Dalhousie University –Environmental Science

Nova Scotia's low-bush blueberry industry:

Identified areas of concern, what needs done and visions for the future

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Front photograph taken from: http://www.enflower.org/entry/blueberries-for-beauty-and-taste/

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Anna-Sarah Eyrich

1. Abstract

The low-bush blueberry industry is Nova Scotia's most important agricultural industry, occupying the largest area under horticultural production and contributing the most economically. The blueberry industry has become highly mechanized and its yields depend on inputs of energy primarily derived from fossil fuels. Like most agricultural industries there is room for increased energy efficiency. Furthermore, blueberries are a healthy fruit and their consumption should be encouraged.

This study aimed to assess stakeholders' views of the industry, specifically to determine areas of improvement, what should be done, and visions for the future. The eleven stakeholders to the industry (growers, producers, and industry and government workers) were identified through Google searches, the Wild Blueberry Producers Association and personal contacts. The sample was non-representative and made use of purposive and snow-ball sampling techniques. Ten people were interviews over the phone and one responded by email.

Areas identified for improvement include pruning methodologies, chemical inputs, energy efficiency, and domestic market development. The results show more research is needs to determine best practices and develop policy. It is imperative that any solutions or policies aimed at increasing energy efficiency and reducing environmental impacts are cost-effective.

2. Introduction

a. Review of the problem

Agricultural systems, crucial for human civilization, have become increasingly industrialized the last century. This industrialization has made food production systems dependent on direct and indirect inputs of fossil fuel energy, contributed to global environmental problems, and left our species confronting the major challenges of rapid human population growth, fuel shortages and price rises, and climate change (Committee on World Food Security, 2008). To plan effectively for the future in the face of these challenges, it is important to assess individual food production systems. Industry members need to be included in such projects. This study asked stakeholders in Nova Scotia's low-bush blueberry (*Vaccinium angustifolium*)[1] industry their opinions on energy use in its production system, what needs to be done to gear the industry for the future and their views on its future. This is just one of many studies needed as the industry plans for the future.

The low-bush blueberry industry is one of the most important agricultural sectors in the Nova Scotian economy and has only developed into a major industry over the past century and particularly the last 50 years (Kinsman, 1993). Blueberries, native to north-eastern North America, are Nova Scotia's provincial berry (NSDA, a, 2007). They occupy the largest area of all horticultural crops in the province at 41,000 acres (16,500 ha) (Yarborough, 2008). Blueberries accounted for 32.8% of the agri-food exports in 2000 (NSDA, b, 2007). In 2007, Nova Scotia's 28 million pounds (12.7 million kg) of berries had a farm value of CAD 28 million (NSDA, c, 2007).

[1] The low-bush blueberry industry is referred to as the 'blueberry' industry in this paper. It refers to the cultivation, processing and transport of blueberries, also referred to as berries here.

Nova Scotia produced 40.1 million pounds (18.2 million kg) in 2008 (Yarborough, 2008). The world's largest producers are Maine in the U.S. and Quebec, and Nova Scotia in Canada, respectively (Figure 1) (McIssac, 1997; Yarborough, 2008).

