, 2010.

[19] Guillaume Savard, SUB Senior Project Manager, Personal Communication, Nov. 8, 2010.

[20] Jay Baker-French, LFS Orchard Garden, Personal Communication, September 28, 2010.

[21] Heather Wray, University of Toronto, Personal Communication, October 29, 2010; Aimee Blyth, Trent University, Personal Communication, October 21, 2010; Carissa Murphy, YWCA, Personal Communication, September 27, 2010. Graeme Evans, Fairmont Waterfront Director of Housekeeping, Personal Communication, October 28, 2010.

ease, and apply only required amounts, thus conserving water[22]. The UBC farm uses drip irrigation for land of a similar size to the planned rooftop garden, so drip irrigation is a reasonable consideration. Water outlets and the capacity to use overhead sprinklers is beneficial to have as a back up resource, and for specific scenarios, such as certain cover crops.

Various options exist for water sources. The majority of the gardens researched use the building water supply system, however rain collection is used at the District Main building, and the YWCA garden has developed a retrofitted greywater system. A rainwater reservoir is a possibility being considered in plans for the new SUB

In Vancouver, 1,224 mm of rain falls annually, although only 24% of this precipitation is between April and October[23]. In an average year, high water use crops require an additional 717 mm of irrigation to survive this seasonal water deficit. Based on the potential growing area dimensions provided for the layout (960 m^2 in addition to 45 m^2 in the social garden), this corresponds to an approximate annual need of 721 m^3 of water for irrigation. In order to support the garden, a rainwater reservoir system collecting from 590 m^2 of roof space would be necessary (based on Vancouver's annual average rainfall).

Soil

Soil depths of 30 to 46 cm of soil at the YWCA were able to support a wide variety of crops, including fruit trees. At the UBC Botanical Garden, 30 cm of soil is sufficient for growing fruit trees with dwarf rootstocks. Similarly, crop choice at Trent University and McGill was not restricted with 30 cm of soil, and they successfully grew artichokes, sweet potatoes, and other tubers without problems due to rooting depth restrictions. Their experiences also show the difficulty in transporting soil amendments or higher quality soil up to rooftop with limited access. Low quality, inexpensive soil takes time and effort to improve, and will initially have lower crop yields[24].

3.3. Crops

Interviews with potential food purchasers indicated that Sprouts was interested in crops that are available during the school year and provide variety to what is grown by the UBC Farm (although production at the farm encompasses a very diverse variety of crops). AMS F&BS is primarily interested in greens, herbs, berries, and certain specialty items, such as tomatillos. The list of potential crops that should be grown in the Production Garden, and rationale for selecting each crop is provided in Table 3. The table also shows the estimated yield and income for each crop. Additional benefits of Brassicas not mentioned in the selection rationale are that the UBC Farm has clubroot problems that decrease their Brassica production, and overwinter varieties can be harvested in the winter or spring (during the school year). Note that "value" considerations are based on the approximate income per area. Based on interviews with local garden mangers and

[22] Drip Irrigation.ca. Drip Irrigation Saves Money. Retrieved December 15, 2010 from http://www.dripirrigation.ca/HowTo_Save.asp

[23] Daniel Roher (2009). *Rooftop Agriculture: Greenroofs as Productive Envelopes*. UBC, Vancouver: Greenskins Lab

[24] Eamonn Watson, YWCA, Personal Communication, September 27, 2010.

regional seed catalogues, the crops selected can be successfully grown in the climate and can be produced in 30 cm deep soils. The use of a high diversity of crops, and including different families of crops will also help maintain the nutrient capacity of the soil (for example, legumes are nitrogen fixing) and prevent the development of disease.

Crops removed from the potential crop list include runner and broad beans, which are less space efficient than other bean varieties (and broad beans are require more intensive culinary preparation). Corn is also less space efficient, and a lower "value" crop. Asparagus takes three years until it will produce crops. Many fruits also have a low return period (depending on the crop), including kiwis, Asian pears, cherries, plums, peaches, and apples. These fruit generally have higher labour requirements, such as pruning. Rhubarb was a less desirable product for potential purchasers, and is of lower value than the berries. Melons were also removed from the crop list because they are more difficult to grow in the West Coast climate.

AMS F&BS and Sprouts were receptive to the development of a signature item, as suggested at the Thematic Design Workshops and Rooftop Garden Committee meetings. Rooftop berries was a popular suggestion, but an item that can be grown year round (or the selection of a different seasonal item for each season) were also suggested[25].

Table 4 outlines potential crops for the Social Garden, and their relative annual yields and income. This is based on the design team's suggestions that the garden should include herbs and edible flowers (which are AMS F&BS are interested in purchasing), and perennial fruits (figs and currants), which can be grown in containers and provide visual levels in the vegetation. This garden will incorporate a combination of aesthetics and production, and suggestions for non-edible plants, including evergreen hedges, deciduous vegetation, and grasses are outlined in Table 5.

The yields in Tables 3 and 4 assume intensive gardening, with 50% of the space being cultivated. Note that the areas assigned to each crop are based on the suggested crop rotation plan (refer to Appendix F) and that the total area exceeds the actual crop area due to some double cropping (however, this never exceeds 50% of the available area defined in the Revised Program Area at any given time). Total estimated yields are 950 kg from the Productive Garden, and 15 kg for the Social Garden per year, corresponding to annual incomes of $7,549 and $262 respectively. This totals 965 kg of produce and $7, 811 of income per year. Honey and other bee products may also provide additional income, depending on the partnership developed with beekeeper(s).

Comparatively, the YWCA garden yields approximately 650 kg from their 250 m^2 garden (2.6 kg/m); U of T yields 200 kg from 50 m^2 (4 kg/ m^2), and McGill yields 1000 kg from 1100 m^2 (0.9 kg/ m^2). The estimates for the UBC garden correspond to 1.0 kg/ m^2, making it a reasonable yet conservative estimate. Depending on management, the garden may be more productive than estimated; for example the Fairmont produces $16,000 worth of food (including honey) from their 240 m^2 garden each year.

[25] Lizzy Faulkes, Sprouts, Personal Communication, October 28, 2010; Art Bomke, Personal Communication, November 2010.

Table 3: Production Garden potential crop list and associated yield and income estimates[26]

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

[26] Crops: UBC Farm Market Data Sheet; Patrick Lewis, UBC Botanical Gardens Director, Personal Communication, November 10, 2010; West Coast Seeds Catalogue (http://www.westcoastseeds.com/)
Yields/Dollar values: BC Ministry of Agriculture (2008) Planning for Profit: Mixed Vegetable Crops. Victoria: Queen's Press; BC Ministry of Agriculture (2008) Planning for Profit: Mixed Berry Crops. Victoria: Queen's Press Victoria Farmers Market Prices (2008). Retrieved Novmeber 30, 2010 from
http://www.certifiedorganic.bc.ca/rcbtoa/services/moss-str-victoria-prices-2008.pdf.
Notes: Government of Alberta Agriculture and Rural Development (2009). Alberta's Commercial Vegetable Industry Synopsis. Retrieved December 3, from http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agp10893

	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**	

Table 4: Potential social garden crops and associated income and yield estimates[27]

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					

[27] Crops: UBC Farm Market Data Sheet; Patrick Lewis, UBC Botanical Gardens Director, Personal Communication, November 10, 2010; West Coast Seeds Catalogue (http://www.westcoastseeds.com/)
Yields/Dollar values: BC Ministry of Agriculture, Food & Fisheries (2002) Planning for Profit: Mixed Herb Crops. Victoria: Queen's Press. Victoria Farmers Market Prices (2008). Retrieved November 30, 2010 from http://www.certifiedorganic.bc.ca/rcbtoa/services/moss-str-victoria-prices-2008.pdf

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**

Table 5: Options for hedges and non-edible vegetation[28]

Vegetation	Notes
Ornamental Grasses	Can remain through winter, complement flowers
Feather reed grass (*Calamanrostis acutiflora* 'Karl Foerster'	1.2 m high, 0.5 m wide; full sun; easy to grow; hardy
Miscanthus (cultivar: Yakushima Dwarf)	1 m high, 0.5 m wide; full sun; easy to grow; hardy
Giant feather grass	2.5 m high, 1.2 m wide, full sun, easy to grow, hardy; looks good with S*alvia nemorosa* 'Caradonna' and A*llium hollandicum* 'Purple Sensation'
Panicum virgatum 'Shenanhoah'	1.5 m high, 0.8m wide; full sun; easy to grow; hardy
Evergreen Hedges	
Cedar (Thuja occidentalis 'Smaragd')	Height: prune as desired; full sun; easy to grow; hardy; evergreen; good performer; needs pruning
English Yew (Taxus baccata)	10 m high, 6 m wide; full sun to shade; easy to grow, hardy; classy hedge and good as a perennial border; expensive and slow growing; provides a deep green screen, even in small spaces
English Laurel (Prunus laurocerasus)	1 m high, 2.5 m wide; full sun or partial shade; easy to grow; hardy; bright evergreen leaves
Privet (Ligustrum ovalifolium)	4 m high, 4 m wide; full sun or partial shade; easy to grow; hardy can make an attractive hedge that stays green all year round in mild areas (especially the golden leaf form); *Laurus nobilis* and *Echinops bannaticus* 'Taplow Blue'
Boxwood (Buxus sempervirens)	Short evergreen hedge (up to 5 m high and 5 m wide, dwarf versions available), easy, full sun/partial shade, hardy
Photonia (Christmas berry)	4 m high, 4 m wide; full sun or partial shade; easy to grow; looks good with *Chaenomeles speciosa* 'Geisha Girl' and *Forsythia x intermedia* 'Spectabilis'
Japanses privet (Ligustrum japonicum)	3 m high, 2.4 m wide; full sun; easy to grow; hardy
Maculata (Elaeagnus pungens)	4 m high, 4 m wide; full sun to shade; easy to grow; hard; insignificant but strongly scented white flowers in winter months; looks good with *Sarcococca confusa* and *Garrya elliptica*
Laurustinus (Viburnum tinus)	2 m high, 2 m wide; full sun to shade, easy to grow; hardy; looks good with *Choisya ternata* (Sundance) and *Elaeagnus pungens* (Maculata)
Spotted Laurel (Aucuba japonica)	3 m high, 3 m wide; full sun to shade, easy to grow; hardy; slow growing; may be strictly pruned as hedges, left to grow unchecked, or lightly trimmed to shape once annually
Apple Blossom (Escallonia)	2.5 m high, 2.4 m wide; full sun or partial shade; hardy; shelter from cold winds

[28] Outside Contemporary Garden Design, Vancouver BC. Ornamental Grasses. Retrieved December 8, 2010 from http://www.outsidegardendesign.ca/vancouver-garden-design-ornamental-grasses-landscape; Whysall, S. (2008). Best Hedge Choices. Vancouver Sun. Retrieved November 15, 2010. http://www.vancouversun.com/life/in-the-garden/gardening-tips/Best+hedge+choices/898082/story.html; BBC Plant Finder. Retrieved December 8, 2010. http://www.bbc.co.uk/gardening/plants/plant_finder/

Deciduous Hedges	Interesting skeletal branches in winter and crisp new foliage in spring, require shearing more than once a year
Roses (especially rugosa roses, eg. 'Hansa')	1.7 m high, 17 m wide; full sun or partial shade; easy to grow; partial shade; requires pruning
Beech	Easy to grow; full sun; hardy
Forsythia (d)	3 m high, 1.8 m wide; full sun; easy to grow; hardy
Rhododendrons and camellias	Can be trained into hedges

3. 4 Crop Management

Some of the gardens researched, including the UBC Farm, LFS Orchard Garden, and YWCA, adhere to organic management practices, but have not gone through the rigorous certification process. Successful organic management requires a strict crop rotation, and experiences in the LFS Orchard Garden and at the YWCA indicate the need for institutional memory mechanisms to maintain knowledge of management practices and experiences, including the crop rotation, from year to year. Many of the rooftop gardens also found disease to be less of a problem compared to ground level gardens[29].

Some of the seed sources for local gardens were West Coast Seeds, Cedar Rim, Veseys, and GardenWorks, as well as from seed saving programs[30]. The opportunity also exists to grow heritage varieties, as at Trent University. Caution should be exercised in accepting plant donations, because they can be a source of disease, which occurred with the raspberry plants at the YWCA.

