

University of Vermont

A Look at Vermont Population Growth and the Food Supply, Through a Systems Lens

Envs 195- Systems Thinking

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Vermonters for a Sustainable Population (VSP) is an organization whose mission is to educate residents of Vermont on the negative impacts that our growing human population has on the environment, the economy and future generations. This information is intended to help Vermonters make responsible decisions that will help stabilize the human population.

VSP supports implementing policies, at both the state and federal levels that guide people to make decisions that contribute to stable human population. Examples of proposed policies are: limiting federal aid programs that facilitate large families and regulating immigration in a way that allows only as many immigrants as emigrants. VSP also advocates family planning education, both domestically and overseas, so that families may be informed and understand their options. While VSP understands that actions taken at the federal level are clearly more influential than those taken by states, the organization nonetheless believes that the schools, environmental organizations and residents of Vermont have great power and responsibility to share information about reaching a sustainable human population, both locally and globally.

Problem Statement

Vermont population is increasing incrementally. The larger the population the more natural resources are consumed and the more land is destroyed to make room for the growing population. Non-renewable and renewable resources and natural spaces in Vermont are in limited supply. This means that human population, like all systems, will inevitably peak due to at least one of these limiting factors; limited food production, water supply, spread of disease, or ecosystem (habitat) failure from pollution or loss of biodiversity. Arguably, food production is the most important because of the limited amount of arable land and limited petroleum. Since peak oil production has been reached it will inevitably compound the problem of food production because cheap fossil fuels are what have enabled much of the production of food and its transportation to other locations.

In order to control the limiting factors, sustainable population levels must be achieved. A sustainable population is one that does not exhaust natural resources to the point that future generations cannot exist at the same population levels as they do in present time, with the same quality of life. This study assumes a quality of life is one that is different from our current standards. Factors that contribute to the new quality of life standard include health, food and nutrition, family life, community life, material well being, job security, political freedom, gender equality and human rights.

This report will primarily be a study on what a sustainable population range is for Vermont if most of the food consumed was grown in the state. This assumes that in the upcoming decades fossil fuels will either be no longer be available, too expensive, and or too polluting to support our current system of intensive agriculture, food importation and population.

Behavior Over Time Graphs

Graph 1: Population

Exponential population growth. If left unchecked, population growth will reach carrying capacity of the planet for a hard landing (not graphed) but the introduction of human-introduced balancing activities increase the chances for a soft landing.

y axis: # People

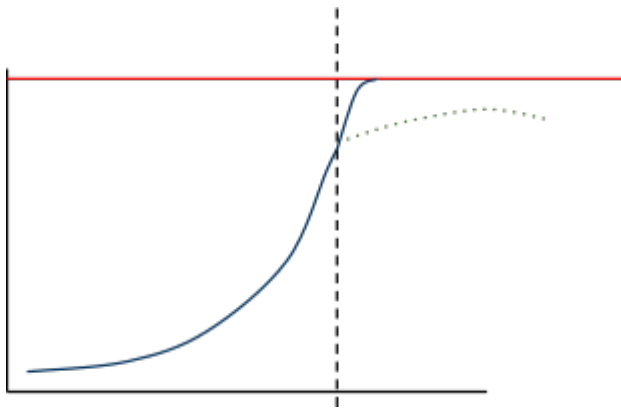
X axis: Time

Dotted vertical line: present time

Red line: carrying capacity

Blue line: population based on continuation of current growth models

Dotted green line: population based on incorporation of balancing activities



Graph 2: Natural Spaces

As population increases and expands into remote areas, the availability of natural spaces decreases sharply. The introduction of balancing mechanisms to slow down and potentially restore natural spaces would avoid hard landings.