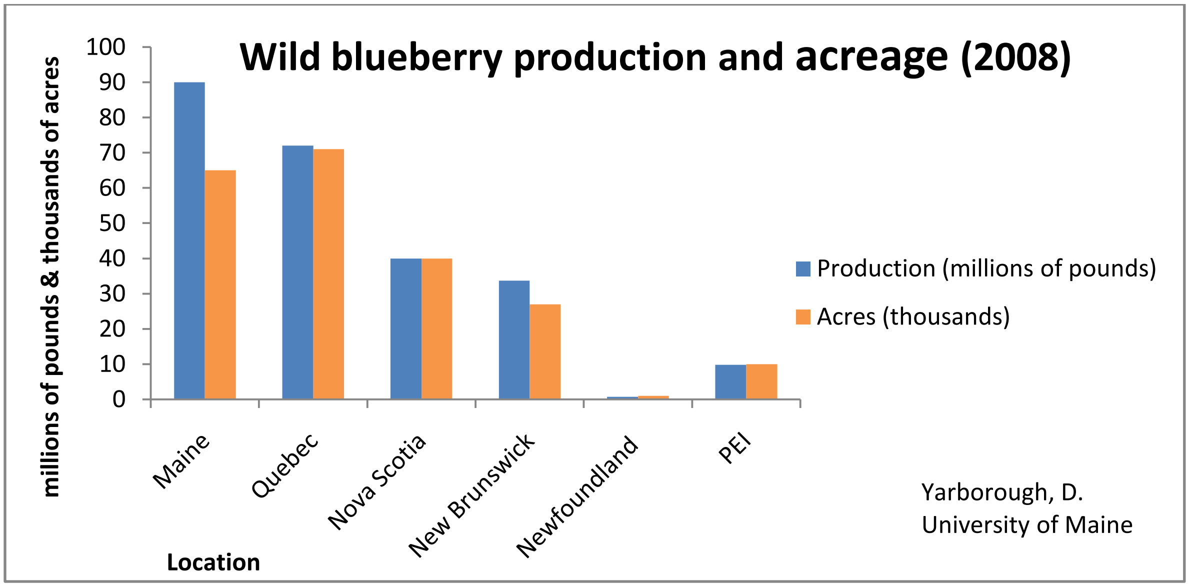

Figure 1 - wild blueberry production and acreage in 2008

Low-bush blueberries are often called 'wild' blueberries because bushes are not planted, rather fields are developed where bushes already exist (Prouse & Jordan, 1996) and the plant is encouraged to expand its range through rhizomes and underground runners. The term 'wild' can be misleading, since the blueberry industry has become highly mechanized in recent decades (Coley et al, 1998) and, like many agricultural production systems, there appears to be room for improvement in terms of energy efficiency.

Fields are pruned bi-annually — either mowed or burnt — to improve yields, encourage field expansion and inhibit natural succession processes (McIssac, 1997). Blueberry production is site-specific and unique. Most growers apply soil-enhancing additives and pest-control products, either over entire fields or as spot-treatments (Wild blueberry net, nd). Both naturally or synthetically derived substances are used (Bell et al, 1999). Past studies have identified chemical additives as having considerable embodied energy. Their use can greatly increase a food's ecological footprint (Kizilaslan, 2008; CAEEDAC, 2000; Mrini et al, 2001). According to Ramirez (2005), embodied energy in fertilizers represents the highest energy demand in many food systems. Mechanization and cheap energy have facilitated ten-fold yield increases in under 50 years; from 18,000 tonnes in 1956 to 18,500 in 1999 (McIssac & Reid, 2000).

Blueberries are harvested in August. Over 80% of the berries are mechanically harvested, the rest are hand-raked (WBANA, n.d). Approximately 2% of Nova Scotia's berries are sold fresh, a small percentage processed directly (juice, pie, etc), and the vast majority are frozen through a process called Individual Quick Freeze (IQF) (NSDA, a, 2007). Industry says IQF blueberries can be kept frozen for up to two years without losing nutritional value or taste (WBANA, n.d). Oxford Frozen Foods in Oxford and Rainbow Farm in Rawdon are the two large processors with IQF infrastructure in Nova Scotia. Berries are transported primarily by road and sea to regional, national, and international markets.

Industry and government supported research into the nutritional and health benefits of blueberries (i.e. high anti-oxidant properties (Wild blueberries, n.d)), coupled with marketing campaigns, have contributed to an increased international demand for blueberries over the past few years (McIssac & Reid, 2000). Canada's wild blueberry industry received a global boost when Guy Ritchie claimed his ex-wife and famous pop-star, Madonna, "tutted over the exact provenance of air-freighted Canadian blueberries" (Boshoff, 2008).

Because blueberry are healthy — they are a source of dietary fibre, vitamin C, and anti-oxidants (NSDA, a, n.d) — their consumption should be encouraged and local markets should be strengthened. However, if the blueberry industry is to support an increase in consumption it will be necessary to address inefficient and environmentally detrimental practices before blueberry production is increased. It is important to engage with industry representatives when developing policies to increase efficiency to ensure their effective implementation.

b. Objectives and significance of study

The objectives of this study, conducted through a serious of telephone interviews with a select group of industry stakeholders, were to:

- identify perceived areas of concern to target improvements with a focus on energy inputs;
- identify and assess what stakeholders believe needs to be done in the blueberry industry;
- assess visions that stakeholders have for the industry's future.

