An Investigation into the Current and Alternative Methods for Produce Storage and Transportation at the UBC Farm

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APSC 262

April 10, 2014

The University of British Columbia
Faculty of Applied Science

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Course: APSC 262
Date: April 10th, 2014

Abstract

This report examines the economic costs of three produce transportation and storage methods for the UBC Farm in Vancouver, Canada. It looks in depth at the current storage method, the rubber-maid totes, as well as two potential replacements, corrugated cardboard boxes and burlap-lined totes. The report not only accounts for the direct monetary costs, but also for the opportunity cost for factors such as labour. Due to the approximations made for opportunity cost, this report may not be applicable to similar for-profit farms.

The report conducts a thorough market research to inform the reader about the current practices in similar (small and big scale) operations. Cost prices are taken from prices published by other farm operation units in the greater Vancouver area.

After comparing the three alternatives, this report concludes that burlap-lined rubber-maid totes are the most long term cost-effective option for the UBC Farm, while taking opportunity cost into account. The corrugated cardboard boxes save money on recurring costs due to labour, washing, and broken equipment but the cost of replacing the single-use boxes adds up over twenty years. The rubber-maid totes saved money due to its long lifespan, but the recurring costs and opportunity costs remains high. By modifying the existing system and adding a burlap-lining drastically reduces the washing cost and labour opportunity cost.

This report recommends the UBC Farm modify their existing infrastructure and purchase burlap to line the plastic totes they already own.

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Glossary

Polyethylene:
Polyethylene (abbreviated PE) or polythene\is the most common plastic. Its primary use is in packaging (plastic bag, plastic films, geomembranes, containers including bottles, etc.). Many kinds of polyethylene are known, with most having the chemical formula $(C_2H_4)_nH_2$. Thus PE is usually a mixture of similar organic compounds that differ in terms of the value of n.

1.0 INTRODUCTION

The UBC Farm is Located on the southern part of the UBC campus in Vancouver. It consists of 24 hectares of farm and forest land and grows nearly 60 000lbs of fruits and vegetables. It sells its harvest in on site and on campus farmers' markets as well as directly to restaurants and distributors in the Vancouver area. Managed by the Centre for Sustainable Food Systems, the UBC Farm focuses on developing and implementing sustainable and ecologically aware farming techniques.

The purpose of this report is to choose a produce storage and transportation vessel that will meet the economic requirements of the UBC Farm and, along with a parallel report written by a colleague group, provide a triple bottom line analysis of the options available.

This report will give a full life cycle cost analysis of the current UBC Farm system, the alternative systems and provide conclusions and recommendations. The report is divided into the following sections:

Section 2: Overview of the current system design of the UBC Farm including an introduction of the design process of each major component.

Section 3: Provides a detailed explanation of the working practices of other farms and distribution systems in Greater Vancouver.

Section 4: Focuses on the evaluation of the economic costs of the current system and the alternatives encountered in our research. This is followed by a comparison of the methods, which allow for a straightforward conclusion.

Section 5: Contains our conclusions for this project and also our recommendations for further work.

2.0 THE CURRENT UBC FARM SYSTEM

The current system of produce transportation and storage has grown with the farm. No prior research conducted to assess feasible solutions or find alternatives to using plastic totes. The current system consists of reusable crates and totes which are washed after each use. This system was adopted because it naturally seems cheaper than one involving one-time use, disposable containers because the farm can reuse containers for years (Saphire, 1994).

2.1. Operations

The current system at the UBC Farm involves use of 150 totes and 52 crates. During operational season (May-October) the UBC Farm harvests vegetables, fruits and flowers. The fresh produce is harvested and stored in plastic totes under a shed near the Harvest Hut in the farm. Thrice a week (on average), delivery trucks load these totes and transport produce to local consumption channels that include restaurants, farmer markets, etc. Most of the deliveries are performed by workers at the UBC Farm and they make the return trip to the farm with the empty totes.

The totes get dirty with rotten produce after multiple uses and are washed by volunteer staff or farm crew on location. The washing schedule varies depending on factors like harvest phase and staff availability. Four volunteers use liquid dish soap and take approximately 5 hours to wash the totes. Each crate or tote takes approximately a minute and a half minute to wash. The washing facility is located outside the Harvest Hut (see Figure 1) and consists of numerous food grade hoses with a common storm drain. All 150 totes get washed at least once per week during peak season. They are left to dry overnight on a rack outside the Harvest Hut and are ready for delivery the following day.