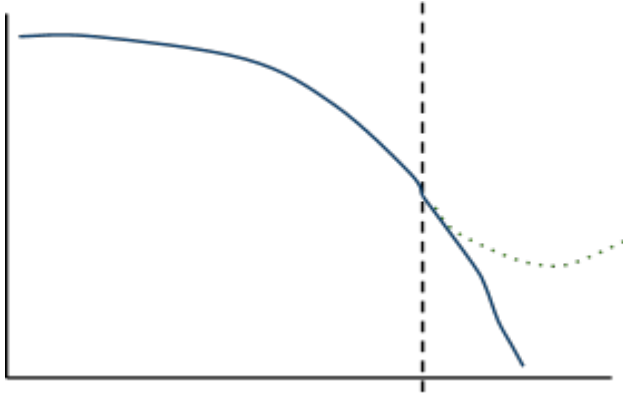
Y axis: # Hectares natural space

X axis: Time

Dotted vertical line: present time

Blue line: natural space based on current models of natural space consumption

Dotted green line: natural space based incorporation of balancing mechanisms



Graph 3: Society's awareness of the effects of population growth

More people are becoming aware of the potential effects of rampant population. The goal of VSP is to accelerate that beyond its normal course so that it becomes more of a top of mind issue for all humans.

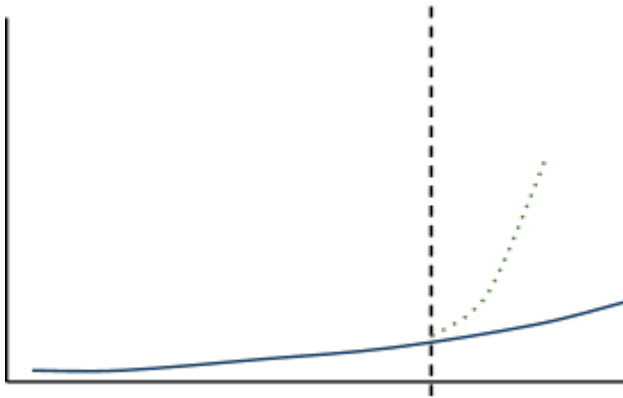
Y axis: # Respondents who list population growth as a top of mind concern