Season extension practices used in the lower mainland include hoop houses or cold frames to start seeds earlier, and grow crops later into the fall[31]. Removable designs can be constructed for flexible management with the crop rotations and between crops as the season progresses, a model design can be observed at the UBC Botanical Gardens. Hoop houses or poly houses can also be used to protect certain crops (such as tomatoes and peppers) from the wet climate. Greenhouses and indoor areas can be used to start seeds in the spring[32]. In addition, with the mild Vancouver climate, winter gardening is an option, and the UBC Botanical Gardens successfully cultivate one third of their community garden during the winter. Caution must be exercised with extensive season extension. Depending on the condition of the soil, cover crops and allowing the soil to lay fallow may be necessary to maintain soil health in the long-term.

A further necessary management option for maintaining soil health is a composting system. Composting systems should incorporate garden waste, but additional inputs are required to account for the produce removed. Trent University uses food waste from a student-run restaurant, while at UBC, the LFS Orchard Garden and the Farm have explored UBC compost as an option (although the LFS Garden managers found it to be weedy). Reliable nitrogen sources are a problem at the UBC Farm, and they are currently exploring new sources, and willing to cooperate with the Rooftop garden in obtaining such sources. In addition to compost, soil amendments used in other gardens include

[29] Ted Hutchinson, Trent University, Personal Communication, October 21, 2010., Carissa Murphy, YWCA, Personal Communication, September 27, 2010.

[30] Eamonn Watson, YWCA, Personal Communication, September 27, 2010.

[31] Carissa Murphy, YWCA, Personal Communication, September 27, 2010.

[32] Aimee Blyth, Trent University, Personal Communication, October 21, 2010.

cover crops, manure, alfalfa pellets, lime, boron, and sul-po-mag[33]. These amendments can be particularly effective if based on annual soil tests, like at the UBC Farm.

Rooftop gardens are generally warmer and drier than ground level gardens[34]. Although this results in a longer growing season, rooftop gardens must be watered more frequently. Given this, best practices include mulching, and watering during cooler hours of the day[35]. In addition, different microclimates are present across the roofscape[36]. Wind direction, aspect, and shading all effect localized conditions on the roof, to the extent that the Fairmont rooftop garden managers are planning to grow mushrooms in a particularly damp, cool zone. Plants can be used to act as bioindicators of these microclimates, and management actions, such as planting large wind breaking vegetation, can decrease certain effects[37].

3.5 Produce Distribution

Options for produce distribution used in other institutions include donations to volunteers and food banks, Meals on Wheels, or other programs for needy individuals[38]. Produce sales, however, are an important source of income for the garden, and student cafes, weekly markets, and Community Supported Agriculture (CSA) weekly box distribution programs would be a more favourable option[39]. Options can also be created for mutually beneficial relationships, for example if the beekeeper works for free in exchange for the honey collected. The LFS Orchard Garden tried distribution through a list-serv with limited success, and found it a work intensive method. They also found the fluctuating variety and quantities of produce available throughout the growing season a challenge. Furthermore, the school year and main growing season are during opposite times of the year. While management practices can extend the length of the growing season, distribution plans must account for the fact that during the summer the UBC campus population decreases, and Sprouts and other student initiatives do not run. During the summer, the student-run café at Trent University works to preserve food for the school year. Plans for excess and unsold produce, however, should be created, as not to waste any food[40].

Based on these options, investigation of the potential roles of the garden's partners in food distribution revealed Sprouts' interest in using produce for in-store stales, their restaurant, and their bi-weekly CSA box program. While the garden would not be able to provide majority vegetables in large enough quantities and at bulk prices for the major AMS F&BS outlets, specialty items used in small quantities could be bought. Their catering service, and a higher-price point restaurant that may be incorporated into the new SUB would be more likely to use rooftop garden produce.

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[33] Andrew Rushmere, UBC Farm Academic Coordinator, Personal Communication, October 28, 2010.

[34] Graeme Evans, Fairmont Waterfront Director of Housekeeping, Personal Communication, October 28, 2010.

[35] Aimee Blyth, Trent University, Personal Communication, October 21, 2010.

[36] Carissa Murphy, YWCA, Personal Communication, September 27, 2010.

[37] Ted Hutchinson, Trent University, Personal Communication, October 21, 2010.

[38] Sara Brunelle, Alternatives (McGill University), Personal Communication, October 8, 2010; Heather Wray, University of Toronto, Personal Communication, October 29, 2010.

[39] Aimee Blyth, Trent University, Personal Communication, October 21, 2010.

[40] Carissa Murphy, YWCA, Personal Communication, September 27, 2010.

Furthermore, this fall, the AMS ran farmers markets that have potential to be expanded to a longer season and incorporate produce from the rooftop garden. The UBC Botanical Garden expressed interest in their weekly Wednesday Salvation Army pick-ups as being an outlet for food from the garden going to waste, as did the Community Eats program. The UBC Farm would be willing to sell items that they do not produce, or that they produce only in small quantities in their market or to create variety in their CSA boxes. In addition, Sprouts, AMS F&BS, and the Rooftop Garden Committee were receptive to the idea of developing a signature item for the garden, and saw marketing potential for such an item.

3.6 Human Resources

The majority of gardens researched have paid employees to manage a portion of the work. In contrast, the YWCA is completely volunteer run, but has a very dedicated volunteer who oversees operations and contributes many hours. Similarly, the U of T garden has only been in operation for one growing season, and was volunteer run, but had 3 student coordinators who received $3,200 honorariums. This garden, however, is much smaller that the planned SUB rooftop garden, and the coordinator position(s) will require a larger time commitment. Table 6 shows the hours worked by paid employees throughout the year in different gardens. On average for the gardens, this equates to 0.6 hours per square meter during the summer, and 0.3 hours per square meter in the winter to manage late crops, ordering, planning, and other administrative tasks.

Table 6: Summary of hours worked by paid employees in gardens researched

Garden	Growing Season (h/week)	Winter (h/week)	Garden Size (m^2)
LFS Orchard Garden	20	10	250
UBC Farm*	490-525	175-210	120,000
Trent	30 (60 h for 5-6 weeks during harvest)	10	4000
Fairmont	16		240
McGill	70	35	1100
Botanical Gardens	24-30	6-12	190

*Equivalent to 14-15 full time positions in the growing season, and 5-6 positions in the winter

A variety of management options were illustrated in the gardens studied. McGill has a year-round full time employee, in addition to hiring a summer student each year. The program is currently trying to secure funding for a second permanent full time, year-round position. The director of housekeeping oversees the Fairmont garden, and garden management is contracted out. At the UBC Botanical Gardens, a horticulturalist oversees the community garden as part of his position. It can be noted that this garden has more fruit trees and perennials that require pruning and more maintenance, increasing the human resources needs. At Trent University, a work-study student position is full time for 20 weeks during the growing season, and part time through the winter. For the parts

of the growing season that overlap with the school year, the position is often shared between two students.

All of these gardens had volunteers doing a portion of the work. The LFS Orchard Garden found it difficult to recruit student volunteers during the summer months, while the U of T garden found the opposite. McGill and the UBC Farm had success with creating scheduled work sessions a few times a week.

In general, experiences in these gardens revealed a need for a stable overseeing individual or group to maintain functioning of the garden, and ensure that management is adhering to the project objectives[41]. The LFS Orchard Garden has an advisory committee of relevant stakeholders, including professors and building managers, helping fill this role. An additional recommendation from the LFS Orchard Garden manager was to split student coordinator positions into two roles to allow for sharing of ideas, thoughts, and solutions to any problems encountered.

Based on the paid staff required to manage other gardens, and the relative size of the planned SUB rooftop garden, roughly 60 hours per week in the growing season, and 30 hours per week during the winter will be required. Some of these gardens, however, show that successful volunteer management can reduce the number of paid staff hours required. Andrew Rushmere, the UBC Farm Academic Coordinator, indicated that the role could likely be managed by the equivalent of a full time year-round coordinator.

In discussion with potential managing partners, Sprouts indicated that a Sprouts Board of Directors position could be created for a rooftop garden liaison to coordinate food distribution to Sprouts, help manage volunteers, and work on any programs that could involve collaboration between the rooftop garden and Sprouts. Justin Ritchie, the 2010-2011 AMS Sustainability Coordinator, said the position could likely contribute 8 to 10 hours per week in the summer, and 5 hours per week in the school year to working on the garden. Potential tasks include grant writing and completing funding applications, volunteer management, and acting as an AMS liaison.

For the main coordinator position(s), one option is to create two student positions through the UBC Work Study Work Learn program. This position would only be available to students (who would have to balance the role with their courses), and the university would subsidize wages. However, each work-study position needs to be reapplied for each session, and the funding is not guaranteed. The UBC Farm currently oversees the LFS Orchard Garden work-study positions, and could potentially help oversee this role, provided external funding was found for the wages. In addition, the coordinator would have to be an AMS staff member, but currently the only AMS offices that can support work-study students are Archives and Design[42]. With the approximately $9 per hour UBC Subsidy, the garden would have to fund roughly $6 per hour. For 2 student positions of 20 hours per week in the summer and 10 hours per week in the school year, $6, 300 dollars would be required.

Another option is to have a full-time coordinator position, that is not necessarily a full time student and who may have more flexibility and a greater skill set. Because the salary would not be subsidized, more funding would be required, or wages would have to be lower. If a coordinator worked 40 hours a week for 20 weeks during the growing

[41] Jay Baker-French, LFS Orchard Garden, Personal Communication, September 28, 2010

[42] David Hannigan, (AMS Senior Manager, Human Resources) Personal Communication, November 17, 2010.

season and 20 hours per week the rest of the year, at $8/h, $11,520 would be required for wages.

Garden coordinators will likely have varying expertise, and providing access to training materials will be integral. While the UBC Farm already has volunteer programs and a yearlong practicum course, no short-term introductory programs exist. The UBC Farm and the Botanical Gardens both expressed interest in creating a "Getting Started with Gardening" workshop for coordinators, as well as the wider UBC community.

Management of the beehives is a more specialized role, and requires more expertise. The LFS 450 groups made contact with Allen Garr, an experienced urban beekeeper, who was interested in maintaining the beehives for free in exchange for the honey, 24-hour access and free parking[43]. A similar relationship is successfully used with the bees at Trent University. The UBC Farm also has bees, and there may be potential to collaborate with their beekeeper(s).

3.7 Financial Resources

Many of the gardens surveyed started with grant funding, including the YWCA, McGill, U of T, Trent. Grant sources used by other organizations are the Young Canada Learn Foundation, UBC Teaching and Learning Enhancement Fund, and funding from municipalities, governments, universities and community or non-governmental organizations, in addition to personal donations[44]. In-kind donations were also a source of start-up tools and other materials. Such donations are often faster and more feasible for companies to implement[45]. Corporate sponsorship is another option, and can capitalize on the public relations and social responsibility programs of corporations. U of T received sponsorship from Home Depot, and contributions from RONA were discussed at the Thematic Design Workshops. Sources of ongoing funding at Trent and McGill Universities are annual student levies. The Trent University rooftop garden also found that taking advantage of the many resources around the campus (ranging from cardboard to weed wackers) and cooperating with the institution and campus groups saved money. Wages were identified as the largest cost for gardens[46]. Creating positions through the university student worker subsidy programs, as at Trent University, can reduce funding needs. Creative uses of resources, such as seedling sales, or use of the space for social events can act as sources of income beyond crop sales[47].

It is clear from these findings that most gardens do not function without external funding. For this project to proceed, sources of start-up resources and initial funding need to be secured, and plans made for longer-term financial resources. While the idea of

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[43] LFS 450 Group 8 Report, 2010.

[44] Liska Richer, Personal Communication, October 27, 2010; Heather Wray, University of Toronto, Personal Communication, October 6, 2010; Andrew Rushmere, UBC Farm Academic Coordinator, Personal Communication, Oct. 28, 2010.

[45] Carissa Murphy, YWCA, Personal Communication, September 27, 2010.

[46] Sara Brunelle, Alternatives (McGill University), Personal Communication, October 8, 2010.

[47] Andrew Rushmere, UBC Farm Academic Coordinator, Personal Communication, Oct. 28, 2010; Aimee Blyth, Trent University, Personal Communication, October 21, 2010.

economic sustainability does not align with the objectives of all projects (for example those developed more for educational purposes), such practices do not model financial sustainability. Financial resources can be a constraining factor in development, and the constant need for funding applications and new sources of resources can be a large consumer of human resources.

