



Supply Chain Development for Vermont-grown Frozen Blueberries

Project Summary

The Intervale Center completed the following feasibility study for a Vermont-grown, organic frozen blueberry product for sale through local and regional market channels. We documented current Best Management Practices, conducted a market analysis to assess potential demand and developed financial models to evaluate cost of production and market pricing.

Through this research, we concluded that:

- While market opportunity exists in local and regional markets, price is the most limiting factor to increasing demand for local product.
- Organic blueberry production requires a large initial investment for establishment. While it can be a very profitable crop, it takes many years to realize a positive return on investment.
- Frozen blueberry production favors scale. A solution to increase profitability for small scale growers is to diversify by including sale of fresh berries into retail markets, such as pick-your-own.
- Harvest and post-harvest labor are the two biggest expenses in small-scale production of frozen blueberries. Creating efficiencies in these areas is essential to lowering production costs and increasing profitability.
- Post-harvest processing practices require a high level of management and oversight to ensure an end product that meets both quality standards and consistent supply in the marketplace.
- Regional market channels may require increased product liability coverage and food safety certifications. Producers at any scale should be aware of and follow current FSMA regulations.
- An aggregator model for blueberries would be beneficial to manage end-product quality, increase supply, build efficiencies in scale, and meet increased food safety requirements in the marketplace. That being said, current market demand is not large enough to warrant a separate aggregator to increase supply and build efficiencies in scale. Greater production and market analysis needs to be conducted to determine the appropriate scale and point in the supply chain for aggregation.

What follows is a summary of best practices, market analysis and financial models that we have developed to assist farmers, processors, distributors, service providers, and others interested in food system development to better understand the feasibility of aggregated frozen blueberries for Vermont farmers.

Best Management Practices

Organic Frozen Blueberry Production

Organic blueberry production in Vermont consists of northern highbush varieties and is mostly small-scale with farms producing on five acres or less. While blueberries are a suitable crop for smaller growers, start-up costs are high and profitability is long-term. However, once established, operating costs decrease over time, and as long as plants are maintained properly, blueberries have the potential to be a profitable enterprise.

Compared to other berries, blueberries have a long shelf life of -up to one week fresh if refrigerated - but they are still highly perishable and have a fairly short period of availability. Because of these

limitations and the increased cost of production in organic systems, the majority of organic blueberries in Vermont are grown for short supply chains and markets offering higher prices. These markets include direct retail sales such as farmers' markets and Pick Your Own and direct wholesale to restaurants, food hubs, coops and natural foods stores.

A viable alternative to increase availability and satisfy demand is to freeze blueberries. They are easier to freeze than other berries, as they require less post-harvest processing, making it feasible to use low-tech systems to produce a marketable frozen product. In Vermont, frozen blueberries are produced both on-farm for direct sales and by regional post-harvest processors for sale into larger market channels.

The following Best Management Practices are based on information provided by several Vermont blueberry suppliers, including one grower of fresh organic blueberries, one processor of frozen blueberries, and one aggregator of frozen blueberries who manages a branded product line.

Production Cycle

Blueberries are a perennial crop that requires an establishment period before yielding any fruit. Complete blossom removal in the first two years of growth is necessary for plants to develop a strong root system. In years three to five, partial blossom removal is recommended. After establishment, blueberries will produce a light crop of fruit, increasing annually until plants reach full production. During this five to ten year period, yields average approximately 4,000 lbs per acre annually. At full production, blueberries can yield over 10,000 lbs per acre in ideal conditions, but 6,000 lbs per acre is a more conservative estimate. If maintained properly, blueberries can be productive for up to 50 years.

Soil Preparation and Fertility

Preparing a field prior to planting is essential to establishing a healthy crop, especially in organic systems. Because weed control is such an important factor in organic production, growing a cover crop for one year prior to planting is recommended to smother weeds and reduce weed seed populations. This practice also helps build soil organic matter, improving fertility and water holding capacity, both important factors for blueberries because of their shallow root systems.

Blueberries require an acidic soil with a pH of 4.5-5.0. To lower soil pH, sulfur can be applied. Rates vary depending on soil type, ranging from 500-1,500 lbs per acre to lower pH by one unit. Although soil organic matter can buffer pH, an acidic environment is essential for fertility. Blueberries prefer nitrogen in the ammonium form, which is maintained in acidic soils.