X axis: Time

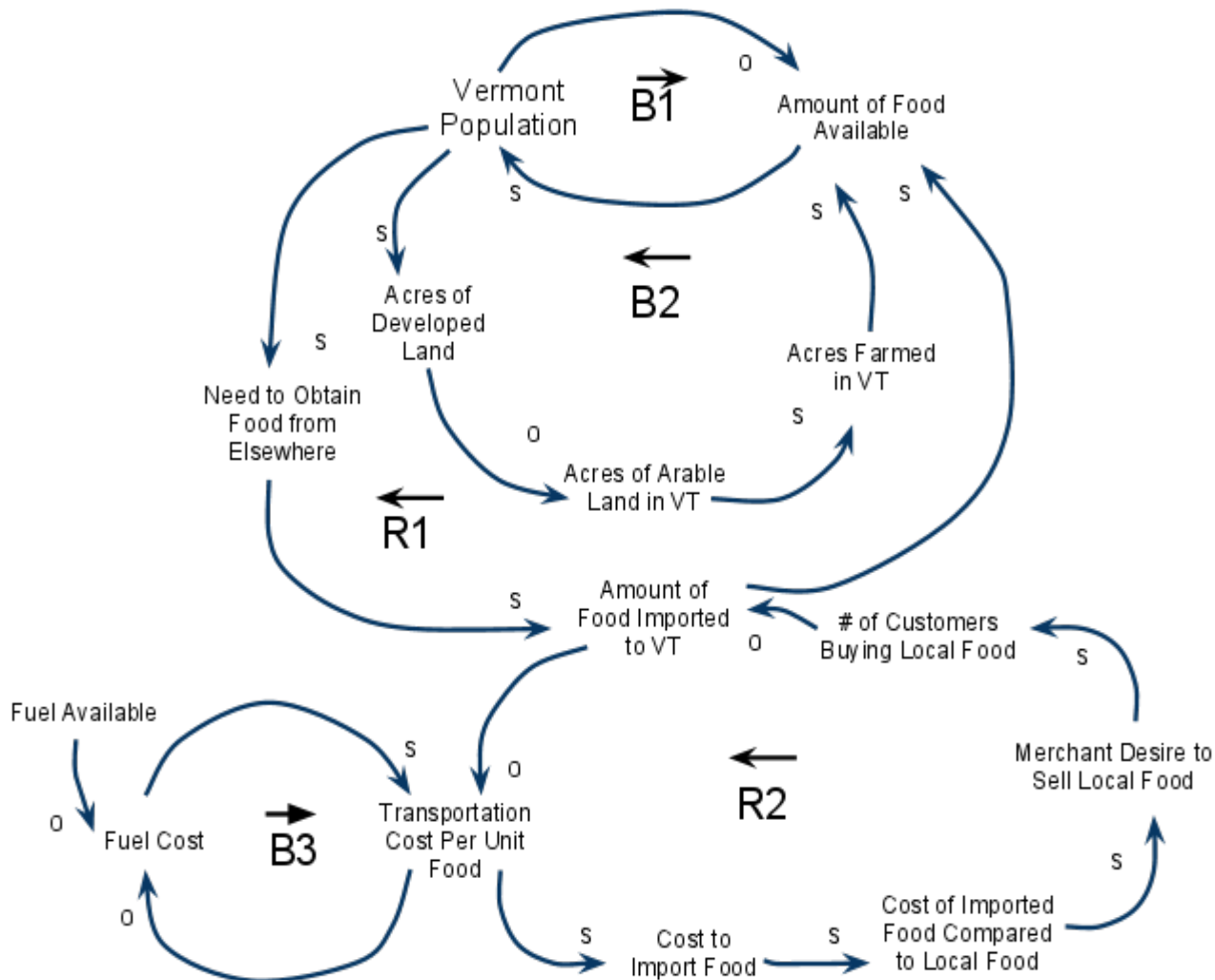
Dotted vertical line: present time

Blue line: level of awareness based on existing model of increased awareness

Dotted green line: level of awareness based on incorporation of awareness acceleration techniques



Causal Loop Diagram



Key:

R- Reinforcing loop; when starting from any variable and following it through the loop once, the starting condition will be the same as the beginning condition. This results in exponential growth or decay

B- Balancing loop; when starting from any variable and following it through once, the starting condition will be the inverse of the beginning condition. The result is a limit to growth or leveling off.

S- The condition of the variable on one side of the arrow moves in the same direction as the variable on the other side (ex. if variable A goes up, variable B goes up)

O- The condition of the variable on one side of the arrow moves in the opposite direction as the variable on the other side (ex. if variable A goes up, variable B goes down).

Causal Loop Narratives

B1: When more food is readily available to a population, the population grows because there is a resource to support that growth. In turn, while the population grows, that growing population consumes that food and reduces the food available.

B2: As any population grows more land is devoted to urban development in order for that population to live and work. Land that was once used for farming or had the potential to become agricultural land may be reallocated to urban development. As less land is agriculturally productive, the state's supply of food drops and there is less food available.

R1: One way to ensure that food is available for the existent population or for the projected population is to acquire food from other locations. When more food is imported it can sustain a larger population.

B3: A factor which limits the amount of food that can be imported is the cost of transportation. This cost is driven by the amount of fuel available. Since fuel sources (mainly oil) have been readily available and cheap it has been efficient to import food. But, as fuel is a finite resource, its value will increase proportionally with its depletion.

R2: An increase in importation denotes a decrease in the price of food because it can be bought and transported in bulk. Large trucks or trains will replace smaller transport methods, making the cost of food per unit cheaper. Since food can be imported so cheaply, it can also be sold to the consumer at a cheap price. A decrease in price inspires an increase in demand. At the same time, Vermont's agricultural production capability is limited by the amount of arable land. As a result of this limitation, the scale of food production in Vermont is inherently smaller than what is available for import. Due to economies of scale, local food is likely to be more expensive than imported food and therefore less desirable to merchants and consumers. With less food on merchant's shelves and less Vermonters buying local food, the demand decreases and the price of that food increases further. The increase in price for local food only amplifies the price difference between local and imported food.

