Sunrise Orchards: Greening the Production and Distribution Process

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Community Partners: Barney and Chris Hodges

EC265 Final Project
Professor Isham
May, 2007

INTRODUCTION:

Sunrise Orchards is a third generation family farm in Cornwall, VT that is owned and operated by Barney and Chris Hodges. It is one of the largest and most productive apple orchards in the state – 175 acres, containing 50,000 trees under cultivation. Sunrise produces approximately 110,00 bushels of McIntosh, Cortland, Empire, Red Delicious, Early Varieties, and other specialty apples every year. Their apples are distributed locally, including to Middlebury College and to larger retailers in New England. Sunrise Orchards currently demonstrates its commitment to sustainability through its partnership wit Red Tomato, a non-profit fruit and vegetable marketing organization that seeks to support small scale farmers. Specifically, Sunrise Orchards supplies Red Tomato with "eco-apples". This designation means that the orchard is certified using integrated pest management (IPM), which is a strategy that minimizes the use of chemical pest control through integration of natural pest management strategies. Barney and Chris are committed to further reducing their environmental impact. In response to this commitment, we analyzed two possible strategies: 1) replacing cardboard boxes with plastic ones and 2) a conversion to biodiesel.

Through this analysis, we found that the first strategy is highly cost-effective while the second strategy is not currently so. However, the two strategies in combination are cost-effective. Therefore, we recommend that both strategies be implemented, with the cost savings from the first project used to finance the second.

STRATEGY ONE: REUSABLE PLASTIC CONTAINERS

I. OVERVIEW:

One of the more unsustainable areas of Sunrise Orchard's business is its corrugated cardboard distribution system. The cardboard boxes are both a significant operational cost and a wasteful product. Packaging represents nearly one-third of the total solid waste stream, and materials used to transport goods (transport packaging) make up nearly half of packaging waste[1]. We considered two options to improve the system of distribution: the reuse of cardboard boxes and their substitution by reusable plastic containers (RPCs). For either system to function, both options necessitated the cooperation of those at the boxes' end destination, the orchard's clients. Their concern regarding storage space and extra handling costs of engaging in the re-use of these boxes was one of the major challenges of our project. We succeeded because we concentrated on the local demand chain, a set of long-term and frequently served clients with whom the orchard has a relationship of trust. Additionally, when used in the local supply chain, the higher upfront costs of RPCs are recovered much faster due higher use, i.e. displace more cardboard boxes. Therefore, we present a cost-benefit analysis of a distribution scheme involving plastic boxes in the orchard's local distribution network.

Primary Stakeholders:

The primary stakeholders in this initiative are Sunrise Orchards, the grocery stores that are part of Sunrise's local distribution, and the producers of the reusable plastic containers.

Sunrise Orchards

[1] Inform.

Sunrise Orchards will be the driver of the transition from cardboard boxes to reusable plastic containers.

Grocery Stores

There are twenty-six grocery stores (including Middlebury College), listed in the chart below, to which Sunrise delivers its apples. Approval of the transition to plastic boxes has been obtained from the Hanover and Lebanon Food Coop, Middlebury College, the Middlebury Natural Food Coop, and the eleven Price Chopper stores. Approval has not been received from the Shaw's locations because the District Director has not yet authorized contact with the store managers.

Plastic Container Producers

We have been in contact with Amatech Polycel and RPC Plastics, producers of reusable plastic containers. Amatech Polycel produces packaging, storage, and protective material. It has two manufacturing plants, one in Erie, Pennsylvania and the other in Columbus, Ohio. RPC plastics has operations in almost every state. Both companies produce plastic containers that can be folded flat (collapsible). These producers were chosen because of their superior product and pricing.

Sunrise Orchards' Local Distribution:

Store	**Contact person/ Produce Manager**	**Given approval?**
Hanover and Lebanon Food Coop	Bruce Follet	Yes
Middlebury College	Charlie Sargent	Yes
Middlebury Natural Food Coop	Karen	Yes
Shaw's		
Power House - Lebanon, NH	Debbie	In process
Upper Valley - Lebanon, NH	Russell	In process
Springfield, VT	Sharon	In process
Fair Haven, VT	Jim	In process
Manchester, VT	John	In process
Colchester, VT	Paul	In process
Berlin, VT	Mark	In process
Stowe, VT	Bob/Todd	In process

Williston, VT	John	In process
Vergennes, VT	Bob/Todd	In process
Middlebury, VT	Paula	In process
South Burlington, VT	John	In process
Price Chopper		
Shelburne, VT	Don Rich	Yes
St. Albans, VT	Dale	Yes
Morrisville, VT	Mark	Yes
Barre, VT	George Saunders	Yes
Essex, VT	Jenny or Pat	Yes
Rutland, VT	Sean	Yes
Manchester, VT	Rick	Yes
Brattleboro, VT	Bob Bagerly	Yes
West Lebanon, NH	Dick	Yes
West Rutland, VT	Sherry/Don	Yes
Bennington, VT	Rich/Mark	Yes

Timeline of Implementation

Given the simple nature and low cost of this initiative, this project could be implemented immediately. Since apple distribution starts in September, the purchase and organization of the RPC boxes should be completed by then. This project is obviously contingent on the agreement of retailers – we hope that the Shaw's confirmation process will be completed by September. If not, the project can be started with the other retailers.

II. COSTS:

We calculated the total costs of our proposed distribution system (RPCs) and the total costs of the current cardboard distribution system over 10 years using a discount rate of 9% - a just approximation, given the market for alternative investment. In those costs, we only included the purchase of boxes, except under our proposed system, which has some extra labor costs. We did not include the transportation or packing costs of the distribution system because those are not altered by the switch from cardboard to

plastic boxes. According to our calculations, our proposed system is not only cost-effective but saves the orchard nearly 2/3 of its current costs! The explanation is simple: the system requires only 4% of the previous box total.

(A) Costs of Proposed System:

The total cost of an RPC distribution system for Sunrise Orchards' local demand chain includes: 1) the purchase of RPCs 2) continued purchase of cardboard "dunnage" for Count Box and 3) the extra labor time required for retrieving the RPCs from Sunrise Orchard's apple retailers.