Once a crop is established, supplemental nitrogen is the main focus for fertility management. Nitrogen requirements are fairly low, yet soluble nitrogen is key. Because the majority of organic fertilizers are slow-release and less soluble, one solution to increasing solubility in organic systems is to provide weekly applications of liquid fertilizer, such as fish emulsion, through a fertigation system. This will provide frequent doses of soluble nitrogen directly to the root zone.

Planting and Variety Selection

Blueberries are planted in rows spaced 10-12 feet apart, with four to five feet of spacing between plants in a row. Two-year old plants are most commonly used in new plantings. Variety selection is based on a number of factors, including market diversity, product availability, taste, and harvesting methods. Vermont farms tend to have a wide range of blueberry varieties present in one planting, mainly to increase the length of the harvest season. This is also beneficial because cross-pollination is necessary

for some varieties to fruit. Specific varieties are bred for mechanical harvesting with a focus on time of harvest and firmness of berries, but most varieties used on Vermont farms would be suitable.

Pruning

Blueberries require annual pruning at the end of their dormancy period, usually in March when fruit buds are easily visible. Pruning shapes the plant, controls crop load, increases berry size, and stimulates new cane growth. It also helps to increase light penetration into the center of the plant, which is needed to initiate flower buds. Fruiting occurs on branches that are 2-7 years old, so older branches are removed to maintain productivity.

Irrigation

Irrigation is essential in blueberry production, even in Vermont, due to the crop's high water demand. Blueberries require at least four inches of water per week. Because of their shallow root system and lack of root hairs, applying water directly to the root zone is necessary. Drip irrigation systems are most common and can be used to apply fertility to plants with the use of liquid fertilizers, such as fish emulsion.

Weed Control

Weed control is the most significant difference between organic and conventional systems. Because blueberries have such shallow root systems, controlling weeds in-row is necessary to reduce competition for water and nutrients. Use of black landscape fabric or organic mulches, such as wood chips, are common materials for in-row weed control. As for inter-row management, controlling weeds to reduce potential weed seed population in-row and proper soil management are top priorities. It is important to create an inter-row space that works for both foot and equipment traffic. Living mulches, such as perennial ryegrass, are the most common way Vermont growers manage inter-row space. Frequent mowing is required, and this is justified when compared to the negative effects and costs of bare ground cultivation.

Pest Management

There are numerous animal, insect and disease pests in blueberries. Some pests affect the fruit, while others the plant. Pesticide application is one method of control, yet there are few approved chemicals that are effective in organic production. Proper monitoring and cultural practices have the greatest effect on minimizing pest infestation.

Animal pests include birds and deer, which can be controlled by various scare tactics, such as reflective tape and noise devices. In the case of excessive deer and bird pressure, exclusion fencing and netting can be used to secure perimeters and cover plants. Mummy Berry, a fungus that overwinters in berries that have fallen to the ground, is the most common disease in blueberries. Practicing proper sanitation by removing infested berries from the plant and ground, as well as applying a thick layer of mulch around the plant for coverage of infested fruit is the best method of control.

Currently, the most serious insect pest of blueberries in the Northeast is Spotted Wing Drosophila (SWD), which affects all fruit crops. SWD pressure is more severe later in the growing season so early maturing varieties are one strategy to avoid damage. Monitoring, sanitation, pruning, and rapid cooling of fruit post-harvest are all strategies for control. Entrust (Spinosad) is one pesticide approved for organic production that has shown good results in controlling SWD, but limiting use is necessary to pest resistance.

Harvest

Depending on variety, blueberries in Vermont have on average an eight-week harvest period, from July to August. At full maturity, a blueberry plant can yield up to 10 lbs of fruit annually. Currently, all local blueberries grown in the state are harvested by hand. This is the single greatest expense in blueberry production.

While hand harvesting is common industry practice for the fresh market, it greatly reduces the market potential for frozen blueberries due to high costs in labor. Through our research, all producers cited mechanical harvesting as the missing piece to creating a locally grown, frozen blueberry product that is viable in the marketplace. That said, mechanical harvesting equipment can cost up to \$30,000 and may not be compatible to the size of individual farms in our area. We recommend further analysis to determine the cost-benefit of mechanical harvesting in Vermont.