Policy Recommendations

Policy Solution I: Local Food Tax Breaks for Retailers

VSP believes that population size is directly linked to available food and that the exponential growth in population that we are seeing is a direct result of readily available food. Food production in Vermont is finite, but because we continue to import roughly 80%* of our food from elsewhere it distorts the true ability of local land to support the local people. Once oil is no longer cheap, VT will face the hard truth of dramatically increased prices for imported food. What can we do now to support local food initiatives and prepare for the imminent rise in oil prices? We can break down existing barriers to selling local food at most retail grocery stores and encourage chain retailers to get behind local food producers. A tax incentive to grocers would help make local foods comparable in price to the same imported foods, and therefore encourage merchants and consumers to purchase such foods.

Implementation:

Grocery stores would receive property tax breaks from the State of Vermont that are proportional to the amount of space occupied by local foodstuffs. For example, if Shaw's in Colchester dedicated 2% of its retail floor space to selling local food, that store would pay a reduced rate on 2% of its property taxes. This would require VSP to work with the state legislature to submit the bill to a vote. Other pieces of information needed in the bill would be estimated growth rates and acceptance/ participation goals, source of funds used to realize the tax benefit, and clear requirements to determine what food is local.

Grocers will also be encouraged to promote local food through programs that educate the public on the true cost of imported food. Merchants have a clear incentive to support these programs as they have the potential to increase demand for local foods, which would result in more tax breaks for the merchants. Once there is enough demand for local foods, prices should go down and make local food even more affordable than imports, further encouraging buying.

Feasibility:

VSP would support this policy because it provides incentives for large, conventional chain markets to seek out more local vendors and provide more local food options in order to earn tax breaks. Stores that took this approach would likely be supported by shoppers who recognize the value of local, of which there are many in Vermont. The retailers would be interested in making the local section succeed because with an increase in sales of local food comes an increase in tax breaks. Assuming that local food is more expensive to the consumer than imported food, one sensitive issue might be that retailers decrease their potential market by providing a higher proportion of expensive foods, limiting their market to only those who can afford these expensive foods. This reduction in store sales could offset the tax breaks and leave the store worse shape financially. It is important that the retailer experience the financial benefit of promoting and selling local food.

Policy Solution II: Food Production Technology

Investing in technology that can increase the yield of food per acre or increase processing efficiency may allow Vermont to sustain its current population and perhaps an increased population as well. By analyzing the amount of arable land and the number of acres required to feed each person, the number of people that could sustainably be fed in Vermont could be determined. If that number exceeds the current or potential future population, or some of the land is marginal or reserved for other uses, it would make sense to try and do more with less.

Implementation:

It is important to consider the possible side effects of certain technologies. Many that have been tried in the past have had disastrous unintended consequences; for example, the waste and use of hormones and antibiotics in factory animal farming, and the use and need of environmental pollutants in agricultural mono-cultures. An understanding of how certain technologies may impact the ecosystem can be used in deciding to avoid those technologies or in implement of mitigation strategies.

Additionally farmer and consumer interests and needs should be considered. The technology must be practical and safe to implement and appropriate for typical farm size.

Food production technology could advance in many ways; such as investing in research of hybrid or genetically modified or other species domestication techniques. These varieties can be made to resist pests and diseases and therefore have the potential for greater yield. While hybrids have been used successfully for many years, there is still controversy around use of GMO's, including the threat of cross pollination with non GMO crops. Because these plants are designed to be resilient they could also become invasive to native plants. However, a possible mitigation strategy is to use sterile seeds. Some farmers may not embrace this because sterile and hybrid seeds prevent them from saving seed for the following seasons and create dependence of seed providers, especially if the technology is patented.

Less controversial investments could be made to advancing organic farming methods and irrigation technology. Organic methods are preferred because they employ more sustainable methods of natural resource (soil, water, nutrient) management than mono-culture and require less fertilizers and pesticides. Because these methods currently cost more per yield than mono-culture, advances in organic farming that reduce the cost of production would be especially beneficial and promote long term health of the land.

Food processing could also be done more efficiently with technology. For example there the use automated robotic mechanisms to milk cows. There are just as effective as milking by hand but without the need of a person, resulting in increased production and decreased labor costs, which could be especially helpful for farmers in Vermont.