1) Price of RPCs

To determine the total costs of the purchase of RPCs we needed to find out their price but also the quantity needed to establish the system. For pricing, we contacted six manufacturers:

1. RPC Packaging supply, Inc. Contact: Bob Goyle (Ext 3014)
2. Norseman Plastics. Contact: Katherine Ammon 920-261-0741 and Carl Beroluwitz 617-938-2252
3. Georgia Pacific. Contact: Michael Davis 801-230-4382
4. Amatech Polycel: Vincent Campanelli (800) 403-6920 ex. 18 vcampanelli@amatechinc.com
5. Chep: Contact: 407-370-2437
6. Plasgad Products: Contact: 972-4-6939295

We asked them to quote us prices for **collapsible** plastic substitutes of the Quad Box and the Count Box. Our client and his clients (the apple retailers) made it clear that the boxes would need to be collapsible to occupy as little space as possible. The details of those boxes are in Figure1:

Figure 1:

	Dimensions (inches)	Price ($)	# Used 06/07	Function
Quad Box	15.75x24x11	1.40	18,500	Bagged apples (40 lbs)
Plastic substitute	Similar	4.55		same
Count Box	13x18.5x12.5	2.20	9,000	Delicate apples (40 lbs)
Plastic substitute	Similar	4.30		same

Figure 2:
The pricing that we obtained is as follows:

	Dimensions (inches)	Price ($/unit)	Tooling cost ($)	Turns	Function
Quad Box (cardboard)	15.75 x 24 x 11	1.40	0	0	Bagged apples
RPC Packaging	15.75 x 24 x 11	7.32	1275- 1500	250-300	
Norseman Plastics	15.7 x 23.6 x 10.6	12.43	0	250-300	
Amatech Polycel	15.75 x 24 x 11	4.55	2500	500	
Count Box (cardboard)	13 x 18.5 x 12.5	2.20		0	Delicate apples
RPC Packaging	13 x 18.5 x 12.5	4.74	1275- 1500	250-300	
Amatech Polycel	13 x 18.5 x 12.5	4.30	1250	500	

2) Quantity of RPCs

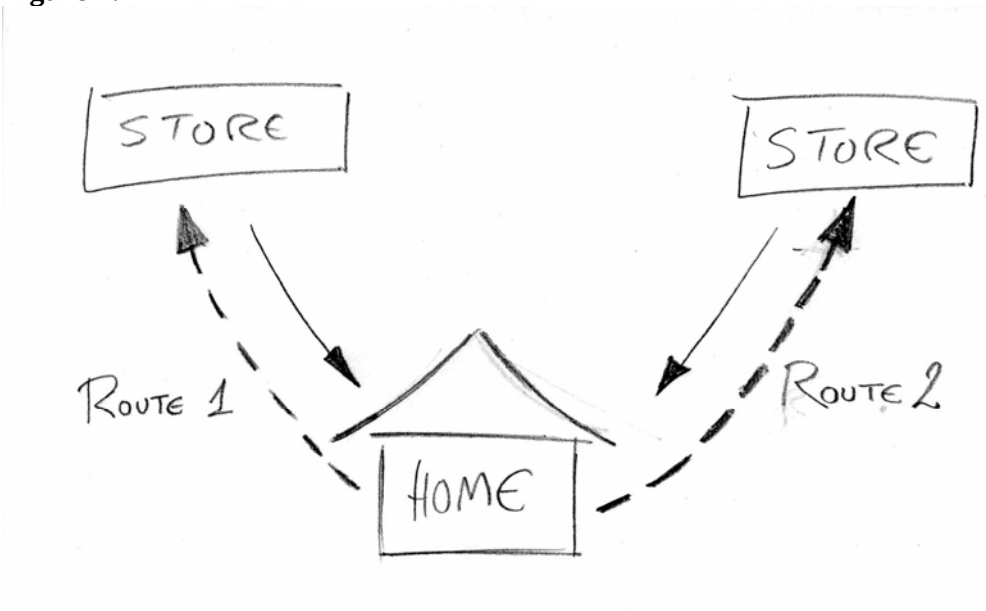
Our calculation of the number of RPCs to be purchased: 1000 boxes, considerably overshoots the actual number required for the system to function because we consider that the losses from not having enough boxes far outweigh the costs of the extra boxes. If under some circumstance, the truck could not pick up the RPCs on one of the routes and there was a spike in demand, the orchard would sully its reputation as a solvent supplier and lose out on a sale. For that reason, we took Sunrise Orchard's peak demand estimate for a daily shipment: 250 boxes, and added 2 days worth of such shipments as a reserve to be kept in inventory. Thus, at all times, there would be a

maximum of 500 boxes at the retailers on either Route 1 or 2. There would be 250 boxes in transit to either Route. And 250 boxes in storage. This will allow the system to operate at an efficient level, with risk-mitigating inventory. Figure 3 shows the movements of RPCs over a 4 Day period and Figure 4 is a graphic representation.

Figure 3:

	Day 1	Day 2	Day 3	Day 4
Distribution	250 boxes (Route 1)	250 boxes (Route 2)	250 boxes (Route 1)	250 boxes (Route 2)
Inventory at packing facility	750	500	250	250
Boxes retuned	0	0	250	250

Figure 4:



The above analysis results in an estimate of approximately 1000 plastic boxes in inventory. however, the following calculations will use a total of 3750, as stipulated by Sunrise Orchards.

3) Costs of Purchase of RPCs

Now that we obtained the prices and quantity of RPCs, we calculated not only the cost of their initial purchase, but the costs of maintaining the inventory needed to maintain the RPC system operational over the next 10 years.

Cost of Amatech Polycel RPCs

Figure 5:

AMATECH POLYCEL LLC
CUSTOM DESIGNED PACKAGING PROFESSIONALS

1460 Grimm Drive Erie, PA 16501
Phone: 814-452-0010 Fax: 814-452-0303

Quotation

Quote To: John Thorp
4447 Middlebury College
Middlebury, VT 05753
United States

Quote Number:	2924		Contact:	John Thorp
Quote Date:	05/07/07	Expires: 06/06/07	Inquiry:	
Customer:	JOHN THORP		Terms:	Net 30 Days
Salesman:	House		Phone:	(802) 989-4150
Ship Via:	To Be Determined		FAX:	
FOB:	Our Plant			

Thank you for the opportunity to submit this quote. All prices and term are valid for 30 days from the date of this quote.