Post-Harvest Processing

Post-harvest processing includes washing, sorting, freezing and packaging of fruit. In Vermont, frozen blueberries are produced both on-farm and by regional processors. There are currently two regional processors of frozen fruit, one in Vermont and the other in New York. In all scenarios, fairly low-tech systems are used to freeze blueberries, as they require minimal processing compared to other fruit. After harvest, berries are first air-cooled to reduce field heat. Washing is done either by submerging berries in water multiple times in a 3-bay sink, or by using automated rinse lines common in fruit and vegetable processing operations. Pre- or post-wash, berries are sorted to remove any poor quality fruit. The majority of quality control should occur on-farm, prior to processing, but this is still a recommended practice. Conveyor lines lend themselves well to this process to maintain efficiency and workflow.

Currently, all freezing is done using a vertical staging system, where berries are spread out on trays, stacked vertically on mobile racks, and placed in a walk-in blast freezer. Once frozen, berries can be removed from trays into bulk containers to be packaged for sale. While this process does produce individually frozen fruit, automation using a conveyor type IQF (individually quick frozen) unit would increase productivity and improve quality. One producer interviewed in this project said greater automation in post-harvest processing is necessary to lower costs and improve quality.

Packaging

Frozen blueberries are packed in food-grade plastic bags for sale. A 10oz. bag is most common for retail sales and a 20lb bag is most common for bulk sales. Bags are packed into cardboard or wax boxes or re-useable plastic containers for distribution. Packaging is done almost entirely using manual labor, favoring bulk pack as more efficient and cost-effective.

Market Analysis

Our research examined price and demand data as well as anecdotal evidence from buyers of various local and regional market channels including retailers, distributors and institutions. We analyzed four market channels for organic frozen blueberries. All markets indicate frozen blueberries are in demand in both retail and bulk packaging. However, price and availability are the most limiting factors to increasing local market opportunity as well as regional market entry.

Frozen Blueberry Demand

Blueberries are a popular crop among consumers, both fresh and frozen. In particular, as is the case with most berries, fresh product is in high demand because of its limited shelf life and short window of

availability. This fact coupled with substantial harvest costs for fresh product has resulted in relatively high prices in the marketplace, creating a market opportunity for small-scale producers. In addition, demand is high for certified organic blueberries because of consumer concerns about pesticide residues on fruit eaten fresh. This is especially true in local markets due to the limited supply of organic product. For frozen blueberries, consumer demand for locally grown product is the main factor driving market opportunity. Local producers are less likely to compete with open market prices for frozen blueberries because mechanized harvesting is standard practice in the processing market. In addition, there is less demand for certified organic product in the frozen category, most likely because frozen berries are used as an ingredient in further processed products rather than eaten whole. That said retail prices for organic product are comparable for both local and non-local, ranging from about \$8 to \$9/lb. In contrast, the retail price for conventional product ranges from approximately \$5 to \$6/lb for non-local and \$7 to 8/lb for local. If demand can be increased for organically grown frozen blueberries, local producers may be able to increase sales in more direct supply chains.

Of the various market channels examined in this study, the majority of frozen blueberries sold are supplied by national brands. All locally produced frozen blueberries are sold through local markets, which show greatest demand and willingness to pay a premium for local, yet not necessarily for certified organic. Demand in individual local markets for frozen berries ranged widely from approximately 1,000lbs–8,500lbs annually with local product representing anywhere from 0-100% of purchases. Consistent availability is cited as the most limiting factor to increasing sales of local product.

As for regional markets, price is the limiting factor for market entry. The average wholesale price is \$2.25/lb for non-local, conventional product and \$3.50/lb for local, organic product. While increased market opportunity in local markets is not huge, it is still significant enough to explore the feasibility of lowering the cost of production through mechanized harvesting or other means to increase sales and access wider market channels. This is especially true for certified organic product.

Frozen Blueberry Budget Assumptions

The example farm includes a small-scale frozen blueberry enterprise, which represents 25% of total farm income and assumes an equal proportion of the farm mortgage and fixed expenses, including land taxes and \$1 million in liability insurance. The farm has a mortgage of \$250,000 for 30 years at 3.5%, with a farm purchase price of \$300,000. This includes existing building structures that could be renovated to house blueberry processing and storage areas, as well as farmer housing.