3.8 Educational Opportunities

Although research of educational opportunities was not a specific project goal, many were encountered in interactions with stakeholders and garden managers, so these results were included. Educational initiatives undertaken in the gardens researched include incorporation of the garden into university courses, research projects by professors and students, tours, and volunteer programs[48]. An extensive variety of workshops are facilitated though the gardens on topics such as seed saving, bee keeping, planting, cultivation, preservation, composting, winter gardening, and organic practices[49]. More passive programs, including crop labels, and information signs are another option[50]. The UBC Farm also shows more extensive partnership programs developed with external partners, such as the Aboriginal Community Kitchen Garden program, and the Mayan Garden. These initiatives show the diversity of opportunities to involve the student body and UBC community in the garden, and achieve the social and educational objectives.

Research done by the LFS 450 groups indicated that community members, and professors from the Faculties of Land and Food System, Commerce, and Landscape Architecture were interested in running seminar, workshops, and using the space in university courses[51]. Topics of interest were broad, ranging from medicinal plant use, and green roofs to urban beekeeping. The garden could also be used for elementary and secondary school awareness and educational programs.

3.9 Phase Implementation

Uncertainties in the management and financial models of this project indicate that it will take time to develop such mechanisms. As time progresses, unexpected barriers to project implementation will be met, and management strategies will have to be adapted accordingly. This may include changes in crop selection or management practices. The garden interviews revealed that many gardens develop infrastructure, such as greenhouses and irrigation, over the years, particularly because such equipment can be expensive when budget is limited during the start-up phase[52]. Certain practices, such as composting, however, are integral to the sustainability and success of the garden, and should be implemented immediately. Distribution options that are already in place, such as Sprouts, will be more feasible to implement during the first season of the garden.

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[48] Jay Baker-French, LFS Orchard Garden, Personal Communication, September 28, 2010; Andrew Rushmere, UBC Farm Academic Coordinator, Personal Communication, Oct. 28, 2010.

[49] Heather Wray, University of Toronto, Personal Communication, October 6, 2010; Aimee Blyth, Trent University, Personal Communication, October 21, 2010.

[50] Carissa Murphy, YWCA, Personal Communication, September 27, 2010.

[51] Jay Baker-French, LFS Orchard Garden, Personal Communication, September 28, 2010.

[52] Carissa Murphy, YWCA, Personal Communication, September 27, 2010.

Development of an AMS Farmers Market, and programs that do not currently exist in the ideal capacity may be postponed, provided other options for crop sales are sufficient, and income is not being sacrificed.

As at exhibited by the gardens as other institutions[53], the employment structures evolve as garden needs and the availability of financial resources change. Transitions observed were from largely volunteer-run gardens, to the creation of student positions, and even the creation of external full time roles. For the AMS SUB garden however, student involvement in managing the garden provides educational and leadership opportunities for students, and helps facilitate student involvement on campus.

Many options for future projects exist, and managers of the McGill garden voiced the need for transparent, multi-stakeholder approaches during project implementation in post-secondary institutions. Potential future projects include the expansion of educational initiatives or the introduction of more new or different crops (such as fruit trees or asparagus); particularly those that may have longer produce return periods, and may require longer-term financial stability. The idea of renting out plots to community members was raised at the Thematic Design Workshops and committee meetings, although questions of liability, and whom plots should be rented to were raised. Appendix E provides an outline of the rental agreement system used in community garden at the UBC Acadia Park family residences for future reference.

4.0 Recommendations

4.1 Garden Objectives

Based on opportunities for the role of the garden identified, key objectives should be to act as a model urban farm, exhibiting environmental, social, and economic sustainability with respect to the operations of the garden, and its contribution to the AMS and SUB as a whole. The social component should include using the garden as an educational tool, as well as improving to the overall food security of the SUB and UBC Community, with respect to the accessibility, appropriateness, and availability of food. A multi-stakeholder approach to implementation will help create a rooftop garden that the AMS and student body can be proud of and that will contribute to UBC's reputation as a global leader in sustainability.

4.2 Garden Design

Table 7 shows the recommended revised Program Area for the Production Garden. The crop area would ideally be a series of raised beds with 30 cm of high quality growing soil, this allows for some of the economic and environmental benefits of green roofs (as shown in Table 1), but is lighter and has lower soil costs compared to a full green roof. Considerations of leaks, the weight of the soil, precipitation inputs during the wet Vancouver winter must be taken into account. The garden should be equipped with a drip irrigation system, as well as the capacity for overhead sprinkling if required. A

[53] Heather Wray, University of Toronto, Personal Communication, October 6, 2010; Sara Brunelle, Alternatives (McGill University), Personal Communication, October 8, 2010); Aimee Blyth, Trent University, Personal Communication, October 21, 2010.

rainfall collection area of approximately 600 m^2 that is stored in a basement reservoir is recommended to supply the garden with the necessary irrigation water, although greywater reuse is another option.

Recommendations for the layout of the area are to have a main entrance with the shed, greenhouse and sorting area, and to have the bee hives away from the entrance at an edge of the roof, with the colony openings facing away from the garden. A central, accessible main pathway through the garden would be beneficial for users and tours. There is also potential for small-scale art throughout the garden.

Access should be as open as possible. Due to the need for supervision, especially at night, open hours for the garden can be scheduled, in addition to tours, volunteer shifts, and individual requests. Note that the social garden will have the same hours as the building, because it is a lower risk operation with a primary mandate of being an outdoor social space. Due to the possibility that there will be times when access to the garden is limited, consideration of outside-inside interaction methods should be made. Options include overhead walkways, windows, and transparent doors and barriers. In particular, these can be planned in coordination with the location of restaurants and other SUB operations.

Based on infrastructure needs addressed in the report, a requirements and considerations include:

- A service elevator with direct outside to garden access
- Rooftop water hose, faucets, and sinks
- Greenhouse
- Shed
- Composters
- Drip irrigation system
- Hoop houses /cold frames
- Walk in cooler
- Water reservoir or greywater reuse system
- Greenhouse building heat recovery system

Table 7: Production Garden Revised Program Area

Component	Area (m^2)	Area (sf)	Notes
Composting system	9.0	97	
Apiculture	9.0	97	3 bee hives
Shed	12.0	129	
Washing/sorting area	9.0	97	Covered with sink & tables, attached to shed
Crop Area	960.0	10,333	50% of the area will be required for walkways, includes potential research plots
Greenhouse	32.0	344	
Filler Space	8.5	93	Space between structures/garden, room for perennial container gardening expansion
TOTAL	1039.5	11190	

Container gardening is the most appropriate option for the Social Garden. Containers that provide 40 cm (38 cm figs, 40 cm for currents) of soil will be sufficient for the

rooting depth needs of the edible crops, however, deeper soils may be required depending on the non-edible plants selected by the landscape architects. Table 8 shows a possible Program Area for the Social Garden. This is a hypothetical layout and subject to changes by the design team and architects, however, and was developed largely to provide estimates for yields and income based on edible crops grown in the Social Garden. In addition, individual container dimensions can be according to the architects, as can the type of container, based on aesthetic needs and weight capacity of the roof. A container drip irrigation system is recommended.

Table 8: Potential Social Garden Program Area

Component	Area (m^2)	Area (sf)	Notes
Containers	45.0	484	Herbs, edible flowers, figs, currents, non-edible vegetation
Art & Water	16.5	177	Central display or multiple smaller pieces, fountain/pond
Seating	180.0	1938	Tables, chairs, benches
TOTAL	241.5	2599	

4.3 Crops and Crop Management

Recommended crops for the Productive and Social Gardens are provided in Tables 3 and 4. The crop yield and income estimates should be incorporated into the development of a detailed budget for the garden. Table 5 outlines additional options for the selection of non-edible vegetation by landscapes for the Social Garden based on their desired design elements. For example, evergreen hedges can provide structure to the space and create barriers between seating areas, even in the winter. A detailed Crop Management Guide (Appendix F) has been created, incorporating the management techniques and recommendations from interviewed garden managers. It also contains a detailed crop rotation plan, and has been designed as a working document that can be edited as the project progresses, documenting best practices and experience, and contributing to the project's institutional memory

4.4 Produce Distribution

Throughout the full growing season, food can be sold to AMS F&BS, for distribution of specialty items in their catering services, restaurant outlets, and potentially a higher price point restaurant, if this is incorporated into the new SUB plans. The existing AMS Farmers Market can be expanded to be a weekly event throughout the growing season for sale of all produce. There is potential to collaborate with the UBC Farm, LFS Orchard Garden, and other campus groups in this initiative. While the UBC Farm distribution programs could incorporate certain items (those that the Farm does not produce, or only produces in small quantities), this can only be regarded as a complementary option to the others discussed. Mechanisms where all types of rooftop garden crops can be distributed are more favourable.

In summer, the Salvation Army can pick up leftover food each Wednesday when they collect food donations from the UBC Botanical Gardens. Donations can include

produce items that will not last in storage until their next possible use or produce that is too low in quality for sale. Volunteers can also take leftover food home.

During the school year, produce can be sold to Sprouts for in-store sales, restaurant use, and their CSA box program. Leftover food can be donated to the Community Eats program that runs through Sprouts, and, in weeks when the program does not run, weekly donations to the Salvation Army can be continued.

For sales at any restaurant outlets, potential marketing schemes include weekly rooftop garden lunch specials. A rooftop garden signature item can be a marketing focal point in all distribution methods, whether the product is being sold fresh, or is incorporated into secondary product (such as blueberries being featured with an ice cream desert special). Potential signature crops are berries,

Storage and preservation options include a walk-in cooler (as used at the UBC Farm) to keep produce between weekly markets and sales. A walk-in cooler and space for storage of long-lasting and easily stored items should be incorporated into the new SUB design. Although a root cellar was discussed in the 2010 LFS 450 Reports, a walk-in cooler has more potential to store a wide variety of crops; root cellar temperature and humidity requirements vary for different foods, and this method of storage is not applicable to all produce. Refer to the Crop Management Guide (Appendix F) for specifications on storage conditions, methods, and time periods of different crops. In addition, root crops can be stored into the school year in the ground. Preservation of other crops, such as berries, can be done at volunteer work bees, or incorporated into education initiatives. For instance in jam making workshop, participants could make jam, and take home a portion of the product, while leaving the rest to be sold by the garden.

4.5 Human Resources

Similar to the advisory committee for the LFS Orchard Garden, a Rooftop Garden Advisory Committee should be formed, that will likely have similar composition to the current garden committee for the design phase, and can potentially transition from the existing committee. The AMS Sustainability Coordinator and a Sprouts Rooftop Garden Liaison should act as support staff for as Garden Coordinator. The Potential job descriptions are outlined in Appendix G and have been reviewed by Lizzy Faulkes (2010-2011 Sprouts President), Justin Ritchie (2010-2011 AMS Sustainability Coordinator), and members of the Rooftop Garden Committee. A structured volunteer management program, similar to that of the UBC Farm that involves orientation sessions, and specific volunteer shift times throughout the week is ideal.

For the Garden Coordinator, options exist for a single full-time role of 40 h/week for 20 weeks during the growing season, and 20 h/week the rest of the year, or two positions of 20 h/week during the growing season and 10 h/week during the winter. If student work-study positions can be created, this second scenario would be financially favourable.

Closer to the time of project implementation, relationships should be formed with a local urban beekeeper or beekeepers from the UBC Farm to solidify the management of the rooftop apiary.

4.6 Financial Resources

Potential sources of funding, in addition to income from food product sales, for the rooftop garden include:

- Donations and grants from UBC, NGOs, community organizations, the municipality and other levels of government. Specific options are: the AMS Innovative Projects Fund, the UBC Teaching and Learning Enhancement Fund, and the Young Canada Learn Foundation. In addition the University of Toronto is involved in creating a charitable status Canadian organization with a mandate of initiating urban agriculture projects in cities and educational institutions around Canada that may be able to provide future support.
- In-kind donations from companies for start-up materials and tools, or for annual material needs, such as seeds.
- Monetary or in-kind corporate sponsorship, either ongoing or one-time, can improve public relations of the company and act as advertising, while economically benefiting the rooftop garden. An example is the construction of a RONA Greenhouse.
- Creative use of resources and side projects can also act as a source of income, such as creating higher value products (for instance, selling 'mixed greens' bags), or growing extra seedlings for a profit.