A prototype can be purchased for $20/each (no tooling charge).

Item	Part Number / Description	Revision	Quantity	Price
1	2924-1 Interlocking RSC made from 4mm PP material with (2) die cut handles, heat welded and shipped flat. Size: 15.75" x 24" x 11" OD. Delivery: 3 - 4 Weeks ARO		2,500 One-time Tooling Charge:	$4.550 /EA $1,590.00
2	2924-2 Interlocking RSC made from 4mm PP material with (2) die cut handles, heat welded and shipped flat. Size: 13" x 18.5" x 12.5" OD. Delivery: 3 - 4 Weeks ARO		1,250 One-time Tooling Charge:	$4.300 /EA $1,150.00
			Total:	*$19,490.00*

The boxes provided by this company are made of corrugated plastic and easily collapsible. They provide easy printing capabilities, and are durable enough to last

approximately 500 “turns”, or uses. The maintaining of their inventory is discussed further below.

Cost of RPC Plastics RPCs

Quad Box

2500*7.32=18300

+ “tooling cost” of $1500

= $19,800

Count Box

1250*4.74=5925

+ “tooling cost” of $1500

= $7,425

Total Cost of system:

7,425 + 19,800 = $27,225

The other costs, applicable to both systems, are described below.

4) Cost of Dunnage for Count Box

Sunrise Orchard’s local customers are willing to return and store the RPCs. However, the return of the complicated, protective inner sections of the Count Box, the dunnage, is beyond the time they are willing to devote to this program. Given that the dunnage will be one-use only, we suggest its continued purchase from the current cardboard box supplier. The current price paid for it is $1.10 per unit. Each unit fits into one Count Box.

Currently, 4,618 Count Boxes are used by the orchard in its local distribution, every year. So, the cost of cardboard dunnage for the RPC ‘count box’ substitute will be: 1.10 x 4,618 = $ 5,080.

5) Extra Cost of Labor

Sunrise Orchards estimates an extra 5 minutes at each stop to pick up the RPCs. Given that on average 12 stores get visited each shipping day, the driver will spend an extra hour every working day on the endeavor. His wages are at $12/hour, so for a whole year, the extra labor under our proposed system will be: $12 x 4 (distribution days/ week) x 24 (delivery weeks/year[2]) = $1,152.

6) Total Cost of the System:

The total cost of our proposed system for Year 1: Initial purchase of RPCs + Dunnage + Labor. Year 2: 15% of RPC inventory + Dunnage + Labor. Etc.

Figure 6

Year	New Boxes ($)	Discounting Calculation at 9%	Discounted Cost ($)	Dunnage Cost	Labour Cost	Projected Inventory Loss (10%)
1	19,490			5,080	1,152	375
2	0	(5080+1152)(1+0.09)^2	7404.23	5,080	1,152	375
3	0	(5080+1152)(1+0.09)^3	8070.62	5,080	1,152	375
4	0	(5080+1152)(1+0.09)^4	8796.97	5,080	1,152	375
5	0	(5080+1152)(1+0.09)^5	9588.70	5,080	1,152	375
6	0	(5080+1152)(1+0.09)^6	10451.68	5,080	1,152	375
7	0	(5080+1152)(1+0.09)^7	11392.33	5,080	1,152	375
8	0	(5080+1152)(1+0.09)^8	12417.26	5,080	1,152	375
9	0	(5080+1152)(1+0.09)^9	13535.23	5,080	1,152	375
10	0	(5080+1152)(1+0.09)^10	14753.41	5,080	1,152	375
11	1500*4.24+2,740=9100	(19,490+5080+1152)(1+0.09)^11	66373	5,080	1,152	375

*Note - This table assumes the yearly use of 1000 plastic boxes, and the demand to maintain a total inventory of 3750 boxes.
**Note - The 10% loss of the initial inventory incorporates both loss due to regular wear and tear (loss after approximately 250 turns) and to miscellaneous losses. This percentage will increase as total inventory decreases, due to increased turn amounts. Information obtained from RPC Plastics.

(B) Costs of Existing System:

Sunrise Orchards estimates that 20,000 boxes are used each year on the local route at a 10:3 ratio. Therefore, 4,618 Count Boxes and 15, 381 Quad Boxes are used

[2] Sunrise Orchards usually makes deliveries, 4 days per week, from Sept 1 to March 1. This means 24 weeks of work per year (for the driver).

every year by the orchard. Given that the Count Box costs $2.20 (including dunnage) and the Quad Box costs $1.40, the total yearly costs of cardboard box purchases are: (4,618 x 2.20) + (15, 381 x 1.40) = 10,159.6 + 21,533.4 = $31,693.

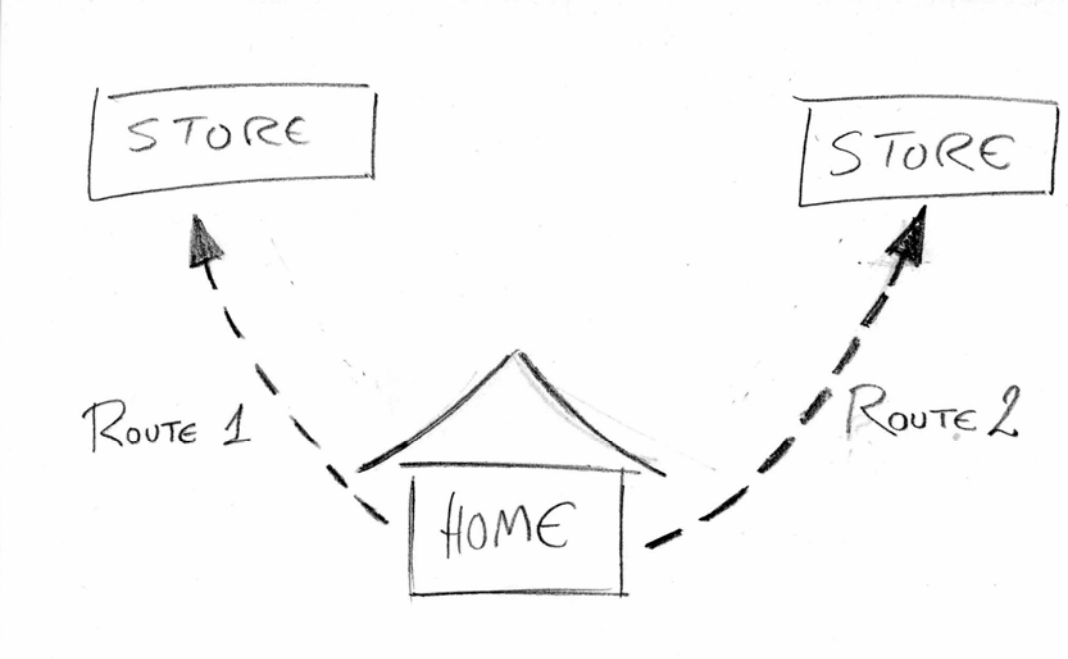
Due to the 20,000 box strong inventory, the orchard must devote significant space to cardboard box storage. We had no way of calculating the extra monetary costs that that supposes but the freeing up of that space can clearly be counted as a benefit of the RPC system.