A more ecology based use of technology is the process referred to as *precision conservation*. This practice utilizes spatial technologies such as global positioning systems (GPS), remote sensing (RS), and geographic information systems (GIS) to understand soil and water flow across landscapes for better long term land management and conservation.

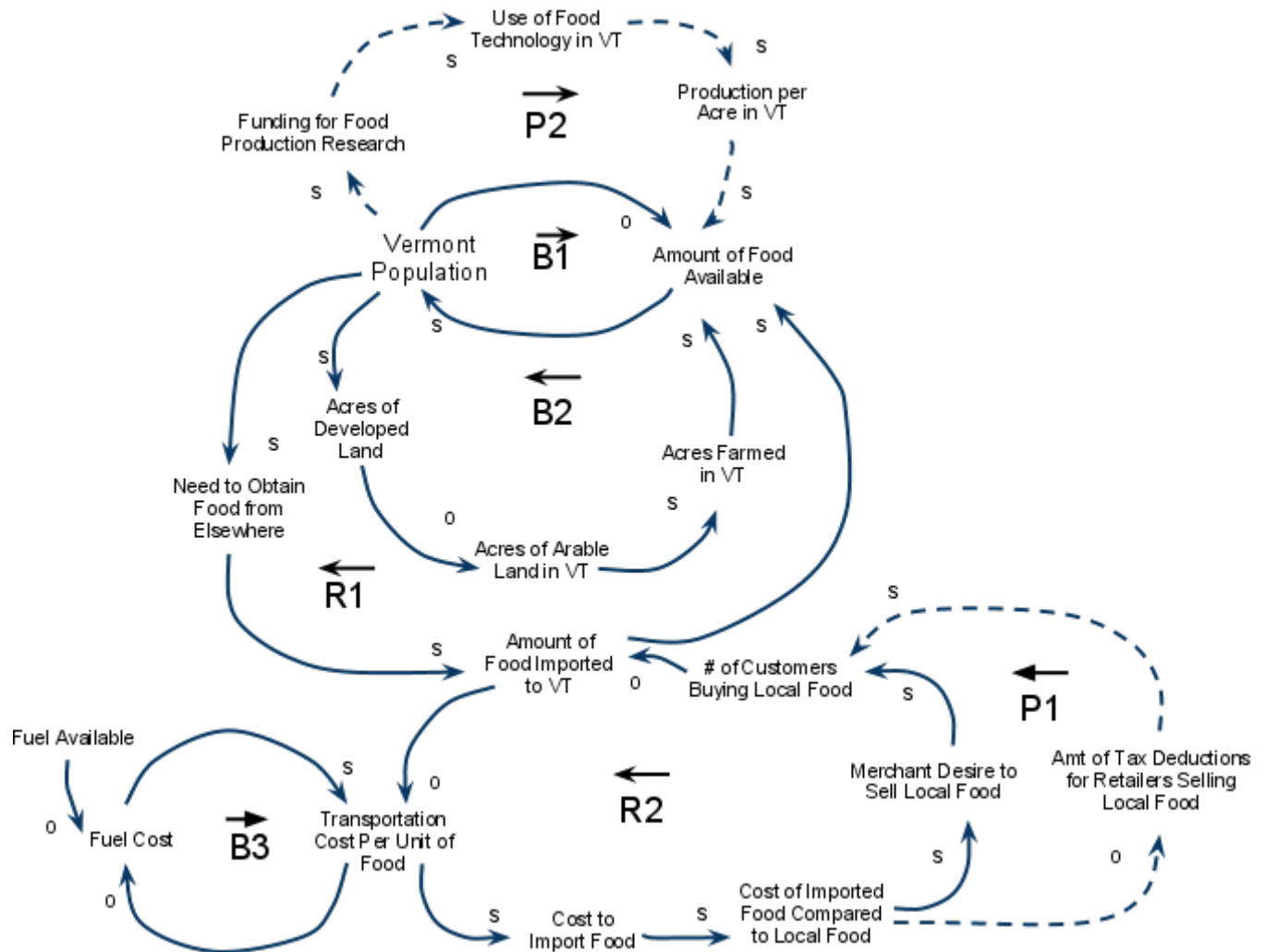
Feasibility:

Each technology would have to be considered on an individual basis and a cost benefit analysis performed. A good starting point would be to determine the current land available for farming in Vermont and how much food could be produced per acre with current and commonly practiced methods. Detailed analysis of the diversity of crops needed to sustain each individual throughout each year would be required first, because different crops would require different acreage.