The blueberry enterprise includes five acres in production at full maturity, yielding 30,000lbs per year. The production cycle is assumed to have an establishment period of 10 years, with no yield in years 1-5, and an average yield of 4,000lbs/acre in years 5-10. There is 5% shrink built into the budget to account for loss throughout the production process including pest damage.

The final product is sold in bulk 20lb cases. Pricing is based on the current average market price for local, certified organic frozen blueberries.

Labor is based on a rate of \$15/hour, which includes all payroll expenses. Labor is calculated for all required labor unless listed separately, which could include labor performed by farm owners. Harvest labor is estimated at \$0.85 for every pound picked. Marketing, sales and delivery of end product assumes management of 12 sales accounts requiring two hours of labor per week. Delivery to those accounts requires four hours of labor plus a total of 60 miles driven per week for 48 weeks a year.

Processing of frozen berries is assumed to be done by a separate processor, and cost is captured as a per pound fee. Distribution to and from the processor is estimated at \$2 per mile with 120 miles per week for an eight week period. Frozen storage is rented at \$50/pallet for 11 months per year through the entire sales period. Sixteen pallets for years 5-9 and 24 pallets at full maturity are required to store the entire annual supply. To supply consistent monthly sales all year, an average of 1.5 pallets per month would need to be sold in years 5-9 and an average of 2 pallets per month at full maturity.

The enterprise assumes a line of credit to purchase supplies at the start of the growing season as well as an operating loan to purchase equipment and infrastructure. The \$25,000 line of credit is assumed to have a 7% interest rate with the principle being paid back within 12 months. The \$64,200 operating loan is assumed to have a 5% interest rate with a 7-year term.

During establishment years, total net costs are \$106,566.92. It would take 5 seasons at full maturity, and a total of 15 years to pay back initial investment for establishment.

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2016

Sample Budget for Frozen Blueberry Enterprise

Planting Year

Income	Unit	Number	Price/unit	Total
Frozen Blueberries				
Total Income				

Expenses

Variable

Plants	each	5000	\$ 3.50	\$ 17,500.00
Soil Test	each	10	\$ 15.00	\$ 150.00
Fertilizer	acre	5	\$ 425.00	\$ 2,125.00
Grass seed	lb	150	\$ 1.00	\$ 150.00
Landscape fabric	ft	10000	\$ 0.33	\$ 3,333.30
Labor - planting	hours	500	\$ 15.00	\$ 7,500.00
Labor - production	hours	400	\$ 15.00	\$ 6,000.00
Equipment repairs and maintenance				\$ 500.00
Interest on operating capital				\$ 1,774.00

Total Variable				\$ 21,382.30
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Fixed

Insurance				\$ 1,250.00
Taxes				\$ 1,500.00
Mortgage				\$ 4,065.87
Total Fixed				\$ 6,815.87
Total Expenses				\$ 28,198.17

Net Income				\$ (28,198.17)
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Loan for Start-up/Capital expense				\$ 11,483.94
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Net after Capital Expense				\$ (39,682.11)
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Net after Capital without Paid Labor				\$ (26,182.11)
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Sample Budget for Frozen Blueberry Enterprise

Establishment Years 1-4

Income	Unit	Number	Price/unit	Total
Frozen Blueberries				
Total Income				
Expenses				
Variable				
Fertilizer	acre	5	\$ 200.00	\$ 1,000.00
Labor - production	hours	400	\$ 15.00	\$ 6,000.00
Equipment repairs and maintenance				\$ 500.00
Interest on operating capital				\$ 1,774.00
Total Variable				\$ 9,274.00
Fixed				
Insurance				\$ 1,250.00
Taxes				\$ 1,500.00
Mortgage				\$ 4,065.87
Total Fixed				\$ 6,815.87
Total Expenses				\$ 16,089.87
Net Income				
Loan for Start-up/Capital expense				\$ 11,483.94
Net after Capital Expense				\$ (11,483.94)
Net after Capital without Paid Labor				\$ (5,483.94)