The distribution system over 4 days can be seen in Figure 7 and its visual representation in Figure 8.

Figure 7

	Day 1	Day 2	Day 3	Day 4
Distribution	250 boxes (Route 1)	250 boxes (Route 2)	250 boxes (Route 1)	250 boxes (Route 2)
Inventory at packing facility	19,750	19,500	19,250	19,000
Boxes retuned	0	0	0	0

Figure 8:



III. NON-MARKET COSTS AND BENEFITS

Environmental

Neither corrugated cardboard nor plastic containers can be considered beneficial to the environment. The questions to be weighed are first, which is more costly to the environment; and second, what is the environmental benefit of the ability to reuse plastic containers in comparison to the one-time use of cardboard boxes?

Cardboard is the most frequently used material for shipping in the US. Approximately 90% to 95% of US consumer, wholesale, and industrial goods are transported in corrugated cardboard boxes (Inform). Although 70% of all corrugated cardboard is recycled (wastecap), the majority of these boxes are used commercially only once (Inform). As a result, corrugated cardboard is a $17 billion per year industry in the US (wastecap). In 1990, 25 billion corrugated boxes were produced in the US –

about 100 per person (Inform). These boxes comprise 12.2% of the national municipal solid waste stream in 1990 and contributed 24 million tons of waste (Inform).

Although the environmental impact of the manufacturing process of corrugated cardboard has been mitigated over the past few decades, there are still substantial negative effects. Corrugated cardboard is created from flat sheets of puncture resistant paper on either side of a sheet of corrugated short fiber paper. The sheets are glued together and folded to create boxes (answers). The creation of these sheets of paper requires pulp, which depletes tree supply and creates sulfur dioxide pollution (wastecap). Using recycled pulp to create corrugated cardboard, and recycling of corrugated cardboard into new products, mitigates their environmental impact by 50% and 25%, respectively, but does not diminish it completely by any means (wastecap).

The environmental impact of plastic containers is arguably worse than that of corrugated cardboard. Plastics are produced from fossil fuels and the production process consumes further energy and resources (O'Neill). Emissions from the production of plastic contribute to ozone depletion, carcinogenicity, smog, and acid rain (O'Neill).

Thus, the production of both plastic and corrugated cardboard containers negatively impacts the environment. However, the ability to re-use plastic containers as many as 250 times is significant in the comparison between the use of plastic and cardboard in Sunrise Orchards' local distribution. Sunrise Orchards purchases 20,000 cardboard boxes per year to distribute their apples, about 67,000 of which for local (Vermont) distribution. These boxes are used once and then recycled by the grocery stores that receive them. We recommend that Sunrise instead purchase 1,250 plastic containers for their local distribution, cutting the number of cardboard boxes needed per year by 67,000. In the initial year of the transition, Sunrise would need to purchase 1,250 plastic containers and 133,000 cardboard boxes. In subsequent years, Sunrise

would need to purchase 133,000 cardboard boxes. After 10 years, Sunrise will have cut the number of cardboard boxes used by 670,000. Thus, the environmental benefits of the proposed transition from cardboard to plastic are sizeable. Although the environmental impacts of the production processes of plastic and cardboard are both negative, these costs can be significantly decreased by the use and reuse of plastic containers.

Social

There are strong social benefits associated with a transition from cardboard boxes to reusable plastic containers for Sunrise's local distribution. The use of plastic containers would encourage increased interaction between Sunrise Orchards and the grocery stores that it distributes to. Moreover, this interaction would represent a cooperative effort of Sunrise and local grocery stores striving to reach the same goal of environmental efficiency. This positive interaction and cooperative effort contributes to the strength of the community, which in turn can encourage other environmentally friendly projects, among other benefits. As Bill McKibben demonstrates in his book Deep Economy, strong communities have a multitude of social benefits, most of which cannot be quantified adequately.

The social costs of a transition from cardboard to plastic can be summed up in the "grumbling factor". This includes the natural resistance many people feel to change and the minor difficulties that grocery store employees and Sunrise Orchard's employees might feel as a result of the adoption of plastic containers.

Public Relations

There are a number of positive impacts in public relations associated with a

transition from cardboard to plastic. The strongest of these is the appeal of a more environmentally friendly product to consumers. Numerous studies have documented the significant value that many consumers place on a "greener" product. A study done in 2001 shows that US consumers are willing to pay a price premium for electricity produced with reduced emissions, and particularly through increased reliance on renewable fuels (Roe et al, 2001). A study done in 2002 shows that some customers are willing to pay a price premium for apples with an eco-label that confirms sound environmental practices in the apple's production (Loureiro et al, 2002). In particular, female customers with children are willing to pay a small but significant price premium. Numerous other studies confirm that eco-labels have value to consumers.

Sunrise Orchards has already distinguished itself as an environmentally friendly producer and a transition to reusable plastic containers will continue this effort. Sunrise is a member of Red Tomato, a nonprofit organization that markets fresh fruits and vegetables produced by family farms in the eastern US. The majority of these products are grown using ecological methods such as organic, IPM, and biodynamic farming. With Red Tomato's help, Sunrise has begun to produce apples with an eco-label that appeals to greener customers. A transition to RPCs would further increase Sunrise's appeal to these environmentally aware customers.