2.2. Rubber-maid Plastic Totes Design

The farm uses Rubbermaid "Roughneck" totes. These totes have an 18 gallon capacity and size 23.9" L x 15.9" W x 16.5" H (*Rubbermaid* 2014). The farm crew buys new totes on a rolling basis (whenever a tote breaks) from Canadian Tire, London Drugs or Inter-crate. The retail price for a single tote is approximately CAD$9.55. New totes need to have holes drilled on their lids and bottom to allow for aeration and water drainage. Roughneck storage totes are sturdy containers that can withstand harsh temperatures from hot to cold, such as attics and basements. Made with a durable polyethylene material (*Rubbermaid* 2014) for a lifetime of durability and strength, they are easy to stack and come with a 10 Year Limited Warranty. The main point of failure of the totes is the handles that break while being handled carrying heavy loads at the farm (see Figure 1). The warranty does not cover for broken handles during farm operations. Thus the expected life expectancy of the totes for the farm is approximately three years.

Figure 1: ***(In clockwise order)*** *Top Left:* Entrance to the UBC Farm, 3461 Ross Drive; *Top Centre:* Reusable crates and totes used for transporting produce; *Top Right:* Open-air rack for totes to fry after washing; *Right Centre:* Basin with food grade hose to wash totes; *Bottom Right:* Tendency of totes to break at handles after repeated/heavy usage; *Bottom Centre:* Tote washing facility uses a storm drain; *Bottom Left:* Holes drilled under totes for aeration/water drainage; *Centre Left:* Totes are stored outside the Harvest Hut under a shed.

3.0 MARKET RESEARCH

To learn more about which transportation and storage options are best suited to the UBC Farm, we will take a more in depth look at how the industry as a whole has chosen to tackle this problem. When it comes to produce transportation, there are two main methods. Practitioners of these can be split quite neatly into two groups with similar attributes. Small farms tend to use reusable shipping containers. Their focus is on quickly getting their produce to market, and their locality gives them certain advantages when it comes to bringing their bins back. Large farms tend to ship long distances and usually opt for disposable cardboard boxes. The boxes are uniform in shape and need not be returned after transport. We now take a closer look at both of these methods and how they might benefit the UBC Farm.

3.1. Small Farms

Small farm operations similar to the UBC Farm are the first and best place to start looking for alternatives transportation methods. Walking around a farmers' market in Vancouver, one can see all types of produce carriers. There is a theme reusability that ties them all together. Some use wicker baskets, some use rubber totes, and many use wooden crates. Sellers at these markets are less concerned about long term storage than larger farm operations because they sell their produce so near to where they grow it.

The Granville market, for example, uses its locality with farmers to have a quick turnaround rate for its produce. Given storage constraints and the highly perishable nature of fresh fruit and vegetables, produce vendors have more frequent deliveries than others. This practice also shifts risk to the supplier and explains why produce businesses at the market need less cold storage (VEDC, 2009). Produce growers are able to offload their produce quickly to local markets like this, avoiding the necessity of large storage facilities and a high number of storage bins. Frequent and local deliveries also limit the difficulty of returning empty containers after shipping. Getting empty rubber totes back to Vancouver farms is an expensive process when shipping internationally, whereas local farms making deliveries themselves can just as easily bring their bins back when they return to the farm.

In general, reusable totes are a much more viable option for small scale farm operations than they are for large farms transporting over long distances (Leo, 1995). As we will see in the next section, grocery chains and large corporate farms have many issues to face, that small farms need not be concerned with.

3.2. Large Farms and Grocery Chains

To learn more about how large scale farms transport their produce, we visited some chain grocery stores. The Save-On-Foods and Safeway produce coolers tell the same story: corrugated cardboard is the best option. If profit-maximizing, corporate farms all choose to ship their produce in cardboard; it is a good indicator that this is the best practice, at least by economic standards. The produce shipped to Save-On-Foods is generally shipped in corrugated cardboard boxes with internal cardboard separators. The motivation is simple: it is much cheaper to crush a cardboard box at Save-On and buy a new one for the farm than to ship reusable boxes even short distances.

The motivations for the ubiquity of cardboard boxes in grocery chains do not apply to the UBC Farm. When selling quickly in a local market, cooled transport vehicles are not necessary. Locally produced fruits can be fairly mature and ripe because the time to market is short. Produce shipped from great distances is often a little less mature than locally produced produce and must be free of mechanical damage and other conditions predisposing it to noticeable quality loss in a long postharvest handling period (Hui, 2009). There are many extra precautions that apply to long distance produce transport as well. The truck must have its temperature, atmosphere, and humidity controlled to put off spoilage for as long as possible. All these issues are largely inapplicable to the UBC Farm.

