FINAL REPORT

GROWING UP:

A STUDY IN VERTICAL GARDENING IN THE NORTH

Kyle Taylor

PROJECT SUMMARY

The purpose of this study was to investigate the productivity of a variety of food-plant species, the construction costs, the maintenance time required, and the effectiveness of simple irrigation systems in three vertical gardens the cool, dry, Zone 2 climate of Whitehorse, YT. Three vertical gardens were constructed out of recycled materials to facilitate this investigation, construction and maintenance hours were tracked, and the productivity and suitability of different species was measured and compared to traditionally cultivated control cases. The study shows that vertical gardens are inexpensive and quick to build, comparable in maintenance hours and yields, and offers distinct advantages in certain landscapes. A discussion considering benefits and possible applications follows.

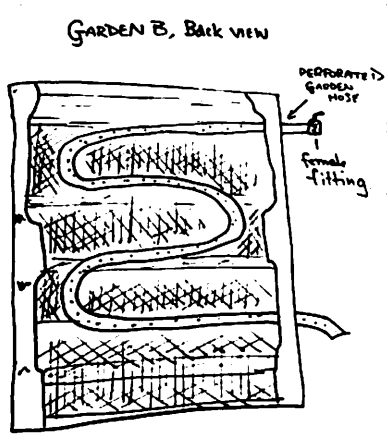
INTRODUCTION

The emergent urban farming technique of vertical gardening is fast becoming popular in the lower latitudes, ranging from the backyard neighbourhood pallet garden, to fully-hydroponic greenhouses in the downtown cores of Canada's biggest cities. The potential value of vertical techniques does not necessarily lie in the possibility of higher yields or lower maintenance times - the technique's most valuable trait is that it offers the farmer the opportunity to cultivate productive varieties of food-plants in spaces where traditional agriculture cannot function; examples of these types of spaces would be places where soil does not exist (balconies, fences, walls, rooftops, concrete slab, etc.), temporary spaces, or where the farmer cannot access permanent rights or title to the land (temporary lease and rental situations). In the challenging climate of the northern latitudes the applicability of vertical gardening remains largely unknown. Foreseeable challenges include the necessity of irrigation, difficulty with water retention in a low-humidity zone, potential for pest and disease increases with higher density plantings, lower comparable yields, higher maintenance times (watering, pest control, weeding, harvesting), and the availability of affordable construction materials.

This study tests the effectiveness of two different pipe irrigation systems, the use of high organic matter soil, and of cloth mulching techniques to address the potential problems of irrigation, water retention, and increased weeding and watering maintenance times. By tracking the productivity and maintenance hours of the gardens and comparing to control cases in traditional gardens, it will be possible to evaluate the suitability of vertical gardening to northern climates. The purpose of this study is not to show that vertical gardens are more productive and require less maintenance than traditional gardens, but rather to see if vertical gardens are not so problematic as to outweigh their primary advantage of allowing a farmer or gardener to use spaces that are traditionally not cultivatable or highly productive. The study will also explore which species are suitable to growing in smaller contained spaces and in a vertical structure by attempting to cultivate food plants of many different varieties and measuring their relative yields to compare to control cases, as well as investigating the availability of construction materials and their costs.

METHODS AND MATERIALS

MATERIALS and TOOLS



6 untreated, unpainted wooden freight pallets
10 burlap coffee bean sacks
1kg roofing nails
160 kg soil
40 kg compost
1kg coconut coir
10 ft. garden hose
1 female hose fitting
variety of seeds (specified below)
10ft 2" perforated PVC pipe

1 hammer
1 chainsaw or handsaw
1 power drill

CONSTRUCTION

Three gardens, A, B, and C were constructed from the wooden pallets in the following manner. One pallet each for gardens A and B were cut in

half with a chainsaw, along the outside of the central joist. Garden A was then filled with soil from the back, and covered with burlap attached with roofing nails, also on the back side. 4ft of perforated PVC piping was inserted down the center of the pallet as a watering option. Garden B was covered with burlap attached with roofing nails on the inside of the front. The section of garden hose was then perforated at a density of 1 1mm hole/cm² using the power drill, and attached on the inside in an elongated 'S' shape (see fig.1) filled with soil, and then covered with burlap on the backside. Garden C was constructed by covering the inner front and back of four pallets with burlap, filling with soil, and arranging them to form a cube. This cube was filled with horse manure, sheep bedding, and green kitchen waste to form an interior compost pile. This compost pile was left for two weeks before planting commenced into Garden C, allowing temperatures to drop below 20°C in the interior of the pile. About 8 inches of soil mixture were added to the top of the compost pile for additional planting space, to create a four-sided hot bed (3 sides, plus top). Construction details with photos can be seen at:*

http://yukonfood.blogspot.ca/

---

* All soil mentioned here consists of local soil mixed with compost and coconut coir (for additional water retention) at a ratio of 40:10:1 by weight.