A transition to reusable plastic containers would make Sunrise Orchards the only apple orchard in Vermont to adopt RPCs for its local distribution. This could position Sunrise on the cutting edge of distribution practices for apple orchards in Vermont. Other orchards, and even producers of other types of fruits and vegetables, could use Sunrise as a model, causing an overhaul of distribution practices all over New England and beyond.

Cost-Cutting Areas and Synergies

A transition from cardboard to plastic containers for Sunrise's local distribution could result in significant opportunities to cut costs. First, this transition may lead to increased environmental awareness at Sunrise Orchards itself, for the grocery stores it distributes to, and for the consumers that buy their apples. This increased awareness could spur other environmental friendly projects for any of these parties. Second, Sunrise will save a significant amount of resources in the long term by purchasing and re-using plastic containers. The transition would free up these resources for use in other products and processes that could increase Sunrise's productivity and/or reduce its environmental impact.

IV. FINANCING:

There are a number of foundations throughout New England and the US that offer grants to cover expenses for sustainable agriculture projects. One example is the Northeast Sustainable Agriculture Research and Education Organization (SARE). SARE has a "Farmer Grant Program" that aims to help farmers explore sustainable and innovative production and marketing practices. The grant application is fairly intensive and can be found at SARE's website.

We did not research too heavily into potential financing options because of the low cost associated with the transition from cardboard to plastic for Sunrise's local distribution. The time required to research and complete the grant application process might not be worth the money received from the grant itself. This is an issue for Barney and Chris Hodges to navigate.

V. CONCLUSION:

After conducting this project, it has become apparent that im many ways, moving in an environmentally sustainable direction can be tremendously cost effective for many businesses. Specifically, our proposal not only greatly reduces Sunrise Orchard's distribution costs, but also grants enormous social, environmental, and PR benefits. These benefits will be felt both by Sunrise, as well as by the local community. We strongly believe that this project should be undertaken promptly, for the next year of distribution (starting in September).

STRATEGY TWO: BIODIESAL

I. OVERVIEW:

This portion of the project analyzes how Sunrise Orchards can reduce their greenhouse gas emissions from diesel fuel use in transportation and heating, thus improving their sustainability in the future. The main strategy for achieving this goal was exploring the costs/ benefits of supplementing diesel fuel with biodiesel using 1) their current fueling infrastructure and 2) installing a bulk fuel tank on the farm, which could supply all of their fuel needs. Furthermore, this project investigated the idea of instituting a no-idling policy for the farm's delivery trucks and tractors in an effort to reduce their overall fuel demand and emissions.[3]

Biodiesel:

Biodiesel is an alternative fuel made with animal or vegetable based oils that can be used in compression-ignition (diesel) engines, heating broilers, and turbines with few or no modifications. Biodiesel is the only alternative fuel to meet the requirements of the 1990 Clean Air Act. It also is ASTM[4] certified and meets the clean diesel standards established by the California Resource Board (CARB). B100 is considered pure or "neat" biodiesel and is strictly composed of vegetable oils, animal fats, and recycled cooking oils. B100 can be blended (either by a fuel supplier or manually in-tank) at any level with regular petroleum diesel to create a biodiesel blend. B20 (20% biodiesel 80% petro-diesel blend) is the most common form of biodiesel on the market because it

[3] Data for this study came from a variety of sources. Internet research provided a wealth of general information about biodiesel and idling policies. However, the majority of our information and nuanced knowledge about incorporating biodiesel came from contacting, on the phone and in person, various biodiesel suppliers and retailers around the state as well as meetings with the Vermont Biofuels Association.

[4] U.S. Department of Energy. "Biodiesel: Handling and Use Guidelines." September 2006. http://www.osti.gov/bridge. ASTM International is a consensus based group comprised of engine and fuel injection equipment companies, fuel producers, and fuel users whose standards are recognized in the United States by most government entities, including states with the responsibility of insuring fuel quality. Any biodiesel used in the Unites States for blending should meet ASTM D6751.

balances property differences with conventional diesel, performance, emission benefits, and is cost-competitive with regular diesel (sometimes even cheaper!). For the skeptics, B20 has been road tested in vehicles for over 50 million miles, and has proven to be a practical fuel that can be used in any diesel engine.[5] B20 is the minimum blend level allowed for Energy Policy Act of 1992 compliance. Blends of B2, B3, and B5 are also commonly used, but have much lower emission reductions benefits. As biodiesel grows in popularity, some states are beginning to develop biodiesel incentive policies to promote use and production of biodiesel. For example, in 2004 Vermont Lt. Governor Brian Dubie allocated $7,500 in biodiesel to The Vermont Coffee Company, Sugarbush Resort, and Vermont Law School to heat buildings, fuel vehicles, and run maintenance equipment, all using biodiesel. These grants were awarded by the Vermont Sustainable Job Fund (VSJF) and are designed to stimulate the use of biodiesel by Vermont's institutions and companies.[6]

General Benefits of Biodiesel:

There are many benefits associated with using biodiesel. First off, it is a renewable fuel, typically made from domestically produced soybeans. This decreases our dependence on foreign oil and contributes to our domestic economy. Furthermore, using domestically produced fuels can build a demand for alternative fuels within states, which helps the transition to a more local and clean energy economy, further supporting state initiatives such as the Vermont Biodiesel Project. Also, the marketing value associated with using biodiesel could be very positive for Sunrise Orchard. They could stamp "powered by biodiesel" on every box, which could enhance the 'green labeling'

[5] Vermont Biofuels Association. "National Biodiesel Board Guidance." 30 November, 2005. This pamphlet was obtained from a visit to the Vermont Biofuels Association.
[6] Vermont.gov. "Lt. Governor Dubie Announces $7,500 in Biodiesel Grants." 28 October, 2004. http://ltgov.vermont.gov/press_releases.

the orchard already promotes. People might be more inclined to purchase apples from Sunrise Orchard simply because they know that the orchard emphasizes social and environmental responsibility.

Switching to biodiesel can also reduce greenhouse gas emissions, such as CO_2. Figure 1 illustrates the emissions reductions from using biodiesel blends in comparison to regular diesel.