Mechanization of the blueberry industry has made it reliant on energy inputs, primarily from inexpensive and readily available supplies of fossil fuels. If not addressed, this could be problematic in the future as the global population grows, fuel costs rise, fossil fuels are depleted and climate change occurs (United Nations Department of Economic and Social Affairs — Population Division, 2007). As for any food production system, the blueberry industry's energy inputs and environmental impacts must be examined if the industry is to be resilient and to be better able to position itself for the future. It is important to note the blueberry industry is not aiming to feed the world, however, the increase in global population and the stress this will place on the global environment will have indirect effects on the blueberry industry. To obtain a preliminary perspective on issues the industry faces, this study asked eleven stakeholders to the blueberry industry about its energy inputs, its strengths and weaknesses, what needs to be done, and their visions for the future.

The results of this preliminary research are useful in identifying considerable divergence in opinions on the current state of the blueberry industry and its future, and to launch discussion and further research into its sustainability[2]. Consensus will be needed to guide the industry coherently at a time of rapid change and of growing risks. Like other sectors of society, the blueberry industry must address its energy inputs and adapt to these rapidly changing conditions and an unpredictable future. These include increased fuel prices (and subsequently rising costs for chemical additives), environmental degradation, and climate change (European Union, 2008).

Many scientists and global organizations, including the Intergovernmental Panel on Climate Change (IPCC) and the European Union, believe that a 2-degree Celsius increase in global temperatures is the threshold after which the impacts of climate change will be "dangerous" (European Union, 2008). To avoid an increase of more than 2 degrees Celsius[3]

[2] Sustainability and its derivatives are defined in this paper as "meeting the needs of the present generation without compromising the ability of future generations to meet their own needs" (Agenda 21, 1987: 24).
[3] According to 11 scientists quoted in April 2009, the effects of climate change are already occurring, earlier and stronger than predicted. They said that although achieving the needed emissions reductions is scientifically possible, the lacking political will means there is less than a 30% chance of avoiding a 2-degree

there needs to be global cooperation among all countries and sectors to ensure that emissions peak and begin falling before 2020 (European Union, 2008), at which point emissions need to be 23—30% below 1990 levels (EAC, 2009). In Bill no. 146 (2007), the government of Nova Scotia committed the province to emissions reductions by 2020 of at least 10% below 1990 levels.

Under this Bill 146, Nova Scotia is legally obliged to move toward "sustainability". The legislation states that "the environment and economy must be managed for the benefit of present and future generations" (Section 3.2.d). This will partially be achieved through "energy efficiency programs" (Section 3.2.g). The bill also stipulates that Nova Scotia must establish "minimum energy efficiency levels for operations and undertakings within sectors of the economy" (Section 5.b). The blueberry industry represents an important — and large — sector in Nova Scotia's economy and studies are needed to facilitate achieving the government's goals.

3. Review of literature

a. Agricultural production systems

i. Food security

On a global scale the blueberry industry is insignificant in its energy use; it is, however, essential to Nova Scotia's economy and is a part of the greater global industrial system. Therefore it is important to understand the blueberry industry in the context of larger food

increase (Reuters News. (2009). *EU: Earth warming faster*. Retrieved April 11, 2009: http://www.reuters.com/article/environmentNews/idUSTRE5363MV20090407) production systems to determine why every food system, even small ones, needs to be re-examined.

The term “sustainable development” has become a buzz-word used in almost every sector and incorporated into numerous policies and plans of action. Over recent decades in particular, people have been increasingly concerned with sustainable food production, which is needed to keep human societies stable. Kichmann and Thorvaldsson (2000) summarize the four goals for sustainable agriculture: “sufficient food and fibre production, environmental stewardship, economic viability, and social justice” (p. 147). When examined using these criteria, it appears that the increasingly industrialized global food production system is moving away from this concept of sustainability, as are aspects of the blueberry industry.