Williar
Williar

PLANTING GARDENS A, B, and C

Garden A, Planted June 2nd

TYPE (One 60cm row of each)	DENSITY (linear)
Wheaton River Cilantro (2012)	1 seed/cm
Wheaton River Pac Choi (2012)	1 seed/cm
Wheaton River Green Mustard (201	1 seed/cm
WCS Mesclun Mix	1 seed/cm
WCS Amish Deer Tongue Lettuce	1 seed/cm
WCS Wild Arugula	1 seed/cm

Garden B *was a mixed garden planted with seedlings started inside on March 15. Holes were cut through the burlap cloth mulch and seedlings were transplanted through on June 2nd. Garden B was kept in a greenhouse with an average temperature of 18°C.*

3 *Merigolds*
1 Urban Seeds *Korean Mint*
1 Seeds of Italy *Basil*
3 Lindberg *Northern Pickling Cucumbers*
4 Lindberg *Muskmelons*
1 West Coast Seeds *Catnip*
2 Rosemary's Garden *Heirloom English Thyme*
2 Anarchy Farms *Yellow Pear Tomatoes*

Garden C was planted on three sides and the top with transplants started March 15, the North side left alone due to lack of light.

Type	Qt.	Density
Temptation Strawberry	4 plants	1/1250cm^2
Fort Laramie Strawberry	4 plants	1/1250cm^2
Lindberg Northern Pickling Cucumbers	3 plants	1/3300cm^2
WCS Lacinato Kale	3 plants	1/260cm^2
Denali Polar Tomatoes	2 plants	1/2500cm^2
Seeds of Italy Marrow	2 plants	1/2500cm^2

Controls for Cucumbers, Marrow, and Tomatoes were planted in pots in the greenhouse at the same times. Controls for Kale, Korean Mint, Catnip, Wild Arugula, and Deer Tongue Lettuce were planted out side at the same date for comparison in maintenance times and yields.

MEASUREMENT

*Gardens were checked bi-weekly for watering, weeding, pest control and harvesting needs. Time for these tasks was tracked for later comparison with the time spent on the same activities for traditionally gardened controls. This was recorded from time of planting until September 1st. Controls were kept only for a set of representative species as shown in the table titled '**Yields**'.*

Productivity was measured in kilograms of edible fruits in the case of cucumbers and tomatoes, and weight of whole plants in case of herbs, lettuce, mustards, and kale. Yield was measured in kg/m^2, where m^2 represents the total ground area used in the control case, or the total front area of the pallet used (not the ground footprint, this is discussed later).

RESULTS

CONSTRUCTION INVESTMENTS

Construction time was measured by how much time it took to convert the raw building materials into a specific area suitable for sowing seed or transplanting seedlings. For example, Garden A took 0.6 hours for construction and produced 0.5m² of productive area. Garden B, 0.8 hours for 0.5m² (this included fashioning and fastening the irrigation hose). Garden C, 3.2 hours for 4m².

Average construction rate: 0.92hrs/m²

Using the same method, construction costs in $ are calculated. Costs such as seeds, seedlings, and soil are not included as these may be considered the same in all gardening systems. Availability of pallets for frames was very high and will continue to be in Whitehorse in the future. This is based on speaking with different freight companies, all of whom give away pallets for free and have them in continual surplus. Free burlap was found for this project, but was less available. However, landscaping cloth or burlap can be purchased for an acceptable price.

Average construction cost($): $2.10/m²

For educational purposes, such as a school class project, here is a total estimated cost of producing a 0.5m² pallet garden where ***all*** *inputs (soil, seedlings, cloth, etc.) besides the pallet must be purchased, as I did when I built a fourth garden with young children at the Lorne Mountain Community Centre. This is found to be a very affordable project, with minimal expertise required.*

Estimated cost($) for one 0.5m² pallet garden: $44.75
Estimated construction time including planting: 1 hr.

MAINTENANCE TIME

Maintenance times for all three gardens were tracked. This includes weeding, watering, pest control and

harvesting. Results are expressed in total hours spent divided by the area of garden. Results are compared to maintenance times for the control garden. Though watering of the vertical gardens was more time consuming than the traditional garden, weeding times were close to zero due to the effectiveness of cloth mulching, and since the spaces between rows in a vertical garden are covered with wood. Pests were negligible in both experimental and control cases. The watering system in Garden A (perforated PVC) proved to be unnecessary and cumbersome, and was removed; simply lying the garden on its backside and watering from the top proved more than satisfactory. The watering system in Garden B was very easy to use and effective.

TYPE	SEASONAL MAINTENANCE RATE
Vertical Gardens	0.433hrs/m^2
Control (Traditional, Outside)	0.420hrs/m^2

PRODUCTIVITY

Productivity in vertical gardens for most species was comparable to that of the traditionally tended controls, with the exceptions of complete failures in regards to strawberries and muskmelon, which did not yield any fruit in the pallet garden. Tomatoes showed high productivity in Garden C where they had a lower planting density and received extra warmth and water retention from the hot bed, but showed negligible productivity in Garden B in the greenhouse as compared to control tomatoes in the greenhouse. Kale plants grew but showed decreased yields. Lettuce, mustards, cucumbers, and herbs were by far the most effective producers in the vertical gardens, and showed near equal productivity and less maintenance times than controls.