While monetary or in-kind donations are ideal for short-term needs, capital costs, and starting new programs, some necessary longer-term funding sources include:

- An AMS Green Fee or Sustainability Fee that has been mentioned as part of an increase in student AMS fees can act as a stable source of funding. Similarly, a restructuring of the AMS budget and funding that may accompany construction of the new SUB could include annual contributions to the rooftop garden.
- The UBC Work Study Work Learn program can subsidize wages of rooftop garden student employees.

To contribute to the goal of modeling economic sustainability, in the long-term, the project should strive for self-sufficiency. Further research should be done to glean economic best practices from similar projects, and using successful urban agriculture programs as a model. One best practice is the implementation of cost recovery mechanisms for services the rooftop garden provides. This may include holding events in the space for a user fee, or for charging for workshops run through the rooftop garden.

4.7 Educational Opportunities

There is a great potential for individual garden coordinators or other interest groups to pursue a variety of initiatives. Potential opportunities for educational and awareness programs associated with the rooftop garden include:

- Collaboration with UBC staff, faculty, and students to incorporate the garden into courses and research projects.
- Volunteer opportunities.

- Garden tours and the potential for the garden to be incorporated into UBC campus and recruitment tours.
- Collaboration with local elementary and secondary schools.
- Workshops and seminars for students and the UBC community.
- Partnership programs with other campus and community organizations.

4.8 Phase Implementation

Phase implementation for the management staff is important. Because the AMS Sustainability Coordinator is an existing position, their role could come into play leading up to construction completion in securing sources of funding for the first year of the project. Early transition into this role would also include a hiring process (in cooperation with the Rooftop Garden Advisory Committee) for the Garden Coordinator(s). The coordinator should be hired in the winter before in order to have sufficient time to prepare and organize for the first growing season. Depending on the financial state of the project, one of the roles for the first year of the coordinator(s) can be in identifying future sources of funding, as well as making recommendations for future based on the workload. This may also include looking into the creation of a work-study position within the AMS. The Legislative Procedures Committee is currently developing a strategy for work-study within the AMS, and this strategy should consider the needs of the rooftop garden[54]. The decision to create a work-study position depends on the garden budget and work-study capacity within the AMS.

Initial financial limitations can be dealt with through the phase implementation of infrastructure. This includes postponing construction of a greenhouse. The UBC Botanical Garden has offered to cooperate with the rooftop garden and provide greenhouse space for seedling production.

If other distribution options exist, delaying development of an AMS Farmers Market can decrease the workload when other start-up tasks are pressing. Furthermore, building the soil capacity is a main priority over season extension practices. Decreasing season extension practices during garden start-up can also decrease labour needs. Programs that require greater financial stabilization or more human resource needs may be implemented when the project is more established, including more diverse educational programming, more diverse crops, and the creation of rental plots. Overall, a flexible approach to the project is necessary, and the ability to adjust to management issues will be crucial.

4.9 Recommendations for Future Research

This project will require further solidification of relationships with potential partners as it proceeds, and designs for the new building are finalized. Specific areas for which additional research is recommended before the implementation of the project are:

- To develop an introductory gardening program for garden coordinators and the UBC community in collaboration with the Botanical Gardens and UBC Farm.

[54] David Hannigan, (AMS Senior Manager, Human Resources) Personal Communication, November 17, 2010.

- Create a detailed business plan with budget based on estimated income and total needs discussions. This includes start up and recurring costs.
- Design a walk in cooler (preferable over a root cellar) and preservation plan incorporating the needs of the rooftop garden and other groups within the SUB and AMS.
- Create a detailed composting plan and soil management guide, including nutrient management and soil amendments (and potential sources for these inputs).
- To develop the capacity for rooftop garden work-study students within the AMS.

5.0 Conclusion

Based on the experiences of other rooftop gardens, and gardens at post-secondary institutions and in the Lower Mainland, as well as the perspectives of stakeholders and potential project partners, best practices for the functioning of the new SUB Rooftop Garden have been outlined. This includes a discussion of layout, design, and infrastructure needs for the architects, and a potential list of crops and associated yields and incomes for the Productive and Social Gardens, as well as the initial phase of a management guide. Options and recommendations for human and financial resources, educational opportunities, and phases of garden implementation have all been identified. This provides insight into the next steps that should be taken in order to achieve the goals of the project in creating an urban agriculture operation that models environmental, economic, and social sustainability, and that UBC and the AMS can be proud of.

6.0 Acknowledgements

The contributions of potential project partners, including Nancy Toogood (AMS F&BS), Mark Bomford and Andrew Rushmere (UBC Farm), Lizzy Faulkes (Sprouts), Patrick Lewis (UBC Botanical Gardnes), and Justin Ritchie (AMS Sustainabilty Coordinator) were crucial to the development of this project. Similarly, input from the design team and stakeholders at Rooftop Garden Committee Meetings and the SUB Thematic Design Workshops was much appreciated. In particular, Adreanne Doyon, the 2010-2011 New SUB Project Coordinator, was extremely helpful in providing information on the development of SUB plans and coordinating meetings. Thank you, also, to the mangers of the gardens who were interviewed, and provided their valuable knowledge and experiences. Lastly, thank you to Liska Richer, SEEDS Project Coordinator for facilitating the project, and to the directed studies project supervisor, Art Bomke, for his insight and suggestions.

Appendix

A. PRODUCER SURVEY

Building Process
Design: *Roof architecture and design?* *Planting set-up (containers, raised beds, etc.)?* *Satisfaction with design?*
Materials
Costs
Implementation process? *Phases, built retroactively, etc.?*

Soil
Type/source
Depth
Management *Deficiencies?* *Required additives, fertilizers, inputs?* *Impacts of various crops on soil fertility?*

Crop Component
What is grown *Food Crops?* *Non-food crops?* *Success?*
Output Quantities?
Management Techniques? *Organic?* *Processes?* *Rotations?*
Crop Health? *Encountered problems (diseases, pathogens, etc.)*
Growing season? *Extended season crops?* *Greenhouses?*
Input needs? *Water?* *Fertilizers?* *Others?*

Distribution
Crops most desired by purchasers and consumers?
Where do the food products go?
Prices?

Unsold products?
Storage and Preservation?

Garden Access
Public Access?
Success of arrangement?

Waste Management
Composting *Techniques?* *Success?*
Other waste generated?

Water Management
Watering system and drainage *Methods* *Success* *Relative water use*

Non-Crop Component
Social and Educational Programming?
Layout *Non-crop aspects (eg. Art, social spaces, bee hives)?* *Walkways?* *Sheds, Greenhouses, etc.?*

Resources
Human resources-Management *Maintenance?* *Paid/Volunteer?* *Seasonal/Part-time/Full-time?* *Wages?*
Non-human resources *Tools, inputs, seeds?*
Costs
Economic viability

Recommendations for other contacts/resources:

B. PRODUCER INTERVIEW SUMMARIES

I. YWCA Rooftop Garden, Vancouver (September 27, 2010)

Contacts: Carissa Murphy, Eamonn Watson

Garden goal: The focus of the garden is not production quantities, but instead to provide the best quality, freshest and most nutritious food possible for the women at Crabtree Corner, and act as an educational tool, and green space.

Design: An Ornamental 250 square meter garden (with potential to expand to about 300 square metres), with two poly houses. The layout is awkward without paths between the concrete beds.

The garden is open access, but visitors must pass through the building lobby, and visitors are generally residents, volunteers, staff, and fitness gym users. The arrangement is satisfactory. A service elevator with external building access was recommended, as was to keep in mind the varying microclimates across the roof, and to design the building with rooftop garden outcomes in mind.

Soil: Soil is 30 to 46 cm deep (12 to 18"), and is sufficient for growing fruit trees. Soil amendments used include cover cropping, C-soil, and roof compost. A standard four-bin compost setup is used, and incorporates food waste and garden trimmings. External soil fortification is required.

Crops: Food crops include: Kiwi. Blueberries, Asian pear, cherries, plums, peaches, strawberries, raspberries, blackberries, rhubarb, apple, herbs (rosemary, thyme, mint, oregano, basil, parsley, lavender), cabbage, runner beans, tomatoes, turnips, lettuce, cucumbers, bush beans, pole beans, carrots, spinach, beets, Swiss chard, parsnips, sweet peppers, summer squash, potatoes, radishes, peas, eggplant, garlic, fava beans.

Yield for the 2010 season was ~650 kg, with potential for more production with soil improvements and when some of the perennial fruit trees/vine/canes come into full production (e.g. the 3 kiwi vines have yet to fruit and should start to next year)

Health problems are not major, although some aphids, and wire worms. Diseases may be more prevalent in stressed plants. Caution should be exercised in accepting donations; donated raspberry bushes brought in disease.

Non-food crops include: a magnolia tree, currents, flowers, such as sunflowers.

Management: The garden is not certified organic, but follows organic and best practices. Plant seed come from GardenWorks, Cedar Rim, Veseys, and West Coast Seed Catalogue. An indoor light table for starting seeds, as well as nursery beds and cold frames. Polyhouses are used to protect tomatoes, peppers from the wet climate. Season extension is not a main goal; managers are trying not to stress the soil and it is more difficult to get volunteers. Recommendations include organic management (but the certification is too rigorous to bother with), a strict crop rotation with designated areas, and pop-up poly houses.

Water: Perennials are on a drip system, while overhead watering is used for the rest of the crops. The garden needs to be watered often because the rooftop is warm and windy, and the soil is sandy. There is a greywwater system from childcare facility that still needs to be hooked up (the water is separated and pumped up). Recommendations include planning ahead, because retrofitting is difficult, and using heat recovery for greenhouses.

Resources: The garden is entirely volunteer-run, but would not be possible without Ted Cathcard who contributes many hours and oversees the garden. The project started with a ~$10, 000 grant, and runs on donations (money and in-kind). Recommendations include an overseeing body or individual to ensure consistency and adhere to mandates/project goals. In-kind donations are faster, easier, and more successful; firms want their name on things for corporate social responsibilities/public relations.

Distribution: All produce goes to Crabtree Corner (the women's shelter).

Educational Components: Crop labels and composting information.

II. Trent University Rooftop Garden (Oct. 6, 2010, Oct. 21, 2010)

Contacts: Tom Hutchinson, Aimee Blyth

Background: Built as a green roof in 1994, Tom Hutchison took on the project and turned it into a research garden 12 years ago. In 2006 it became production oriented. The University and students are really on board with the project and it has become a recruitment selling point for the institution.

Design: The roof space, plus a 4,000 square metre (1 acre) garden provided by the University, and another green roof with 8 cm (3") of sedum. It is on top of a 3-story building and surrounded by a fence and wall for wind. There is additional space for a root cellar. Recommendations are to consider wind direction and microsite differences across the roof. Biomonitors can be used to test these microsites. Access is not directly open, but is available for tours and upon request. The "Groundhog Walkway" also provides views from above.

Soil: The soil was 46 cm (18") thick, but the membrane developed a leak (roof life was approximately 30 years). The soil was moved, and the leak repaired, but no there are only 30 cm (12") of soil on top of the liner, which they have found to be sufficient to grow pretty much anything, even sweet potatoes. Initially soil quality was not ideal, but has been improved drastically. High pH was the largest problem (characteristic of the area, possibly due to limestone). Soil amendments used include sheep manure, cover crops, and compost (with inputs from the Seasoned Spoon restaurant, the garden, and city compost, which is mostly yard waste and has low nitrogen levels).

Crops: Managers have been able to literally grow anything, and the garden has provided the Seasoned Spoon restaurant with ~10% of the vegetables they use for their $50,000 of

sales per year. The garden has been found to be very productive in the warm rooftop microclimate that has a longer growing season than at ground level. Crops grown include heritage varieties, and (among other crops): beans, salad greens, eggplants, squash, peppers, cabbage, carrots, beets, cauliflower, broccoli, beets, potatoes, tubers (which grow well with sunflowers), herbs, tomatoes, and artichokes.

Management: Seeds are planted in greenhouses (for courses/research) in March, and later seedlings transferred outside. There have been few pest and disease problems, such as cabbage moths and caterpillars. No strict rotation are followed (although all the soil was recently turned over with repairs). Season extension practices include planting of fall crops and the Season Spoon, which is open in the summer hired a Summer Sourcer to preserve foods for the winter. Recommendations are to have good institutional memory mechanisms, and there is potential to raise money through selling seedlings.