Sample Budget for Frozen Blueberry Enterprise

Establishment Years 5-9

Income	Unit	Number	Price/unit	Total	Cost/unit	% cost
Frozen Blueberries	lb	19,000	\$ 3.50	\$ 66,500.00		
Total Income				\$ 66,500.00		
Expenses						
Variable						
Fertilizer	acre	5	\$ 200.00	\$ 1,000.00	\$ 0.05	2%
Labor - production	hours	500	\$ 15.00	\$ 7,500.00	\$ 0.39	11%
Labor - harvest	lb	20,000	\$ 0.85	\$ 17,000.00	\$ 0.89	26%
Labor - marketing/sales/delivery	hours	240	\$ 15.00	\$ 3,600.00	\$ 0.19	5%
Processing	lb	20,000	\$ 0.65	\$ 13,000.00	\$ 0.68	20%
Distribution	miles	960	\$ 2.00	\$ 1,920.00	\$ 0.10	3%
Storage	pallets	96	\$ 50.00	\$ 4,800.00	\$ 0.25	7%
Delivery	miles	2400	\$ 0.54	\$ 1,296.00	\$ 0.07	2%
Equipment repairs and maintenance				\$ 500.00	\$ 0.03	1%
Interest on operating capital				\$ 1,774.00	\$ 0.09	3%
Total Variable				\$ 52,390.00	\$ 2.76	79%
Fixed						
Insurance				\$ 1,250.00	\$ 0.07	2%
Taxes				\$ 1,500.00	\$ 0.08	2%
Mortgage				\$ 4,065.87	\$ 0.21	6%
Total Fixed				\$ 6,815.87	\$ 0.36	10%
Total Expenses				\$ 59,205.87	\$ 3.12	89%
Net Income				\$ 7,294.13		
Loan for Start-up/Capital expense				\$ 11,483.94	\$ 0.60	17%
Net after Capital Expense				\$ (4,189.81)		
Net after Capital without Paid Labor				\$ 23,910.19		
Cost/lb after Capital Expense				\$ 6.20		
Net/lb after Capital Expense				\$ (0.22)		

Sample Budget for Frozen Blueberry Enterprise

Full Maturity Year 10

Income	Unit	Number	Price/unit	Total	Cost/unit	% cost
Frozen Blueberries	lb	28,500	\$ 3.50	\$ 99,750.00		
Total Income				\$ 99,750.00		

Expenses						
Variable						
Fertilizer	acre	5	\$ 200.00	\$ 1,000.00	\$ 0.04	1%
Labor - production	hours	500	\$ 15.00	\$ 7,500.00	\$ 0.26	8%
Labor - harvest	lb	30,000	\$ 0.85	\$ 25,500.00	\$ 0.89	26%
Labor - marketing/sales/delivery	hours	288	\$ 15.00	\$ 4,320.00	\$ 0.15	4%
Processing	lb	30,000	\$ 0.65	\$ 19,500.00	\$ 0.68	20%
Distribution	miles	960	\$ 2.00	\$ 1,920.00	\$ 0.07	2%
Storage	pallets	156	\$ 50.00	\$ 7,800.00	\$ 0.27	8%
Delivery	miles	2880	\$ 0.54	\$ 1,555.20	\$ 0.05	2%
Equipment repairs and maintenance				\$ 500.00	\$ 0.02	1%
Interest on operating capital				\$ 1,774.00	\$ 0.06	2%
Total Variable				\$ 71,369.20	\$ 2.50	72%
Fixed						
Insurance				\$ 1,250.00	\$ 0.04	1%
Taxes				\$ 1,500.00	\$ 0.05	2%
Mortgage				\$ 4,065.87	\$ 0.14	4%
Total Fixed				\$ 6,815.87	\$ 0.24	7%
Total Expenses				\$ 78,185.07	\$ 2.74	78%

Net Income				\$ 21,564.93		
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Cost/lb				\$ 2.74		
Net/lb				\$ 0.76		

Capital Budget for Frozen Blueberry Enterprise

Item	# of units	Cost per unit	Total Cost
Equipment			
Tractor	1	\$25,000.00	\$25,000.00
Mower	1	\$1,500.00	\$1,500.00
Fertilizer Spreader	1	\$550.00	\$550.00
Disc Harrow	1	\$1,500.00	\$1,500.00
Rototiller	1	\$1,750.00	\$1,750.00
Irrigation	1	\$1,000.00	\$1,000.00
Harvest containers	200	\$ 15.00	\$3,000.00
Scales	1	\$ 150.00	\$150.00
Storage/Cooler			
8x10' cooler	1	\$ 12,000.00	\$12,000.00
Distribution			
Used Refrig. Box Truck	1	\$ 20,000.00	\$20,000.00
Total Capital Expense			\$66,450.00