Figure 1: Emissions Properties of Biodiesel in Comparison to Regular Diesel[7]

Greenhouse Gasses	**B20**	**B100**
CO2	-15%	-67%
CO	-12%	-48%
Particulate Matter	-15%	-47%
Sulfates	-20%	-100%
Nitrous Oxides	2%	10%
Total Unburned Hydrocarbons	-20%	-67%

Contrary to popular belief, biodiesel actually has the highest 'energy balance' of any transportation fuel. The DOE/USDA lifecycle analysis shows that for every unit of fossil energy it takes to make biodiesel, 3.2 units of energy are gained.[8] In terms of horsepower, fuel economy, and torque, biodiesel is typically equivalent to diesel when using B20. Additionally, biodiesel provides significant lubricity improvements over petroleum diesel fuel, which leads to longer engine life, lower maintenance costs, less equipment downtime, and protection against fuel injector failure. Even biodiesel blends as low as B1 and B2 con provide up to a 65 percent increase in lubricity.[9] Furthermore, biodiesel maintains superior detergent characteristics, which in the long run reduces particulate, gum, and varnish build-up. In the short run, however, filters tend to become

[7] Biodiesel.org. "Biodiesel Basics." http://www.biodiesel.org/resources/biodiesel_basics/default.shtm http://www.biodiesel.org/resources/fuelfactsheets/default.shtm

[8] Ibid. This figure takes into account planting, harvesting, fuel production, and the fuel transportation to the end user. However, it is important to consider the dangers of using the "wrong" kind of biofuels. Specifically those that use almost as much energy they produce as they save in burning (www.msnbc.com/id/18332282).

[9] Biodiesel.org. "Biodiesel Performance Fact Sheet." http://www.biodiesel.org/pdf_files/fuelfactsheets/Performance.PDF

clogged, so it is necessary to change fuel filters more frequently than normal. Another odd, but pleasant benefit of using biodiesel is the smell. People have noticed that using biodiesel can make diesel exhaust smell better; more like cooking odors.

Performance Precautions:

The main concern associated with biodiesel is its cold flow properties. As with any diesel fuel, cold weather can cloud and even gel the fuel, but this process begins at a higher temperature with biodiesel blends. B100, for instance, typically starts to gel around 32° Fahrenheit, while users of B20 report experiencing a gelling point around 2-10° Fahrenheit.[10] Using a B5 blend during the winter months can be effective in lowering the gelling temperature. Also, using cold flow improvement additives can be very helpful. As mentioned above, the detergent characteristics of biodiesel cause filters to become clogged initially, which translates into an increase in up-front maintenance costs. Higher blends of biodiesel may experience some materials compatibility. Blends over B20 have the ability to soften and degrade certain types of rubber compounds over time, especially in older engines. Furthermore, B50 and B100 require special handling and fuel management, and may require equipment modifications such as the use heaters, changing seals, and/or gaskets that come in contact with the fuel. A final precaution associated with blends of biodiesel over B20 is fuel stability. Industry experts recommend that biodiesel be used within six months of manufacture to ensure that the quality of the fuel is maintained.[11]

II. BIODIESAL AND SUNRISE ORCHARDS

[10] Vermont Biofuels Association
[11] Vermont Biofuels Association

Fuel Use Profile:

Sunrise Orchards currently uses diesel for fueling a furnace, tractors, and delivery trucks, totaling approximately 12,000 gallons/ year. The delivery trucks and furnace predominantly use fuel in the winter months while tractors are exclusively used in the summer and early fall (see Figure 2).

Figure 2: Approximate Fuel Demand by Month (gallons)

	Tractors	Furnace	Delivery Trucks
January	-	535	1200
February	-	535	1200
March	-	535	-
April	-	530	-
May	130	-	-
June	135	-	-
July	135	-	-
August	135	-	-
September	135	-	1600
October	130	-	1600
November	-	530	1200
December	-	535	1200
Total (gallons)	800	3200	8000

MacIntyre Fuels of Middlebury, VT has reliably supplied and delivered diesel fuel to the farm weekly/bi-weekly (depending on demand) for the past couple of years. On-farm fuel is kept in a 275/gallon above ground storage tank (for the tractors) and a 275/gallon tank for the furnace, located in a heated room. Sunrise's two delivery trucks, equipped with Thermo King Refrigerator units, provide apples from the farm to various customers around the state, including Middlebury College, from September to March. Once loaded, the trucks depart the farm on one of two delivery routes (northern and southern), depending on the day of the week. These trucks obtain their fuel en-route from Maplefields gas stations around the state.

Option 1: Integrating Biodiesel w/ Current Infrastructure

The state of Vermont has an established and growing network of biodiesel producers, wholesale providers, and retailers. Therefore, it would be relatively easy for Sunrise Orchards to integrate biodiesel fuel into their fuel demand, at whatever pace and blend they choose. This scenario assumes the use of B20 blends or below because it is 1) the most available on the market 2) most suitable for the cold Vermont climate, and 3) experiences minimal performance issues.

For on-site fuel demand, Sunrise Orchards could switch to biodiesel in the two 275/gallon tanks they already have in use. The orchard's current supplier of on-site fuel, MacIntyre Fuels, does not currently supply biodiesel nor has plans to do so in the near future. However, Champlain Valley Plumbing & Heating supplies biodiesel for off-road and heating purposes to the Middlebury/ Cornwall area, including Middlebury College, and is capable of delivering biodiesel to Sunrise Orchards throughout the year.[12]

For the delivery trucks, there are a number of filling stations situated on or very near Sunrise Orchard's established trucking routes. On the southern trucking route, there are two stations that supply B100 and B20, depending on the time of year, with more coming on line in the next 1-2 years. The northern trucking route passes by three filling stations that supply a range of biodiesel blends throughout the year (see Appendix 1 for maps & station information). Each of these stations have been contacted and are willing and capable of supplying Sunrise Orchard's delivery trucks with biodiesel. Sunrise delivery trucks could thus fill up at any of these stations, at any desired blend with regular diesel, throughout the year.

[12] As explained through a conversation with Barney, switching to Champlain Valley as a supplier of fuel for the farm is more complex than it appears. Sunrise Orchards has built of longstanding business relationship with Rock MacIntyre, predicated upon trust and respect, and has received reliable service throughout the years. Bill Heffernan of Champlain Valley was an employee of MacIntyre Fuels before he started his own fuel supply company. If Sunrise were to switch to Champlain Valley for biodiesel, it may damage the relationship they have established with MacIntyre Fuels and any dealings they have with them in the future. Although Barney is not opposed to using Champlain Valley for fuel delivery, his relationship to Mr. MacIntyre is something to consider.