Water: Supply is built into the building and there are faucets on the roof. Watering is done by hand, and the garden dries out quickly. It helps to water in the evening. For drainage, there is approximately 15 cm (6") of gravel beneath the soil and off-roof drainage points (sloped).

Resources: Funding for the first few years was provided by a research grant. There is now a $1.50 undergraduate student fee for the garden (totaling ~$10,000). This pays to hire a full time garden worker for 30 h/week for the growing season (~20 weeks a year) and a short-term full time employee for 5-6 weeks during harvesting. This year the coordinator position was split into 2 jobs for part overlapping with school year. Some work needs to be done in winter (planning, ordering, etc.). A $2.50 student fee is collected for the Seasoned Spoon (totaling ~$15,000). This pays for 14-15 part time Seasoned Spoon workers. Wages are subsidized by the University work-study program (75% up to $2000). Grants help cover many capital costs (tools, dug a well last year). Volunteers work in Seasoned Spoon and in garden (eg. potato picking bee). Some volunteers are part of a work for school credit program. A recommendation is to take advantage of the many resources around campus, whether human, or material (cardboard, weed wacker, etc.)

Distribution: Originally produce was donated to the food bank, but now they do not accept fresh produce. Now it all goes to the Seasoned Spoon student-run restaurant (similar to Sprouts at UBC). For liability reasons stipulated by the University, all food must be donated. Extra food is donated to Food not Bombs. Volunteers also take some home. Recommendations are to charge consumers/purchases, or create mutually beneficial mechanisms for a more financially sustainable operation.

Educational Component: Workshops include planting, seed saving, cultivation, and preservation. Individual student projects are also done through the garden.

III. University of Toronto Sky Garden (Oct. 29, 2010)

Contact: Heather Wray

Background: The Urban Agriculture Society is a student group established to initiate urban agriculture projects on the University of Toronto campus, and the first growing season of the Sky Garden was 2010. It took a while to get all of the permission requirements in place due to concerns about security because it is a rooftop.

Design: Containers specifically designed for rooftop gardening: lightweight, semi-hydroponic (http://www.biotopcanada.com/). Managers are really impressed with system thus far, but recommend more extensive systems such as raised beds or a green roof if possible.

Crops: The garden is 50 square metres (540 square feet) and grew 200 kg of produce this year (first season).

Water: Use drip irrigation, which they recommend. The system can be put on a timer (which saves water and man-power), and can automatically dose in liquid fertilizer.

Resources: Cost for the first year was ~ $5000. (would have been $10, 000 without donations- mostly for equipment and materials). Funding sources: City of Toronto grant (Live Green Toronto- Community investment program), University and department of building used, equipment donation from suppliers (eg. arrangement with contact at container manufacturing company), Biotop Canada, Urban Harvest Green Alternatives (Toronto), Home Depot, and the U of T Environmental Resource Network.

The garden is also a chapter of a larger organization that is in the process of applying for charitable status in Canada. One of the goals of the organization is to set up more urban agriculture projects at other institutions and in other cities. Interested locations includ Ryerson University, Guelph, and other Toronto buildings. If the new SUB garden managers are interested, this organization could be a way to cut implementation costs.

Most of the work required was for setup (40 hours). Maintenance is easy with water/fertilizer on timer. The garden is monitored daily by a volunteer. Harvesting required an estimated 5h/week. Many students are in city during the summer and able to volunteer. It is volunteer run, except for 3 staff, who received a $32, 00 stipend.

Distribution: Produce is given to volunteers and supporters, as well as weekly donations to the campus food bank (open during the summer), and weekly donations to a student-run vegan café (open during the summer).

Educational Components: Educational and research opportunities for students in organic gardening, winter gardening, composting and seed saving.

IV. Fairmont Waterfront, Vancouver (Oct. 28, 2010)

Contact: Graeme Evans- Director of Housekeeping

Background: Started 1992

Design: Some containers, the rest is raised beds. 240 square metre (2, 600 square foot), south facing, 3rd floor terrace.

Soil: Amendments include worms added to the soil.

Crops: Herbs, fruits, berries, veggies, and bees. Creates $16, 000 annual income (including honey).

Management: The growing season starts in March (onions, turnips) and finishes in October (mint). The hotel has partnered with the Van Dusen Botanical Gardens who start squash tomatoes, etc. The rest of the crops are planted directly into the soil. Recommend accounting for and taking advantage of different zones of the roof, for example next season they are going to try mushrooms in a damp, cool part of rooftop

Water: An "underground" sprinkler is used to water the garden, and the rooftop is hotter and drier than ground level.

Resources: The garden is funded by the hotel, and is management is contracted out to a company who works an average of 16 h/week to maintain the garden, in addition to volunteers.

Distribution: Produce is used in the hotel restaurant.

V. District Main Rooftop Garden (Interviewed by LFS 450 Group 8, 2010)

Contact: John Terezaki

Background: It is an important space for residents to meet and socialize, and provides shade and aesthetics.

Design: a 560 square meter (6000 square foot) garden on top of an apartment building. Soil is 4 feet deep (to make appropriate for trees). Infrastructure includes a greenhouse, sink, and plastic cabinet for tools.

Crops: Include cucumbers, squashes, beans, kale, strawberry, and some Asian vegetables. Short fruit trees that provide shade to help cool the building are also grown.

Management:
Cover cropping; organic garden waste is composted in black compost bins on the rooftop using red razor worms; and there is a rooftop greenhouse, which is mainly used as a vegetable nursery.

Water: Water supply from building is connected to an automatic irrigation system. Rainwater is collected for manual watering. A recent project has been undertaken to integrate automatic system with rainwater barrels.

Resources: The garden cost ~$25,000 to build. The space can be rented out for special occasions eg. birthdays, family reunions, which is a source of income.

Distribution: Food is distributed among residents, and eftovers donated to the local food bank.

VI. LFS Orchard Garden, UBC (Sept. 28, 2010)

Contact: Jay Baker-French

Background: The project goal is to create a miniaturized garden for demonstration and educational purposes, and it is now in its 3rd growing season.

Design: It is 250 square metre (2700 square feet) of growing area, plus the south end has ~ 45 square meters (~500 square feet) of perennials. Access is open, and occasional vandalism events have happened in the past. Cultivates 30-40% of total site.

Soil: The area was filled in after buildings were removed. The soil sources vary from UBC Plant Operations compost, construction site fill, and native soil. It is 2-3 feet at top of slope, and has varying amounts of native soil among beds create different growing conditions. It has an over all low productivity (due to low nitrogen levels). Amendments used include cover crops, some composted chicken manure from the UBC farm, alfalfa pellets for nitrogen (with limited success) and fish emulsion was used in the past. Coffee grounds are a work intensive option that is currently being explored. Compost used has come from UBC Plant Operations (but had lots of weed seeds). The goal for the future is to have a system involving garden waste and food waster form MacMillan.

Crops: Include a variety of vegetables, and apples, grapes, and kiwis. Problems encountered include early mildew in squash, and germination problems with legumes. The garden has not yet reached its production potential.

Management: Garden management adheres to organic practices. No strict crop rotation has been followed (although the UBC Farm plan was originally planned to be used); generally the same family has not been repeated in a location in subsequent years. This year, the goal is define beds and record them in a rotation matrix.
Organic run.

Plants were started in the UBC Horticulture greenhouses. Although the starting conditions were ideal, problems were encountered in transferring plants into an outside environment. Plans for the future include growing all seedlings on-site in mini glass houses build from windowpanes. Season extension was sacrificed for cover crops (soil

care and protection is currently the foremost concern), although carrots, beets, kale, and chard were grown into the fall, and garlic planted in the fall.

Water: Overhead sprinkling is used, and a miniature irrigation system is recommended for the garden.

Resources: The garden is coordinated by a work study student (paid by the UBC farm and UBC work study wage subsidy), of 20 h/week in the summer and 10 h/week during the school year. Difficulties are encountered because each coordinator has different knowledge levels and perspectives, which change annually. Students and community members volunteer in the garden, but difficulties in obtaining volunteers during the summer has been experienced. Recommendations include two coordinators, so ideas and responsibilities can be shared, as well as institutional memory mechanisms to provide continuity.

Distribution: Food mainly goes to the student-run café in MacMillan, Agora, with some to Sprouts in the SUB, and individual buyers. A weekly list-serv for produce sales was tried but it was work intensive, and tough with variations in production levels, weather, etc. Future plans are to solidify the garden's relationship with Agora (who this year, processed and stored many crops).

Educational Component: No formalized workshops apart form volunteer shifts. The garden area has expanded, and The faculties of Land and Food Systems and Education are partnering to create an outdoor classroom for educating teachers about incorporating gardens into school curriculums.

VII. McGill University Rooftop Garden (Oct, 8, 2010, Oct. 29, 2010)

Contacts: Sara Brunelle (Alternatives), Santropol Roulant

Background: The rooftop garden is a partnership between Alternatives, Santropol Roulant, McGill, and a Meals on Wheels program. Alternatives partners with other organizations to implement collective gardening initiatives (not community gardens), and follows several models (in general connecting with a place and oranisation who will tak on management activities). Educational and social components are the main goals.

Design: It is mostly container gardening on a big concrete terrace. Benefits of containers are less weeding, flexibility, control watering. They are good for lettuce, beans, and other crops, but cannot grow crops with greater rooting depths (root vegetables, squash). They recommend non-container gardening if possible; although less flexible, a greenroof soil/membrane setup is more efficient for working in the garden. It is 1,100 square meters (10, 900 square feet). They also recommend a greenhouse.

Soil: From experiences with new building just purchased, 30 cm (12") is lots

Crops: 1000 kg were produced this season (hot summer, increase from last year).

Management: Seedlings grown under lights indoors. This is less manageable as the project grows. Time under lights was decreased to just the germination phase to minimize resource use.

Water: Semi-hydroponic system, which saves water.

Resources: Human Resources include 1 permanent year-round full-time coordinator (they are hoping for a second) who does the planning, networking, ordering, etc. A summer student is also hired for the growing season, and sometimes a second student is hired for short-term roles. 3 weekly drop in volunteer sessions (3 hour shifts) are run, and the volunteers are mostly students. Management requires a multi-stakeholder approach because many concerned parties at an institution.

Operating costs are ~$5,000/y (materials, events, etc.), and an additional $30, 000 for wages. Funding comes from diverse sources: Governments, the municipality, corporations, family donations, other grants, and lots of in-kind donations (tools, etc.) Alternatives uses theses sources to pay for the FT coordinator (primarily grant driven). A new development is potential funding from the McGill sustainability fund, in which the university will match money collected from a student levy (50 cents/credit).

Distribution: The Meals on Wheels uses garden produce for 5 hot meals a week. 40 CSA baskets are made per week- 10 for the Meals on Wheels kitchen, and 30 are distributed to other buyers. Of theses 30, 15 subsidize the other half for more needy individuals. Boxes are also customized for seniors and purchase with special dietary needs. Extra food is given to the kitchen. This contributes to the social priorities of the program.

Educational Components: Part of a partnership with a professor for his research.

VII. UBC Botanical Gardens (Nov. 10, 2010)

Contact: Brendan Fisher, community garden horticulturalist

Design: Approximately 190 square metres (2000 square feet)

Soil: Maximum depth is 30 cm (sufficient for fruit tree growth)

Crops: Garden yield is ~1000 kg. Fruit trees with dwarf rootstocks were successfully grown in containers (which can be moved around to sun/shade). Fruits grown with success include pears, apples, blueberries, and raspberries. Everybearing raspberries and strawberries are a good option. Figs and peaches have been less successful, but are fruitful in other Vancouver locations.

Management: Removable poly houses for plants, such as tomatoes. Can successfully grow winter crops in on third of the production area without depleting the soil. The garden has few disease problems, potentially due to the off-shore breeze.

Resources: Management time required is 1-2 days per week in winters, and 4-5 days per week in summer. Volunteers do the harvesting. Some of the crops (especially fruit trees), require more intensive management.

Distribution: Food is donated to the Salvation Army, and picked up every Wednesday.