Once the proportions of each type of food production required are determined, a look at what is currently produced would follow. The areas of food production that are not sufficient or are land intensive are where new technologies should be considered. Additional technologies that aid in processing or distribution of food should be considered. The selection of new technologies will be determined based on quantitative analysis of production increase and cost of the technology to develop and use. Once technologies are identified optimal farm size should also be considered based on efficiency and distribution of farmed or farm ready land. Only as a last resort should land that is not currently ready for farming or otherwise reserved be considered.

Additionally, because this policy has no financial or other incentive to farm, a close look at the interest of Vermonters to farm for a living should also be considered before investing in technology research. Perhaps a program, in which a certain number of farms must sign up for and commit to funded pilot projects, could be part of each research investment. This would require outreach and farmer education to gauge and obtain interest.

Policy Loop Diagram



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Policy Solution Loop Narratives

P1-Tax Deductions for Retailers selling local Food: Because the cost of imported food is so much less than the cost of local food, retailers choose to sell food from out of state. In order to try and get retailers to begin selling only or a majority of local food we suggest applying tax deductions for those who do make the decision to sell Vermont grown food. As imported food gets cheaper compared to local food, the amount of tax deductions for retailers increase. This in turn will give them the ability to make a profit and increase their desire to sell local food, ultimately resulting in more local food being grown and bought in Vermont.

P2-Applying Food Technology to Vermont: Instead of the state looking elsewhere for food, the amount of food that can be produced in state should be considered and used to determine a sustainable population level. In order to support the current or future population, our group suggests funding research that will increase food production and processing capacity. Increased use of food technology will lead to more food production per acre in the state.

Concluding Thoughts

More food, more problems? George Plumb of Vermonters for a Sustainable Population (VSP) suggests that one of the key factors fueling population growth is increasing food production and food availability. He contends that the more food we make available, the more people there will be, which will increasingly render our planet unrecognizable from human-inflicted environmental degradation.

Ironically, as a society, we typically confront not having enough food for people; we rise to the challenge of feeding the world through advancements in growing, harvesting, and transporting food, but does this activity set ourselves up for tougher challenges and harder landings in the future?

The majority of the food available in Vermont is imported from elsewhere.¹ This supports a larger state population than could be supported with what is currently locally produced. The almost unlimited access to imported food circumvents the natural balance between local population size and local harvest. Because George Plumb and VSP anticipate a hard landing for Vermonters when cheap labor and cheap oil comes to an end, they advocate for devoting more resources to local food initiatives and encouraging more Vermonters to eat increasingly more locally-grown food- now.

In order to make the local food system more viable, here are some recommendations we'd like VSP to consider:

1. **Look at the limiting factors to local food growth. As we found, the barriers to City Market getting more local food were actually around supply, not demand. Talk to grocers, farmers and food processors to find these barriers.** Vermont lacks sufficient food processing (limiting factor in local meat is slaughterhouse availability).
2. **Regarding the policy of tax breaks for retailers who support local food: The purpose or goal of the retailer will manifest itself in its behavior, so make sure that any funds that are made available force the retailer follow to the letter and the spirit behind the support.** Some grocery chains could take advantage of the tax break in a non-meaningful way and produce results that end as soon as the support ends.
3. **Also for policy implementation, sign on to a solid, pre-existing definition of 'Local' for defining food.** City Market is using a two-tiered system that distinguishes between "Local" (products raised, grown, or harvested in Vermont, where the company is also located in Vermont) and "Made in Vermont" (product is significantly transformed by a Vermont owned business.)
 - a. Other things to consider- mileage radius to incorporate Quebec, Upstate New York, New England, etc.
 - b. Other retailers, such as Whole Foods, use a definition of seven or fewer hours by car or truck
 - c. Localvore movements have come and gone, stick with definitions from strong institutions such as NOFA, City Market, Farmer's Market Association, etc.