YIELDS (average kg per m^2 per season)

TYPE	Garden A	Garden B	Garden C	Control
Lindberg Northern Pickling Cucumbers	X	4.86	5.02	5.81

Denali Polar Tomatoes	X	Neg.	3.34	4.97
West Coast Seeds(WCS) Catnip	X	2.66	X	2.82
Urban Seeds Korean Mint	X	2.03	X	2.21
WCS Lacinato Kale	X	X	1.91	2.64
WCS Wild Arugula	6.24	X	X	6.1
WCS Deer Tongue Lettuce	7.23	X	X	7.53
Rosemary's Seeds Heirloom English Thyme	X	1.44	X	1.29

Though there were not controls for all species cultivated, it is possible to make recommendations of suitable species for vertical gardening through direct observations and prior knowledge of a species' productivity. Species are classified as 'Suitable(√)', 'Not Suitable(X), or 'Possibly Suitable (?)".

Type	Suitability
Lindberg Northern Pickling Cucumbers	√
Denali Polar Tomatoes	√
West Coast Seeds(WCS) Catnip	√
Urban Seeds Korean Mint	√
WCS Lacinato Kale	?
WCS Wild Arugula	√
WCS Deer Tongue Lettuce	√
Rosemary's Seeds Heirloom English Thyme	√
Temptation Strawberry	X
Fort Laramie Strawberry	X
Seeds of Italy Marrow	√
Merigolds	√
Seeds of Italy Basil	√
Lindberg Muskmelons	X
Anarchy Farms Yellow Pear Tomatoes	X
Wheaton River Cilantro (2012)	X
Wheaton River Pac Choi (2012)	?

Type	Suitability
Wheaton River Green Mustard (2012)	√
WCS Mesclun Mix	√
William Dam Astro Arugula	√
William Dam Mesclun Mix	√

DISCUSSION

The viability, popularity, and practicality of vertical garden has already been demonstrated in countless southern cities, and this project was able to demonstrate the potential for vertical gardening in northern climates for some food-plant species. As we look at maintenance data, it is shown that vertical gardens do not necessarily require increased labour hours to maintain, yet offer comparable productivity levels. It is also shown that gardens can be constructed for a minimum of investment where materials are available.

It is interesting to note that pest problems did not increase. This seems to be due to the fact that there are less pests in general in the colder climate, and also, that planting densities are not actually higher in a vertical garden as one would presume. The planting distances in these gardens were comparable to those in a traditional system; it is only that the ground footprint of a vertical garden is smaller due to it being upright, and so in this way we may increase our production per ground area. However, since the relative spacing of the plants remains the same, pests and disease are not increased.

This actually demonstrates the particular advantage of vertical gardening that is easy to overlook. While it is shown that there is no advantage in production relative to traditional methods, this is actually only true in situations where traditional gardening in large open spaces is practical. In the cases of Gardens A and B, the ratio of their cultivatable surface area to their ground footprint is 4. That is to say that for every square meter that we use on the ground, we get 4 square meters of gardening space. So, though productivity per square meter is actually slightly less in a vertical garden, the space available is increased four-fold, resulting in a significant increase in total yield. This could easily be enhanced further by making the

gardens even taller.
This technique therefor is particularly useful for edge spaces such as building and greenhouse walls, fence-lines, and places where ground cultivation would be impossible or expensive, such as concrete surfaces.

The successes of salad greens and small cucumbers is especially exciting. This suggests that for a very low time and financial investment, urban gardeners could grow an appreciable portion of their own salad greens on the sides of their houses or fences without disturbing the existing landscaping or rental agreements of their land. This could even be possible on apartment and condominium balconies and rooftops where raised beds would be impractical, too permanent, or undesirable.

The current trend in local food production means that this could be a viable option for restaurants that would be interested in advertising that they grown a portion of their own herbs and greens. As most restaurant spaces are leased, the temporary nature of vertical gardens makes the construction of garden space more easily navigated with building owners. Their visual appeal is also makes for easy publicity, both in the real world and in print.

This also points possibilities in agricultural education, as well as reuse and recycling awareness. Many schools are now building community gardens on their properties. The small vertical garden provides an option for schools and teachers that would like to introduce their students to gardening in a practical and achievable way, even in places where ground space for digging is not available, or where funding is scarce.. Public demonstrations of the gardens built for this study showed a high level of interest among children and adults alike, with many inquirers stating that they were headed home to make their own. I think this speaks to the simplicity, productivity and beauty of the vertical garden, as well as the average citizens' ability and interest to engage in issues of food security and agricultural education when presented with practical solutions. The vertical garden is one such practical solution for the north.