We therefore conclude that cost estimates for cardboard shipping and storage may be less useful than those made based on local farms in similar situations. Though the literature is abundant in this area, it is less relevant. That being said, corrugated cardboard box usage is so common that its life-cycle cost analysis is definitely worth performing (Singh, 2006).

4.0 ALTERNATIVES AND COMPARISONS

In this section we assess the alternatives to the current method outlined in section 2.1, and consequently perform a comparison using the economic criteria of triple bottom line assessment. We then draft a recommendation based on the performance of this alternative method compared to the baseline method.

The alternatives that we explored for the UBC Farm were single-use corrugated cardboard boxes and burlap-lined totes. Our group conducted a combination of primary and secondary research to setup some guidelines for Cost Assessment (International Nursery Products, 2012; GLBC, 2013) First and most importantly, our calculations are for the long-term of 20 years, which is the average lifespan of a plastic tote.

Our group also made some intelligent assumptions for the direct monetary cost ad opportunity cost of water, labour and transportation. The cost of water has been accounted as negligible due to provision of free water to the farm. This water is also consequently used for other farming processes therefore its opportunity cost is also negligible. The farm has volunteers who help with washing the plastic totes therefore labour costs are negligible as well. These volunteer hours could be utilized to contribute to other farm processes, thereby improving efficiency and agricultural productivity (Chonhenchob, 2003). Therefore it was a logical conclusion to incorporate an opportunity cost for labour. The opportunity cost has been approximated at $25 for each washing cycle if time spent is 7.6hours/ cycle and $12.5 for each cycle if time spent is 3.8hours/ cycle. The cost for returning the containers was assumed to be negligible, since the transport vehicle returns to the farm with the plastic totes previously taken to the UBC destination. The environmental opportunity cost of transport was discounted since it is a common factor for all three systems.

4.1: Economic Assessment of Current System

Initial Investment

I1.	Cost of one tote	$9.15
I2.	Average Life Span of re-usable tote	20 years
I3.	UBC farm 20-yearly requirements	150 totes
I4.	Tote Investment over 20 years (I1 x I3)	**$1,372**

Recurring Costs

R1.	Cost of Water	**$0.00**
R2.	Cost of Returning container	**$0.00**
R3.	Cost of Soap bottle (2 litre)	$7.75
R4.	Approximate UBC farm annual dishwasher soap bottles requirement	10
R5.	20 Yearly soap bottle requirements	200
R6.	Soap bottle cost over 20 years (R3 x R5)	**$1,550**
R7.	Cost of labour	**$0.00**
R8.	Volunteer hours per Washing Cycle of 150 totes	7.6
R9.	Opportunity Cost of labour per Cycle	$25
R10.	Washing Cycles per year	14
R11.	Total Washing Cycles over 20 years	280
R12.	Estimated opportunity cost over 20 years (R8 x R10)	**$7,000**
R13.	20 Year estimate for broken totes	60
R14	Cost for replacing broken totes over 20 years (I1 x R13)	**$549**

Total Cost of the Current reusable Plastic Tote System

T1.	Total Monetary Cost (I4 + R1 + R2 + R6 + R7 + R14)	**$3,471**
TO1.	Total with Opportunity Cost (I4 + R1 + R2 + R6 + R7 + R12 + R14)	**$10,471**

The direct monetary costs are largely due to the initial investment into totes, and the cost of soap for washing the totes. They combine to account for less than a third of the total costs including the opportunity cost of labour for 20 years. The opportunity cost of labour is this high because of the slow, cumbersome process of washing totes; time that could otherwise be spent increasing productivity at the farm.

4.2. Economic Assessment of the Burlap-lined Totes

Initial Investment

I1.	Cost of one tote	$9.15
I2.	Average Life Span of re-usable tote	20 years
I3.	UBC farm 20-yearly requirements	150 totes
I4.	Tote Investment over 20 years (I1 x I3)	**$1372.5**
I5.	Cost of one burlap-lining (when bought in bulk)	$3.25
I6.	Average Life Span of burlap-lining	4 years
I7.	UBC farm 20-yearly requirements	750 totes
I8.	Tote Investment over 20 years (I5 x I7)	**$2437.5**

Recurring Costs

R1.	Cost of Water	**$0.00**
R2.	Cost of Returning container	**$0.00**
R3.	Cost of Soap bottle (2 litre)	$7.75
R4.	Approximate UBC farm annual dishwasher soap bottles requirement	5
R5.	20 Yearly soap bottle requirements	100
R6.	Soap bottle cost over 20 years (R3 x R5)	**$775**
R7.	Cost of labour	**$0.00**
R8.	Volunteer hours per Washing Cycle of 150 totes	3.8
R9.	Opportunity Cost of labour per Cycle	$12.5
R10.	Washing Cycles per year	14
R11.	Total Washing Cycles over 20 years	280
R12.	Estimated opportunity cost over 20 years (R8 x R10)	**$3500**
R13.	20 Year estimate for broken totes	60
R14	Cost for replacing broken totes over 20 years (I1 x R13)	**$549**