We recommend that VSP engage in future studies that will strengthen their argument and provide clarity. Our advocating for future studies includes;

1. Consider providing grants for stores to improve relationships with local vendors and for farms to improve the efficiency of production and economy of scale. Instead of focusing simply getting local producers more access to retail space, build a team of store managers and local food producers who would be charged with researching common interests and creatively lowering the barriers between collaboration. Topics could include local growers effect on food safety, shopper loyalty, retailer marketing objectives and farming cooperatives that make logistics to retailers easier
2. Prototype in-store education programs and demonstrations from local businesses aimed at creating shopper awareness and trial.
3. Investigate the role local governments play in helping producers and growers. How can we break the cycle of subsidies?
4. Explore the limits of food production and processing in Vermont. Spend money to remove this barrier to growth by exploring technologies and process improvements that farmers and grocers have identified.

¹ According to David Pimental in a Cornell University Study, 1.2 acres of land (ideal land) per person is needed to maintain current American dietary standards. As of 2007, there was a total of 905,100 acres devoted to crop and pasture land. In that same year, there were 621, 254 people living in Vermont; meaning that there was only about .69 acres of food producing land per person- almost half of what is needed on ideal land (and nowhere is land perfectly ideal, including Vermont). Based off those numbers, it appears that a large portion of a Vermonters diet would come from Vermont, but there would still be close to half of it that would have to be fulfilled with imported foods.

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Appendix

Outside Expert: Evaluator's name: Patrick Burns
Organization: City Market, Onion River Coop
Position: Operations Director
Qualifications: Manages vendor relationships
Email address: pburns@citymarket.coop
Phone: 802-861-9700

While talking with Mr. Burns at City Market, the importance of working on the retailer's goals clearly emerged as a higher leverage point than our simple policy. Because City Market's mission is to "be central to a thriving and healthful community" there is no discord when extra efforts are made to work with local producers to provide fresh, organic food. Furthermore, as a member-owned co-op, City Market is shielded from financial pressures from remote shareholders. This is in direct contrast to publicly-held corporations that prioritize quarterly earnings and the subsequent effects on share value above the longer term needs of the specific communities in which they are located. We can imagine that if an activity is not deemed as profitable to the company, it is at best a non-priority.

One of the key insights from the meeting was that absolute price of imported food will still be cheaper than local food on several products. For example, Mr. Burns pointed out that the price of a 5 pound bag of organic Vermont potatoes, in the prime potato harvesting season, costs around \$7.00 while a 5 pound bag of organic potatoes from California can cost around \$2.60. This would make it very tough for many shoppers to choose local plus organic over organic. The cost gap is very large.

Another insight is that large chain grocers thrive on efficiencies of scale and may not be interested in dealing with small, solitary vendors. Mr. Burns noted that a typical Hannaford's store may be generating \$50MM of income from 50 different vendors while City Market generates roughly \$30MM from 357 different vendors. The figure of 357 for City Market is even more astonishing considering that the major distributor which supplies City Market with most of the grocery items (ranging from cereals to oils to cleaning products, etc) still only counts as one vendor, implying that the number of small scale producers working with city market are highly specialized. As a result, City Market's receiving bay is always busy, receiving orders 6 days a week. Mr. Burns doubts that larger chain stores would be able to incorporate the smaller vendors in a way that is cost neutral, which would make the tax incentive less appealing.

Although he did not comment directly on the use of food technology, the statement that grocers thrive on economies of scale implies that higher yields from each farm would make them more appealing. Additionally instituting farm cooperatives, such as the very successful Cabot cheese co-op, may increase the appeal to grocers because they will logistically be dealing with only one organization. Burns also mentioned the production bottleneck due of lack meat slaughtering facilities in Vermont. He has identified an opportunistic area in which technology investments should be implemented. If slaughtering can be performed more reliably and efficiently more farmers could diversify and more food provided. Talking with grocers and farmers, and finding out where other bottlenecks exist, could provide more valuable insights.