Costs:

Quantifying the costs of biodiesel in comparison to regular diesel is oftentimes difficult due to the fluctuating nature of fuel prices, especially when evaluating biodiesel blends. In general, on-road B20 is typically cost-competitive with regular diesel while B100 is about $.30-.60 more expensive. All of the filling stations contacted in Vermont quoted a range of prices for biodiesel and noted that the price varied throughout the year and with diesel fuel prices. The prices used in this report for on-road diesel and biodiesel were derived from the Clean Cities Quarterly Alternative Fuel Report, which provides average prices for alternative fuels over a year, by region, from a survey of suppliers across the country.[13] Champlain Valley's fuel price quotes were used for off-road fuel costs comparisons.

Figure 3 illustrates the annual costs of supplementing biodiesel for 100% of Sunrise Orchard's fuel demand. The use of B20 in delivery trucks would save approximately $80.00/year, while the use of biodiesel for the on-farm fuel demand would actually cost the farm more money. Thus the orchard would spend $120.00 more on fuel per year with a 100% switch to biodiesel.

Figure 3: Cost Comparison Between Regular Diesel and B20

	Gallons/Yr	Costs w/ Diesel*	Costs w/ B20*	Savings
Heating Furnace	3,200	7,040	7,200	-160
Tractors	800	1,760	1,800	-40
Delivery Trucks	8,000	21,360	21,280	80
Totals	12,000	$30,160	$30,280	**$(120)**

*Costs of off-road fuel prices calculated using an April 2007 quote from Champlain Valley Plumbing & Heating (diesel= $2.20/g and B20=$2.25/g). On-road fuel prices for diesel calculated using US DOE March 2007 quotes (diesel= $2.67/g and B20= $2.66).

[13] US Department of Energy: Alternative Fuels Data Center. "Clean Cities Alternative Fuel Price Report." March 2007. http://www.eere.energy.gov/afdc/resources/pricereport/price_report.html

However, it is worth noting that the price variance for diesel is $0.08 and only $0.01 for B20 in New England (not explicitly accounted for in this calculation). This means that on-road biodiesel (B20) can be even more cost-effective depending on the price of diesel. Furthermore, petroleum fuel prices have been on the rise in the past couple of years and are projected to continue to climb, potentially making biodiesel more cost-effective in the future.[14]

Figure 4 demonstrates the net present value (NPV) of the costs/savings of integrating a B20 blend of biodiesel into 1) all fuel use categories and 2) solely into delivery trucks of Sunrise Orchard's fuel portfolio over ten years. The calculations show the NPV of using biodiesel for all fuel categories is $-770.12 and $513.41 for using biodiesel in just the delivery trucks.

Figure 4: Net Present Value of Costs/Savings Over Ten Years

All Fuel Categories

	Discount Rate
Year	0.09
1	-110.09
2	-101.00
3	-92.66
4	-85.01
5	-77.99
6	-71.55
7	-65.64
8	-60.22
9	-55.25
10	-50.69
Total	**$(770.12)**

Delivery Trucks Only

	Discount Rate
Year	0.09
1	73.39
2	67.33
3	61.77
4	56.67
5	51.99
6	47.70
7	43.76
8	40.15
9	36.83
10	33.79
Total	**$513.41**

[14] Energy Information Administration. "Short-Term Energy Outlook." May 2007. http://www.eia.doe.gov/emeu/steo/pub/contents.html

As mentioned in a previous section, the use of biodiesel sometimes requires more frequent changing of engine filters as a result of its detergent qualities. This may initially increase the costs of using biodiesel, but will most likely decrease as engines are cleaned out and mitigated in the long run by the decrease in maintenance costs and increased longevity of the engines.

Option 2: Addition of Infrastructure

In the long run, assuming that the machinery performed well with biodiesel in Option 1, Sunrise Orchards could install a bulk fuel tank on their property for on-road biodiesel fuel. An on-site fuel tank would allow the delivery trucks to fill up at the farm and negate the need to stop at gas stations along the way. Furthermore, wholesale fuel is typically cheaper (by a few cents) than retail fuel and thus could potentially save some costs (see Appendix 2 for a general cost savings assessment with bulk tank).

However, through conversations with fuel suppliers and the Vermont Biofuels Association it does not seem cost-effective for Sunrise Orchards to install a tank at this time. The cost of a bulk tank (~ 1500 gallons) would be approximately $2000, including pumps and accessories. This figure excludes maintenance costs, which could potentially be very high with biodiesel and its gelling properties. Currently, there are no government grants at the state or federal level that could help subsidize the cost of installing a tank. None of the fuel suppliers that we spoke with believed this to be a cost-effective investment.

Quantifying Social Benefits:

In addition to the benefits of biodiesel outlined above, it possible to quantify the social benefits of reducing Sunrise Orchard's carbon emissions. There is much debate over what the proper cost of a ton of carbon, with prices ranging from $30- $350 in the

scholarly literature. However, for the purposes of this paper we have used the price of a ton of carbon within voluntary offset market for our benefits analysis. The voluntary offset market provides a barometer of the willingness to pay for carbon in society and thus one way to quantify the social costs of a ton of carbon. Figure 5 illustrates the price of Sunrise Orchard's current carbon emissions in offsets ($1800) compared to the money saved, in offsets, if they integrate biodiesel into their operations ($270) per year.

Figure 5: Social Benefits of B20 based on Prices of Carbon Offsets

	Gallons of Diesel	Carbon Emissions[15] (tons)	Cost to Offset[16]	Emissions w/ B20 (tons)	Cost Savings in Offsets
Heating Furnace	3,200	35.8	479.91	30.4	71.99
Tractors	800	9.0	119.98	7.6	18.00
Delivery Trucks	8,000	89.5	1199.78	76.1	179.97
Totals	12,000	134.3	$1,799.67	114.2	**$269.95**

In order to account for the uncertainty over the future benefits of reducing a ton of carbon we calculated the NPV of the social benefits for three different discount rates, ranging from low to high. The 2% discount rate is representative of a discount rate that is close to the growth of net national welfare and the Nordhaus model. A 9% percent discount is representative of the rate of return on investment of private capital, and 5% is a mid-range rate between the two. Figure 6 shows the NPV value of B20 over a period of ten years.