VIII. UBC Farm (Oct, 28, 2010; Nov. 12, 2010; Nov. 17, 2010)

Contact: Andrew Rushmere, Mark Bomford

Design:

It was noted that 50% of the area used for cultivation assumes it's a pretty intensively used raised bed space with very constrained pathways / access and that you're not taking groups in there. For example, only 10% of the actual area of the children's garden at the farm is used for cultivation and 90% is for people, cars, bikes, wheelbarrows etc. to get in and out. If more than 50% with a raised bed system on a small lot, it really only becomes appropriate as a non-public space; a place where a single person can navigate through the garden but very difficult to allow the public to come and go without damaging crops.

The size of greenhouse selected depends if the goal is seedling production for on-farm uses or for a crop production greenhouse. For a 1,000 m^2 area, like the rooftop garden, very little room would be necessary for seedling production, probably no more than a 12' x 10' hobby-style greenhouse. For production, though, the decision needs to be made as to how much space is put in greenhouse crops. Greenhouse-dependent mixed farms such as Eliot Coleman's in Maine have as much as 1/4 of their growing area in greenhouses, which in the case of the rooftop garden would be a bit of a monster (over 200 square meters). One this size was just built at the farm and it was certainly a major undertaking). It was recommended to stick with a 4 m width, perhaps a 4m x 7 or 8 m for beginning production, or if the resources are available, 4.5 or 5 m width.

Management: Soil amendments include cover cropping (which, was noted can be tough on a small scale, unless a rotatiller is available), and other amendments based on annual soil tests, such as Sul-Po-Mag, lime, and boron. UBC and UBC Farm compost is also used, but generally lacks nitrogen, and are exploring other nitrogen options. Difficulties for season extension are faced because cover crops need to be planted. In the spring hoop houses allow plants to be started earlier. Seedlings are started in the greenhouse or on the benches outside (warm season crops: lettuce, flowers, basil) or directly in the field (root crops, salad, greens, corn, peas, beans, large seeds, spinach).

Water: Overhead impact sprinklers are used for what goes moldy and hoop houses (carrots, beets, corn, fennel, parsnip). Drip irrigation is used for tomatoes, peppers, beans, peas, and most herbs, flowers, and perennials.

Resources: Financially, one third of revenues is from the market (workshops, food, market fees) and two thirds are from grants, donations, cost recovery mechanisms. In the summer there are 14 to 15 full-time paid staff, and 5 to 6 in the winter, and volunteers do additional work. Recommendations are that 1 full-time equivalent would be enough to manage the new SUB Rooftop Garden, and to explore Young Canada Learn funding.

Distribution: Food is sold at the weekly farm market, campus sales, a CSA box program, and various other food outlets on campus and in Vancouver.

Educational Component: A variety of workshops and learning programs are offered. Research and student projects also take place at the Farm, as do components of UBC courses. Furthermore, the UBC Farm hosts many other programs including the Aboriginal Community Kitchen Garden, the Kids Garden, and Mayan Garden.

C. POTENTIAL PARTNER INTERVIEW SUMMARIES

I. Sprouts Natural Food Co-op and Restaurant, UBC SUB (Oct. 28, 2010)

Contact: Lizzy Faulkes, 2010-2011 Sprouts President

What to Grow: Ideally for Sprouts, the rooftop garden would provide different and complementary product to what the UBC Farm grows. Currently, Sprouts gets get greens, kale, chard collards, and garlic form the farm. They were receptive to the idea of creating a SUB Rooftop Garden signature item, potentially something that could be grown year-round, or preserved and used year-round.

Garden Management: Sprouts is not structured to fully take on the project, but is willing to sell produce, help coordinate volunteers, and potentially create a Sprouts Board position to liaise with the garden.

How to Distribute Food: Sprouts is willing to pay for the produce, and can distribute food through their box program, in-store sales, and restaurant food. It is important to keep in mind that Sprouts is only open during the school year.

II. AMS Food and Beverage Services (Nov. 12, 2010)

What to Grow: AMS Food and Beverage Services (AMS FBS) is mainly interested in specialty items that they consume in small quantities. The garden cannot provide enough of vegetables consumed in large quantities, and it is not cost effective for AMS FBS to purchase such items from the garden, where prices would be higher than those of mass producers. Crops they are interested in include; arugula, Swiss chard, and other specialty greens, tomatillos, herbs, and berries. AMS FBS was supportive of the idea of growing a SUB Rooftop Garden signature item.

Garden Management: AMS FBS would not be a contributor to garden management, with respect to human resources and financial resources.

How to Distribute Food: These products would be used in AMS FBS outlets, in particular their catering service. A higher price point rooftop restaurant, if included in plans for the new SUB, is an good potential outlet for garden crops.

III. UBC AMS Sustainability Coordinator (Oct. 29, 2010)

Contact: Justin Ritchie, AMS Sustainability Coordinator 2010-2011

Garden Management: From his experience, the AMS Sustainability Coordinator position has been would likely be able to contribute 5 h/week during the school year and 8-10 h/week during the summer to helping manage the rooftop garden. Appropriate tasks for the positions to take on may include grant writing, funding applications, and volunteer management. If the AMS decides to rent out rooftop garden space to campus residents, the Sustainability Coordinator could help manage this.

IV. UBC Botanical Gardens (Nov. 10, 2010)

Contact: Patrick Lewis (Director)

Garden Management: An offer was made to potentially allow the SUB rooftop garden to use UBC Botanical Gardens greenhouse space. In addition, they are willing to collaborate in the creation of a gardening training program that the garden coordinator (and the general student body) could take part in.

Food Distribution: It is likely that the Salvation Army will be willing to pick up extra food from the rooftop garden on their Wednesday pick up visits to the UBC Botanical Gardens

V. UBC Farm (Oct. 28, 2010, Nov. 12, 2010, Nov. 17, 2010)

Contacts: Andrew Rushmere, Mark Bomford

Garden Management: The UBC Farm would be very interested in collaborating with the Botanical Gardens in developing a "Getting Started with Gardening" workshop that would help train garden coordinators. The Farm's year-long practicum course and volunteer program also are options for garden coordinators to gain experience. The farm would also potentially be interested in overseeing a work-study garden coordinator position (primarily if external funding was obtained for wages). An additional area for potential partnership is with compost, and collaborating in obtaining external nitrogen sources.

Food Distribution: There is potential to sell rooftop gardens that the farm does not grow (or only grows in small quantities) at the weekly market, and to sell produce to the Farm for resale in the CSA boxes to fill out low produce weeks and create variety.

D. ROOFTOP DIMENTIONS (November 8, 2010)

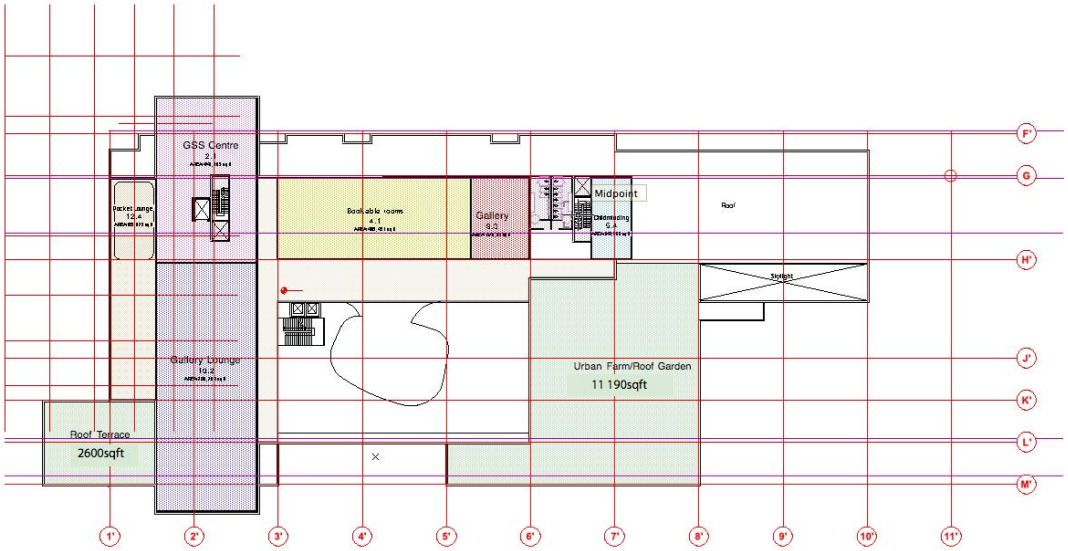

Figure 1: New SUB rooftop dimensions[55]

E. ACADIA PARK COMMUNITY GARDEN RENTAL PLOT AGREEMENT

Only residents who currently live in Acadia Park or University Apartments are eligible to rent a plot in the garden[56]. When residents move out of our housing, they are no longer

[55] Obtained from Andreanne Doyon, New SUB Project Coordinator (November 11, 2010)

able to keep the plot. The yearly fee for the plot is $35, and this gets paid in January of each year. The fee covers things like a stipend for the garden coordinator, new tools for the garden, and some socials for the garden community. The Department of Student Housing & Hospitality Services is responsible for the maintenance of the raised plots (lumber, repairs, etc) and the pathways in between the plots. Below is the contract that plotholders must sign.

Acadia Park Garden Program Plotholders Agreement

1. Plotholders must cultivate their plots to prevent the overgrowth of weeds and the harbouring of insects and pests, as this is detrimental to their own and neighbouring gardens. Plots that are not fully utilised or are a source of weed or pest problems will be reallocated at the discretion of the Garden Coordinator. Therefore, plotholders who go away for extended periods should arrange for someone to look after their plot. Garden plots will be inspected in May and July to ensure compliance with the agreement.
2. Plotholders are responsible for the removal of rubbish from their plot. **All stakes, trellises, etc. must be removed before giving up the plot.** The paths around the plots are also the responsibility of the plot holders and must be kept free of vegetation or containers for vegetation/fertilizer/compost.
3. Refunds will not be given for the plot fee. Plotholders may transfer their plot to another Acadia resident if they are moving. Compensation for the plot is to be agreed upon between the outgoing plotholder and the new plotholder. Contact the Garden Coordinator for more information and a transfer form.
4. Each Plotholder is required to provide four (4) hours of volunteer labour. All Plotholders must participate in two work opportunities which are two (2) hours each and thereby satisfying this requirement. Otherwise the plotholder must call and arrange another time with their garden coordinator or they will not be permitted to renew their plot for the following year.
5. Plotholders will abide by the recommended policies with regard to the use of environmentally friendly fertilisers and pest or disease control methods
6. All new Plotholders must attend a New Plotholder Info Session to be arranged by the Garden Coordinator.
7. Watering is the responsibility of each Plotholder. Running water must not be left unattended overnight or for extended periods during the day. Plotholders who damage their neighbours' plots by indiscriminate watering will be required to make adequate compensation for any losses. During periods of dry weather, it may be necessary to observe watering schedules which will be set by the Garden Coordinators.
8. No structures are allowed alongside neighboring plots. If a structure is put up in a plot and there is a complaint from a neighbor about the shadows produced by that structure on her/his plot, the Garden Coordinators will decide if the structure should be moved elsewhere within the plot or removed completely.
9. Growing of marijuana or any other illegal substance is prohibited.
10. Children must be supervised at all times in the Acadia Park Garden.
11. As a courtesy to nearby families, gardening is not permitted after sunset or before 8:00 am.
12. There can be no trench or open composting in the Acadia Park Garden. Because of the impact that the odour has on nearby neighbours, and because of the health risks, no animal or human waste (i.e. manure) may be utilised as fertiliser. Packaged, composted animal manure may be used.
13. Plotholders may sign out a key for the garden tool shed. The tools are for use in the community garden only and may not be taken home.

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[56] Carol Young, Acadia Park and University Apartments Residence Life Manager, Personal Communication, December 1, 2010.

14. In addition to the above, Plotholders will abide by any other Acadia Park Garden Program regulations that are decided upon by a majority vote of the Plotholders at a General Meeting (if required).

15. Plotholders should advise the Garden Coordinator of infringements of these rules. Persons involved in alleged violations of any of the contractual agreements will have an opportunity to meet with the Garden Coordinators to respond.

16. **The person whose signature appears on this agreement must be a current registered leaseholder in Acadia Park or University Apartments. If you move before the end of the January, 2011, please inform the Garden Coordinators.**

Should a Plotholder be advised that they are in contravention of this Agreement, and fail to rectify the problem within the time limit provided by the Garden Coordinators, this Plotholders Agreement will be terminated, and the annual plot fee will not be refunded.