Note: Jared Carter, the director of the non-profit organization Rural Vermont is in the process of reviewing our work. The combination of the organization's dedication to creating a self-reliant food system in Vermont and the experience of a director with a law degree and a background in political advocacy lends itself to providing constructive suggestions for improvement on our work thus far.

ACRES OF VERMONT LAND NEEDED TO FEED ONE PERSON
Draft of November 20, 2010

In the coming years Vermonters are going to have to raise more and more of their own food as the cost of oil rises. How much land does it take to grow most (75%) of the food that is needed to feed one person? The answer to that questions depends on type kinds of food that are grown. The most likely scenarios are that because of space, time, and skills some people will grow only fruits and vegetables. Others may have more land and the motivation to also raise chickens for both the poultry and eggs. Those who have even more land would be able to grow not only vegetables, fruits, and poultry but also some form of meat and dairy products.

Based on the best information available and assuming average growing conditions for the state as a whole the following acres of land are estimated to be needed to grow these different foods to feed one person.

Amount of Vermont Land Needed to Grow 75% of the Food for One Person

	Vegetable and Fruit Growing	30 Chickens	1 Dairy Cow for Milk	1 Beef Cattle	1 Pig	3 Sheep	Total Acres
Vegetables and Fruits Only	2,000 sq.ft. or 1/20 th acre						2,000 Sq. Ft. Or 1/20th Acre
Vegetables, Fruits and Poultry	1/20 th acre	1/4 acre					3/10th Acre
Vegetables, Fruits, Poultry and Dairy	1/20 th acre	1/4 acre	3 acres				3+ Acres
Vegetables, Fruits, Poultry, Dairy and Meat	1/20 th acre	1/4 acre	3 acres	3 acres	1 acre (1/20 th acre for pen + or – 1 acre for food)	2 acres	*Average of 5 Acres

*This figure includes one form of meat only which could be beef, pig, or sheep.

Assumptions:

The figures for vegetable growing are based on intensive gardening techniques. If non-intensive techniques are used then the land area would be greater. Vegetables and fruits will be grown

during the summer season and then people will preserve much of the food for winter use by storing, canning, or freezing. The same with poultry and meat.

Thirty chickens assumes eating one chicken a week for thirty weeks. Some people will also choose to keep chickens on a year-round basis for egg production. This would require ?? chickens to provide enough eggs for one person year-round.

One dairy cow produces about 1,600 pounds of milk per year but the average person consumers only 200 pounds so there would be a surplus to help feed others.

It is estimated that one beef, one pig, or three sheep, or some combination thereof would provide enough meat (about 150 pounds) to feed one person year-round. The acreage for the beef or sheep assumes that at least one or two additional animals would be kept on a year-round basis and therefore hay land would be needed in addition to summer pasture land.

The grains needed for the chickens and animals would be grown elsewhere, hopefully as much as possible in Vermont.

Acres of Land Needed

It is assumed that a great majority of people would want to eat a combination of vegetables, fruits, poultry and eggs, milk, cheese and meat. What they cannot grow themselves would be purchased from local farmers as much as possible. This would also likely be the best use of the land as much of Vermont land is better suited to pasturing and hay cropping than growing vegetables and fruits. The other 25% of the food would still be purchased from out of state suppliers.

It is therefore estimated that it would take an average of five acres of Vermont land to feed one person.

Vermont has approximately 1,000,000 acres of crop, pasture, and home site acreage. It is recommended that only a small amount of land that is now forested be converted to food production. The forested land has its own value in helping to reduce global warming, provide wood for heating, game for hunting, and edible wild plants.

It is estimated that the average size of home plots of land is one acre or less.

These figures also do not take into consideration the energy that is needed to grow, harvest, hay, and transport this food. If for instance we would need to go back to using more horsepower that would decrease the amount of available land as would using that land to produce biomass for ethanol production.

These figures also do not take into account other human needs such as energy, clothing, and other material goods.

Based on the amount of land available and the amount of land needed to grow 75% or more of the food needed per person, Vermont could sustainably support a population of approximately 200,000 people.

It is acknowledged that these are not scientific figures but we believe that they provide a good starting point for having the discussion of about how many people Vermont could sustainably support with food without access to cheap oil.