Figure 6: Net Present Value of Social Benefits of B20

NPV B20	Discount Rates		
Year	0.02	0.05	0.09

[15] Assumes 22.385 pounds of CO2/ gallon. The Climate Trust "2007 RFP Conversion Metrics." 2007. http://www.climatetrust.org/solicitations_2007_Metrics.php

[16] Price per ton of carbon = $13.40 Value derived from the average of price of a ton of carbon from fourteen different offset providers in the US and abroad. http://www.tufts.edu/tie/tci/carbonoffsets/price.htm

1	264.66	257.10	247.66
2	259.47	244.85	227.21
3	254.38	233.19	208.45
4	249.39	222.09	191.24
5	244.50	211.51	175.45
6	239.71	201.44	160.96
7	235.01	191.85	147.67
8	230.40	182.71	135.48
9	225.88	174.01	124.29
10	221.45	165.73	114.03
10 Year Total	$2,424.86	$2,084.49	$1,732.45

Furthermore, in the likely event that Congress passes climate legislation in the next year, in the form of carbon tax or permits, Sunrise Orchards would have the competitive advantage of already lowering their carbon emissions by using biodiesel.

Option 3: Idling Policy

While switching their current fuel use to biodiesel may not be the most cost-effective option right now, implementing an idling policy is something that Sunrise Orchards can easily do to reduce their costs and greenhouse gas emissions. Currently, the orchard uses delivery trucks and tractors, which spend a lot of time idling. Idling wastes fuel and money. A typical tractor or truck burns approximately one gallon of diesel fuel and releases 22.4 pounds for every hour it idles. Today, diesel costs approximately $2.67 per gallon and if one tractor or truck idles for 1 hour a day, 300 days per year, a low estimate, would incur a cost of approximately $801 of pure idling time. Furthermore, running an engine at low speed (idling) causes twice the wear on internal parts, compared to driving at regular speeds. Consequently, the American Trucking Association claims that such wear can increase engine maintenance costs by almost $2000 per year and shorten engine life.[17] If the tractor and truck operators for Sunrise Orchards follow what most manufacturers recommend, they can safely let their

[17] EPA.gov. "What you should know about truck engine idling." April 2002. www.epa.gov/ne/eco/diesel

vehicle run for 3-5 minutes prior to driving and for the same amount of time to let the engine cool-down.

Furthermore, some states, like Connecticut, Massachusetts, and New Hampshire, have adopted anti-idling laws to reduce overall emissions, and currently there are three anti-idling bills being considered in the Vermont state House. "Idle-Free VT" is an ad hoc, non-profit, grassroots statewide campaign with the goal of raising awareness of unnecessary vehicles idling, and is working diligently to get these bills passed.[18] If Sunrise Orchards were do adopt anti-idling policies for their business they could not only set an example for other business to follow, but also, if these bills are enacted they would not have to make sudden changes.

III. CONCLUSION:

The cost-effectiveness of Sunrise Orchards converting to biodiesel for their on and off-farm fuel uses is rather variable and apt to change in the coming years. However, the social and environmental benefits may outweigh the relatively minimal cost increase of biodiesel into Sunrise Orchard's operations. The biodiesel network in Vermont is strong and growing and therefore would be relatively easy for Sunrise Orchards to begin integrating biodiesel (in the delivery trucks at minimum) into their fuel portfolio in the short-term. If biodiesel proves to be an effective alternative fuel for Sunrise Orchards, further investigation into a bulk fuel tank could occur in the long-run. Lastly, the institution of an idling-reduction policy would be an easy and cheap way for Sunrise to lower their greenhouse gas emissions and save money on fuel.

[18] "Idle-Free VT." http://idle-freevt.org/about.index.html.

FINAL CONCLUSION:

Te goal of this analysis was to minimize Sunrise Orchard's environmental impact, through 1) a replacement of cardboard boxes with Reusable Plastic Containers for local distribution and 2) a conversion to biodiesel to fuel furnaces, tractors and delivery trucks. The results of our cost-benefit analyses indicate that both proposals should be implemented, with the cost savings from the first used to finance the second. The non-market costs and benefits re-inforce our recommendation. The first project in particular represents an example of Bill McKibben's strong belief in the existence of "low hanging fruit", easily plucked to improve the environment.

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APPENDICES

Appendix 1

Filling Stations with Biodiesel on Current Sunrise Trucking Route

Southern Route:

Number	Station Name	Address	Phone #	Fuel Availability	Price Range
1	Evans Group	171 Bridge Street White River Junction	(802) 258 7552	Warm months: B100 Cold months: B20	Same as diesel
2	Fleming Shell Food Mart	429 Canal Street Brattleboro	(802) 254- 9727	Warm months: B100 Cold months: B20	Same as diesel

Northern Route:

Number	Station Name	Address	Phone #	Fuel Availability	Price Range
3	Boise Citgo	3039 Route 22A Bridport	(802) 758-2361	Warm months: B100 Cold Months: B20/B30	$3-3.20 (B100)
4	Steve's Citgo	3171 Ethan Allen Hwy (Rt 7) Charlotte	(802) 425-2741	B5	20 cents higher ($3.17)
5	Lucky Spot Variety	174 River Road Richmond, VT	(802) 434-2332	B5	$3.06 (little higher)

Appendix 2

Table 1: Smart Tank Return on Investment

	Offsite		Onsite
Employee Cost Hr	$25.00	USD	$25.00
Travel Time Each Way	10	min.	0
Avg. Qty	50	Gallons	50
Dispenser Flow Rate	12	GPM	20
Dispensing Time	4	min.	3
Store Time (Donuts, Coffe, Lotto, etc.)	5	min.	0
Total Time	29	min.	3
Employee Time Cost per Gallon	$0.24	USD	$0.02
Fuel Cost (Rack vs. Retail)	$1.10	USD	$1.00
Total Cost per Gallon	**$1.34**		**$1.02**

This table was found through a generic bulk fuel tank provider and describes potential cost savings with using a SmartTank®, excluding the upfront costs. These savings may or may not prove true for Sunrise Orchards, but at least provide some idea as to the benefit of a bulk fuel tank on-site.