Name Address
Phone Number

Signature Email Address

Date Plot # (if renewing)

****A LIST WILL BE AVAILABLE TO PLOTHOLDERS WITH PLOTHOLDER NAMES, EMAIL ADDRESSES, AND PLOT NUMBERS.**

YELLOW COPY – UBC HOUSING / WHITE COPY – PLOT HOLDER COPY
2010 - 2011 ACADIA PARK GARDENS

Acadia Park Garden plot holders will enjoy their plots until January 31, 2011. Acadia Park residents wishing to acquire a garden plot are asked to read this letter carefully.

PLOT ASSIGNMENT

Priority for plot assignment is as follows:

(1) Current plotholders may renew their plot agreements during the month of January if they have satisfied all the terms of their garden agreement for the previous year. Plot adjustments may be done at this time.

(2) Unassigned plots will be distributed to those people whose names are on the Garden Wait List during the month of February.

(3) A new Sign-up sheet will be available at the Commonsblock front desk after February 28th to create a waiting list for any unassigned plots at the end of February.

The annual plot fee is $35. The garden program must be self-sustaining. Plots will be assigned to new plotholders as is.

Those plotholders who are **renewing** their agreements must

i. Pick-up a 2010-2011 Plotholder's Agreement at the Commonsblock front desk.

ii. Submit the completed form along with cash or a cheque for $35.00, payable to **UBC**, by JANUARY 31, 2010.

Completed Agreements and cash or cheques can be handed in at the front desk.

Those **new** plotholders on the current waiting list will be contacted by the Garden Coordinator. Once contacted with their plot number (based on availability), these new plot holders may pick up a Plotholder's Agreement in February from the Commonsblock front desk and must submit

i. A completed 2010-2011 Plotholder's Agreement
ii. Payment of cash or cheque for $35.00 (garden fee), payable to **UBC.**

Completed Agreements and cash or cheques can be handed in at the front desk.

New plotholders will be contacted about the New Plotholder Info Session.

Carol Young
Residence Life Manager
604-822-6389
carol.young@ubc.ca

F. CROP MANAGEMENT GUIDE[57]

Like UBC Farm adhere to organic management guidelines without the difficulties of becoming certified. Canadian Organic Production System Standards are available on the web at http://www.tpsgc-pwgsc.gc.ca/cgsb/on_the_net/organic/index-e.html.

Seeds

Where to get seeds:

- West Coast Seed Catalogue- selection of non-GMO and organic seeds for the region
- GardenWorks
- Cedar Rim Nursery
- Veseys

Ever-bearing varieties can work to boost yields. While in-kind donations of seeds and plants save financial resources, caution should be exercised in accepting plant donations, because there is potential to import pests/diseases too. Seed saving also works to save resources. The AVRDS The World Vegetable Centre Publication *Saving Your Own Vegetable Seeds* can be found at http://www.avrdc.org/pdf/PROD6-saving_your_own. For beginners, seeds of beans, lettuce, peas, peppers and tomatoes are the best options for successful seed saving. They produce seeds the same season as they are planted, and are mostly self-pollinating, minimizing the need to be mindful of preventing cross-

[57] Based on best practices and recommendations from interviews, refer section 3.0 Results and Discussion for detailed citations.

pollination[58]. Corn, cucumbers, radishes, spinach, squash, and pumpkins require more experience because they produce seeds the same season they are planted, but require separation to prevent unwanted cross-pollination. Beets, Swiss chard, cabbage, carrots, onions, radicchio/endives, turnips, and Chinese cabbage require the most expert seed saving techniques because they typically require more that a year for seed pollination, and separation to prevent cross-pollination is necessary.

Soil

It is recommended to start with start with high quality soil, and improves initial yields and requires less retroactive soil conditioning. An article on what constitutes good gardening soil (including a neutral pH, high organic matter content, and a sandy loam texture) can be found at http://gardening.about.com/od/soil/a/GardenSoil.htm.

A variety of soil amendments exist for different soil conditions, including manure, alfalfa pellets, Sul-Po-Mag, lagnamite, lime, boron, and cover crops. Tillling in covercrops in a rooftop garden, however, has high labour requirements unless workers have access to a rotatiller. Compost is another important input, and outside sources of compost (such as food waste from the SUB), and nitrogen are necessary. Soil tests and observations of soil deficiencies through plant indicators can help indicate which amendments should be applied. A variety of symptoms are described at http://www.primalseeds.org/nutrients.htm.

A□ □c□h□a□p□t□e□r□ from the BC Environmental Farm Planning guide found at http://www.ardcorp.ca/userfiles/file/efp/EFP_Reference_Guide_March_2005_part_6.pdf □d□i□s□c□u□s□s□e□s□ □s□o□i□l□ □a□m□e□n□d□m□e□n□t□ □p□r□a□c□t□i□c□e□s□ □f□o□r□ □p□r□o□t□e□c□t□i□o□n□ □o□f□ □t□h□e□ □e□n□v□i□r□o□n□m□e□n□t□.□ □I□t□ □c□o□n□t□a□i□n□s□ □i□n□t□r□o□d□u□c□t□o□r□y□ i□n□f□o□r□m□a□t□i□o□n□ □o□n□ □t□h□e□ □r□e□l□a□t□i□o□n□s□h□i□p□ □b□e□t□w□e□e□n□ □s□o□i□l□ □a□m□e□n□d□m□e□n□t□s□ □a□n□d□ □t□h□e□ □e□n□v□i□r□o□n□m□e□n□t□, as well as on □e□n□v□i□r□o□n□m□e□n□t□a□l□ □c□o□n□c□e□r□n□s□,□ □l□e□g□i□s□l□a□t□i□o□n□ □a□n□d□ □b□e□n□e□f□i□c□i□a□l□ □m□a□n□a□g□e□m□e□n□t□ □p□r□a□c□t□i□c□e□s□ □r□e□l□a□t□e□d□ □t□o□ nutrient and soil conditioner applications.

Mulching and the use of plastic and paper (for crops such as large brassicas, early cucurbits, and alliums) help will help maintain soil moisture on the warm, windy rooftop. In addition, watering at night, in the morning, or evening helps prevent evaporative losses.

To further maintain soil health, a crop rotation should be implemented. A suggested crop rotation, including cover crops and fallow periods is provided in Tables 9 and 10. It was developed. This rotation plan is a dynamic guide, but it is important that the key principles of maintaining a minimum of four years between crops of the same family, allowing for fallow periods, and using cover crops to renew the soil nutrient capacity.

[58] International Seed Saving Institute (1994). Basic Seed Saving, Retreived November 20, from http://www.seedsave.org/issi/issi_904.html

Alterations may be made based on emerging problems in future years, the popularity and growing success of various crops (including the development of a signature item), and experiences with different microclimates identified on the rooftop. This rotation has the crop area divided into 9 beds. 8 are for the main crop rotation, and the 9th is for the perennial crops. It is recommended that these taller crops are planted in the north west edge of the roof to provide maximum wind protection.

Table 9: Sample Production Garden crop rotation[59]

Season	Family	Crops	
Spring	Nightshades	Tomatoes, tomatillos, peppers, eggplant	Potatoes
Summer			
Fall		Ryegrass + Vetch	
Winter			Rye
Spring	Leafy Brassicas	Mustard greens, mizuna, rapini, pak choi, choi sum	Arugula, kale, collards
Summer			
Fall			
Winter		Rye	
Spring	Cucubrits	Winter squash, pumpkins	Cucumbers, zucchnini, summer squash
Summer			
Fall			Rye + Vetch
Winter		Rye	
Spring	Alliums, Legumes	Onions, Leeks	Peas
Summer			
Fall		Garlic, overwinter onions	White Clover and Ryegrass
Winter			
Spring	Cover Crop/Fallow		
Summer		White Clover and Ryegrass	
Fall			
Winter			
Spring	Other Brassicas	White Clover and Ryegrass	Turnips, Rutabaga, Kohlrabi, Cabbage, Broccoli, Cauliflower, Brussel Sprouts, Radishes
Summer			
Fall		Overwintering cabbage, brussel sprouts, broccoli, cauliflower, radishes	

[59] Based on lessons learned from the UBC Farm crop rotation;
Mohler, C.L. & Johnson, S.E. (Eds.) (2009). *Crop Rotation on Organic Farms: A Planning Manual*. New York: Natural Resource, Agriculture, and Engineering Service.

Winter			Winter Rye
Spring	Asteraceae, Apiaceae	Carrots, Lettuce, Endive/Radicchio, Celeriac, Parsnips	Fennel, Celery
Summer			
Fall			Spinach
Winter		Rye	
Spring	Legumes, Cenopodicaceae	Beans, Sorrel	Swiss Chard, Beets, Spinach
Summer			
Fall		Crimson Clover and Ryegrass	
Winter			

Table 30: Sample Production Garden perennial crop rotation

Years	Crop
2 to 5	Blackberries/Raspberries
3 to 5	Strawberries
2	Cover Crop/fallow
20	Blueberries
2	Cover Crop/fallow
5	Artichokes

Intercropping reduces pest infestation and allows for more effective management of cover crops, and more efficient use of space. It can help produce soil nitrogen and organic matter, leading to higher yields. Important considerations are:

- The use of tall crops to reduce drought or heat stress in smaller crops
- Intercropping of plants with partially overlapping growing seasons
- The use of legumes (bush beans, peas) versus non-legumes
- Care not to impose competition for crops
- Caution not to alter the crop rotation
- Ally cropping (for example, using ryegrass and vetch or clover)
- Leaving cover crops from previous year in allies

Figure 2 provides an overview of cover crops and cash crops that can planted together , and identifies associated benefits and problems. Cover crops can also be oversown into an established crop. If this is done before a crop is established it will be dense enough to compete with weeds, but also competes with the cash crop. If cover crops are planted after a cash crop is established, negligible soil nitrogen or organic matter will be provided to that crop. In general, cover crops are best for late crops (which have low weed pressures). For example, the UBC Farm oversows late cucurbits with ryegrass and crimson clover.

Cover crop	Cash crop	Method	Benefits	Problems
Red clover, annual or perennial ryegrass[1]	Corn, late sweet corn	Broadcast after last cultivation[2]	Good organic matter production; N-fixation by red clover	Establishment may be poor in a dry summer; annual ryegrass may winter-kill
Rye	Corn, late sweet corn	Broadcast in early fall at 3 bu/A	Reasonable establishment most years[3]	Stand may be patchy; stand may be poor if the fall is dry
Annual ryegrass, creeping red fescue, red clover, white clover, alfalfa[4]	Soybean (planted in rows)	Broadcast after last cultivation[2]	No interference with harvest; N-fixation by legumes	Establishment may be poor in a dry summer
Rye, winter wheat, spelt	Soybean	Broadcast at 1.5X usual rate at leaf yellowing	Allows establishment in wet years and late harvested soybean	Timing is critical[5]; stand may be poor if the fall is dry
Crimson clover	Soybean	Broadcast at 20 lb/A at leaf yellowing	N-fixation; good production	Useful only from zone 6 & south – further north it winter-kills after little growth
Red clover, alsike clover, alfalfa, yellow sweet clover	Winter wheat, spelt	Sow on frozen ground in early spring	Good organic matter production and N-fixation before next spring crop	Ground may not freeze sufficiently to support tractor
Bell bean[6]	Fall brassicas	Plant two rows of bell bean between crop rows after last cultivation	N-fixation for next crop; grows fast and then winter-kills; upright growth does not interfere with crop	Expensive seed. Cover crop will be damaged at harvest.
Annual ryegrass	Tomato, pepper	Broadcast after last cultivation[2]	Good dry matter production by next spring	May winter-kill
Hairy vetch	Late harvested vegetables	Plant 1 or 2 rows between rows of vegetables after last cultivation	N-fixation for next crop; no interference with crop; spreads out to give fair winter cover and good spring production	None apparent
Rye	Late harvested vegetables	Plant 1 or 2 rows between rows of vegetables after last cultivation	Falls over to give fair winter cover; no interference with crop	None apparent
Rye	Late harvested vegetables	Broadcast at 2 to 3 bu/A 3 to 5 weeks before harvest	Provides more uniform cover than drilling between rows[3]	Stand may be patchy; stand may be poor if the fall is dry; interferes with harvest of short, leafy crops

Figure 2: Intercropping options, and associated benefits and problems[60]

Crops

For specific calendar dates of when to plant, transfer, and harvest crops, refer to the West Coast Seeds *Planting Guide*: http://www.westcoastseeds.com/admin/files/PlantingChart2011.pdf. Guidelines for specific crops are available at http://www.garden.org/plantguide/ and http://www.westcoastseeds.com/how-to-grow/Vegetable-Seeds/.