Total Cost of the Burlap-Lined Plastic Tote System

T3.	Total Monetary Cost (I4 + I8 + R1 + R2 + R6 + R7 + R14)	**$5,134**
TO3.	Total with Opportunity Cost (I4 + I8 + R1 + R2 + R6 + R7 + R12 + R14)	**$8,634**

After the inclusion of burlap-linings in the original system at the farm, the direct monetary costs increase. The additional initial investment that has to be made for burlap-linings, overpowers the decrease in cost due to use of lesser soap for washing the burlap-linings. The total cost including opportunity costs however are drastically lower. This is because of reduced volunteer hours, since washing is now a far easier, quicker and more efficient process.

4.3. Economic Assessment of the Corrugated Cardboard Boxes

Initial Investment

I1.	Cost of one corrugated cardboard box (when bought in bulk)	$0.28
I2.	UBC farm annual requirements	2100
I3.	UBC farm 20-yearly requirements	42000
I4.	Cardboard Box Investment over 20 years (I1 x I3)	**$11,760**

Recurring Costs

R1.	Cost of Washing (Water + Soap)	**$0.00**
R2.	Cost of Returning container	**$0.00**
R3.	Cost of labour	**$0.00**
R4.	Estimated Opportunity Cost of labour	**$0.00**

Total Cost of the Corrugated Cardboard Box System

T2.	Total Monetary Cost (I4 + R1 + R2 + R3 + R4)	**$11,760**
TO2.	Total with Opportunity Cost (I4 + R1 + R2 + R3 + R4)	**$11,760**

For this system, all the costs are from the initial investment. There are no recurring costs, since the cardboard boxes are single use. There are no opportunity costs, since there is no washing, and therefore no labour.

A direct comparison of the three systems shows us the following:

System	Direct Monetary Cost ($)	Opportunity Cost ($)	Total Cost ($)
Current @ UBC Farm	3471	7000	10471
Current+ Burlap-linings	5134	3500	8634
Corrugated Cardboard Boxes	11760	0	11760

5.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the economic assessment of the methods available to us, if we do a direct monetary comparison we can see that the current UBC Farm system is the least expensive. However if we account for opportunity cost of volunteer hours, it seems that the most viable option is to modify the current system with the addition of burlap-linings. This would increase the initial investment costs, but at the same time would drastically reduce washing cost due to soap, and reduce the opportunity cost of labour at the farm.

We recommend the UBC Farm to take the opportunity cost as an important factor while making their decision, and consider buying burlap-linings for their current re-usable tote system.

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7.0 APPENDIX

The following water consumption data was measured using a DLJ water meter on December 16, 2013 by UBC Farm Field Research Assistant Michael Millar. Water consumption and time were recorded for 52 crates, 150 totes, and 10 lids. An estimate for 150 lids was made from the measurements taken from 10 lids. An estimate of total labour time was made for the washing time as well as the setup and organization time.

Crates and Totes		**Lids**		**Total Crates (52), Totes (150), Lids (est. 150)**	
Time (min) / (202 Crates and Totes)	296	**Time** (min) / (10 lids)	8	**Time** (min)	406
Time Hrs	4.93	**Time Hrs**	0.13	**Gallons Used**	386.9
Number of crates	52	**Number of lids**	10	**Gallons / min**	0.95
Number of totes	150	**Number of min / lid**	0.8		
Total crates + totes	202	**Gallons Used**	6.9		
Number of min / tote + crate	1.47	**Gallons / min**	1.16		
Gallons Used	247.7	**Gallons Used** (est. 150 lids)	139.2		
Gallons / min	0.84	**Total min** (est. 150 lids)	120		

Total washing time and water consumption for 52 crates, 150 totes, 10 lids, and an estimated 150 lids.

Estimated Total Labour Time	Time
Total washing (min) totes/crates/lids	406
Total setup and organization (min) (est.) including Moving tables Moving stacks together Organizing tote/crate sizes Clearing space to work Peeling tape Taking down and moving stacks Taking down and moving tables	50
Total Time (min)	456
Total Time (hrs)	7.6

Total estimated labour time for 52 crates, 150 totes, and an estimated 150 lids including setup and organization time.