A variety of season extension options exist, including winter varieties. Hoop houses or cold frames can be used to protect nightshades from the wet climate, and for warm season crops in the spring and late summer. For example, tomatoes, cucumbers, spinach, Swiss chard, onions, and leeks, can be started earlier in the spring under hoop houses. The greenhouse will also serve as an option for starting seedlings and winter growing. The West Coast Seeds *Winter Gardening Guide*: http://www.westcoastseeds.com/admin/files/west-coast-seeds-winter-guide.pdf provides additional details.

[60] Mohler, C.L. & Johnson, S.E. (Eds.) (2009). *Crop Rotation on Organic Farms: A Planning Manual*. New York: Natural Resource, Agriculture, and Engineering Service.

Preservation

Preservation of crops can be an important factor at universities because the school year and growing season are at opposite times of year. Figures 3 and 4 outline the preservation potential of certain crops in a the fridge or freezer, and in root cellars. Additional preservation options are canning or preserves (for crops such as berries), and leaving root crops in the soil until they are required for use.

VEGETABLES			
Asparagus	2-3 days	8-12 months	Freeze vegetables in moisture- and vapor-proof materials. Refer to Extension publications.
Beans, green or wax	1 week	8-12 months	
Beets, carrots, broccoli	3-5 days	8-12 months	
Cabbage, celery	1-2 weeks	N.R.	
Cauliflower	1 week	8-12 months	
Corn, in husks	1 day		
without husks		8-12 months	
Cucumbers	1 week	N.R.	
Lettuce, other salad greens	1 week	N.R.	Store in bag or lettuce keeper.
Mushrooms	1-2 days	8-12 months	Do not wash before refrigerator storage.
Okra	3-5 days	8-12 months	
Onions, green	3-5 days	N.R.	
Peas, lima beans, unshelled	3-5 days	8-12 months	Store unshelled in refrigerator until used.
Peppers	1 week	8-12 months	
Radishes	2 weeks	N.R.	
Tomatoes, ripe	5-6 days	8-12 months	Follow recommended procedures. Use as canned tomatoes.

Figure 3: Fridge and freezer storage specifications[61]

[61] Penner, K.P. (1990). *Refridgerator/Freezer Approximate Storage Times*. Manhattan: Kansas State University Cooperative Extension.

A1135

STORING VEGETABLES AT HOME

H.C. HARRISON

Home storage is a good and inexpensive way to keep many vegetables. When stored properly, fresh vegetables keep most of their food value and original flavor. Successful storage depends on proper choice of crops, careful harvesting and preparation, maintenance of a suitable temperature and humidity, and adequate care during the storage period.

HARVESTING AND PREPARING VEGETABLES FOR STORAGE

Store only mature vegetables of good quality. Use small, cut, bruised, or broken produce in early fall or preserve them by freezing or canning.

Root Vegetables and Potatoes

In most cases, and especially for root vegetables which withstand light frost, delay harvesting as long as possible. Harvest and handle with care to avoid cuts and bruises. Remove the soil from beets, carrots, celeriac, parsnips, potatoes, rutabagas, salsify, turnips, and winter radishes by careful washing. To help prevent rotting, allow excess water to evaporate before storing the vegetables. Cut off tops of root vegetables ½ inch from the crown. Both tops and tap roots are commonly removed from rutabagas; tap roots need not be removed from other root vegetables. Do not wax rutabagas and other root vegetables for storage; it reduces shriveling but does not slow growth when the temperature is too high.

Sweet potatoes generally do not get mature enough in Wisconsin to store well. Store only larger, more mature roots harvested before the vines are frosted. Handle them carefully and cure them for 10 days at 80° to 85°F under moist conditions. They should keep for about a month or more in a cool (55° to 60°F), dry place. Use the smaller, younger roots soon after harvesting or freeze or can them.

STORAGE REQUIREMENTS FOR COMMON VEGETABLES

Commodity	Temp. (°F)	Relative humidity	Average storage life
Beets	32	95%	1-3 months
Brussels sprouts	32	90-95%	3-5 weeks
Cabbage	32	90-95%	3-4 months
Carrots	32	90-95%	4-6 months
Cauliflower	32	90-95%	2-4 weeks
Celeriac	32	90-95%	3-4 months
Celery	32	90-95%	2-3 months
Chinese cabbage	32	90-95%	1-2 months
Dry beans	32-50	65-70%	1 year
Endive	32	90-95%	2-3 weeks
Garlic	32	65-70%	6-7 months
Horseradish	30-32	90-95%	10-12 months
Jerusalem artichoke	31-32	90-95%	2-5 months
Kale	32	90-95%	10-14 days
Kohlrabi	32	90-95%	2-4 weeks
Leeks	32	90-95%	1-3 months
Onions	32	65-70%	5-8 months
Parsnips	32	90-95%	2-6 months
Peppers, dry	32-50	60-70%	6 months
Peppers, sweet	45-50	90-95%	8-10 days
Potatoes	38-40	90%	5-8 months
Pumpkins	50-55	70-75%	2-3 months
Rutabaga	32	90-95%	2-4 months
Salsify	32	90-95%	2-4 months
Sweet Potato	55-60	85-90%	4-6 months
Tomatoes, mature green	55-60	85-90%	2-6 weeks
Turnips	32	90-95%	4-5 months
Winter radishes	32	90-95%	2-4 months
Winter squash	50-55	70-75%	3-6 months

Figure 4: Root cellar storage specifications[62]

[62] Harrison, H.C. (1996). *Storing Vegetables at Home*. Madison, WI: University of Washington-Extension.

G. JOB DESCRIPTIONS

Position: UBC SUB Rooftop Garden Student Coordinator[63]

Duration: 1 year, details pending management model decision

Wage: TBD

Position Description:

COMMUNICATION

- Maintain regular communication with the AMS Sustainability Coordinator, the Sprouts representative, and all relevant stakeholders.
- Provide regular progress reports and updates on specific components to be implemented to the Advisory Committee.

FINANCES

- Work with the AMS sustainability coordinator to manage the garden's budget

GARDEN MANAGEMENT

- Instigate and coordinate components of the garden's construction and design that are not yet completed
- Implement (and adjust if necessary) production and harvest plans for the Garden (e.g. crop rotations, maintenance, and harvest; pest monitoring).
- Coordinate bee-keeper involvements and relationships

DISTRIBUTION

- Coordinate buyer-seller relationships with Sprouts, AMS Food and Beverage Services, and the UBC Farm

HUMAN RESOURCE MANAGEMENT

- Recruit and manage volunteer positions to help with Garden duties (e.g., weeding, watering, planting and harvesting).
- Maintain a record of hours for the position, and for volunteers

EDUCATION

- Direct and advise the AMS Sustainability coordinator in creating educational and promotional material and programs
- Work with the Sprouts representative to implement garden-related workshops
- Work with UBC faculty/staff and community members to implement research components

INSTITUTIONAL MEMORY

[63] Based on the LFS Orchard Garden coordinator job description

- Review relevant job descriptions, management manuals and outcomes of LFS and SEEDS reports.
- Maintain a written garden journal of the garden's history including what is planted and when, management activities, dates of maturity, crop yields, weather conditions, pest problems, soil issues, and additional observations.
- Write a summary report outlining successes, challenges and experiences with the garden, including recommendations for the following season
    - Include a section recommending amendments to the position role descriptions for the Garden Student Coordinator, the AMS Sustainability Coordinator, and the SUB Rooftop Garden Advisory Committee
- Be involved in training and transitioning for the next Student Coordinator

Position: Sprouts SUB Rooftop Garden Liaison (Sprouts Executive Board position)

Duration: 1 year, works September- April, 10 h/week

Wage: volunteer

Position Description:

COMMUNICATION
- Maintain regular communication with the Garden Student Coordinator(s), the AMS Sustainability Coordinator, Rooftop Garden Volunteers, Sprouts Executive Board and all relevant stakeholders.
- Provide regular progress updates the Rooftop Garden Advisory Committee.
- Attend weekly or biweekly meetings with the Sprouts Executive Board.

DISTRIBUTION
- Coordinate sales and transport of crops to Sprouts in consultation with Sprouts Products Coordinator, Store Coordinator, and Kitchen Manager(s).
- Work with the Student Garden Coordinator to implement programs for food preservation and storage for use by Sprouts and AMS Food and Beverage during the winter.

EDUCATIONAL
- Work with the Garden Student Coordinator and Sprouts Workshops Coordinator(s) to implement educational workshops related to the garden.

HUMAN RESOURCES
- Maintain a record of hours worked for the position, and work with the Garden Student Coordinator to record volunteer hours.
- Work with Garden Student Coordinator to recruit volunteers for the garden.

INSTITUTIONAL MEMORY
- Review relevant job descriptions, management manuals and outcomes of LFS and SEEDS reports.

- Maintain a document of management activities
- Write a summary report outlining successes, challenges and experiences with the garden, including recommendations for the following season
    - Include a section recommending amendments to the position role descriptions for the Garden Student Coordinator, the AMS Sustainability Coordinator, and the SUB Rooftop Garden Advisory Committee
- Be involved in training and transitioning for the next Rooftop Garden Sprouts Liaison.

Position: AMS Sustainability Coordinator

Duration: 1 year (May-August 8-10 h/week; September-April 5 h/week)

Wage: N/A (funded by AMS)

Position Description:

COMMUNICATION
- Maintain regular communication with the Garden Student Coordinator(s), the Sprouts representative, and all relevant stakeholders.
- Provide regular progress updates and budget reports to the Advisory Committee.

FINANCES
- Research potential in-kind donations, grants, bursaries, awards and additional sources of funding for the garden
- Based on available funding and preliminary budgeting, create a budget and manage the garden's finances

EDUCATION
- Facilitate garden outreach initiatives for publicity and raising garden awareness. This may include developing educational and promotional materials and programs for the garden, including signage (e.g., crop identifiers, developing nutritional profiles for crops), and if hours and funding permit, the construction of a website.

HUMAN RESOURCES
- Maintain a record of hours for the position
- Act as a liaison with the AMS student council
- Facilitate the formation and meetings of a Garden Advisory Committee. Meetings should be held no less than once a month.

INSTITUTIONAL MEMORY
- Review relevant job descriptions, management manuals and outcomes of LFS and SEEDS reports.
- Maintain a document of management activities
- Write a summary report outlining successes, challenges and experiences with the garden, including recommendations for the following season

    - Include a section recommending amendments to the position role descriptions for the Garden Student Coordinator, the AMS Sustainability Coordinator, and the SUB Rooftop Garden Advisory Committee
- Be involved in training and transitioning for the next AMS Sustainability Coordinator

Position: SUB Rooftop Garden Advisory Committee

Duration: Permanent (members change corresponding to position lengths). Meetings will be organized by the AMS Sustainability Coordinator, and held at minimum once a month.

Potential Members:

- Student Garden Coordinator(s)
- AMS Sustainability Coordinator
- Sprouts Board of Directors Rooftop Garden Liaison
- AMS Food and Beverage Services representative [Nancy Toogood]
- UBC Farm representative [Mark Bomford]
- Botanical Garden representative [Patrick Lewis]
- SUB building and maintenance staff representative
- UBC faculty representative(s) [individuals interested in educational and research components, those who have expressed interest to date include: Dr. Andrew Riseman, Dr. James Vercamme, and Dr. Daniel Roehr]
- Work study position supervisor
- Rooftop Garden Beekeeper

Committee Role;

- Provide mentorship to the Garden Coordinator, AMS Sustainability Coordinator, Sprouts representative, and volunteers.
- Provide support when needed, to help ensure successful operation of the garden
- Ensure that production and educational mandates and all other objectives are met
- Monitor the garden's financial situation
- Help ensure the continuity of the garden, including passing on documents and planning a training schedule for new Garden Coordinators, AMS Sustainability Coordinators, and Sprouts representatives.
- Annually amend position descriptions and garden objectives.
- Maintain an inventory of all relevant garden documents.