Sustainable agriculture is necessary to ensure future food security. Food security is essential for social and political stability (Smith, 1998). Food security is defined by the United Nations Food and Agriculture Organization (FAO) as “a condition in which all people, at all times, have physical and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life” (Centre for Studies in Food Security, 2008). Weis (2007) says increased food costs could be the most destabilizing force to the global agricultural economy. In 2007, Jacques Diouf, head of the FAO, correctly predicted global food riots if the trend in food and energy price increases continued (Brough, 2007). In 2008, a wave of food-price related riots swept the globe (Basu, 2008). Though increased blueberry prices are unlikely to cause global riots since they are a specialized and higher-end product with a limited scope, increased input and product prices could have significant destabilizing effects on people involved in the low-bush blueberry industry and affect the livelihoods of thousands in rural Nova Scotian communities.

The price of food globally is expected to continue to rise (Committee on World Food Security, 2008), which would affect more than the 920 million people who are already undernourished (Shah et al, 2008). Most estimates predict the human population of 6.7 billion will reach 9 billion by 2050 (United Nations Department of Economic and Social Affairs — Population Division, 2007). Though the blueberry industry is not and will not be important in sustaining the majority of the world population, the environmental and economic stress induced by the increased population will have spin-off effects that will indirectly affect the blueberry industry. In this context, global food production systems will need to be re-examined relatively quickly in view of their sustainability, while also trying to meet the growing population's increased demand for food. Agricultural systems need to decrease their dependence on fossil fuels — particularly oil and diesel — that developed with their mechanization. This required a lot of effort, but if industries and practices are assessed individually the process can be facilitated.

ii. Energy use and environmental concerns

The availability of cheap fossil fuels revolutionized the agricultural industry; machines largely replaced draft animals, and higher yields became dependent on chemical inputs, more elaborate irrigation methods and new plant-breeding techniques (Kirchmann & Thorvaldsson, 2000). Inexpensive fossil fuels also allowed human beings to surpass the earth's ecological limits (Weis, 2007; McCluney, 2005). While it was the availability of cheap energy that contributed to huge increases in global food yields (Black, 1971); the question arises as to how these yields will be maintained if fossil fuel use is decreased for whatever reason — because of scarcity and higher prices or as a measure to reduce carbon emissions and combat climate change. Adopting energy efficiency measures could be one method to begin reducing fuel consumption. Agricultural systems do not use energy efficiently, especially when energy inputs are compared with the energy outputs in the final product; though yield per person has increased, the overall ratio of energy-in to energy-out has, in many cases, dropped significantly (Black, 1971). This is starting to rise again in many sectors as production strategies are changing (Swanton et al, 1996).

Intensive monoculture plantations are a critical component of the current agricultural paradigm. The arguments in favour of monocultures cite their efficiency and ability to maximize the amount of food they produce (Trewavas, 2001) because their definition of efficiency is based just on labour inputs and outputs according to a specific land area. Agricultural systems should be assessed and modified according to efficiency calculations based on an agro-ecological definition, which includes all agricultural processes as well as nutrient flow and an area's net output (Weis, 2007). This would lead to the adoption of sustainable practices.

In industrialized nations, food represents one of the most energy-intensive and resource-demanding sectors (Point, 2008). In the United States, 19% of all fossil fuels consumed are either directly or indirectly used in agriculture (Ziesemer, 2007); in Sweden that figure is 20% (Carlsson-Kanyama & Faist, n,d). This figure was not found for Canada. However, Canada's industrial sector is the largest direct user of energy at 38.5% (this includes food processing) and agriculture directly accounts for 2.7% of all energy use (Cuddihy et al, 2005). Transportation and freight account of 29% of total energy use; 40% of this in turn is used to transport goods, including food (Cuddihy et al, 2005). Nova Scotians are among the world's highest per capita energy users (NSDE, a, 2009). Agriculture and waste directly account for 4.6% of total energy use, transportation for 28.1%, and electricity at 46%, and it should be noted that electricity is used to freeze blueberries (NSDE, b, 2009).

Energy use in agriculture can be a proxy to measure environmental impacts because the use of fossil fuels that supplied much of the energy is linked to many environmental problems (Dutilh & Kramer, 2000). The increases in global food production as a result of large energy inputs have not been without costs and have "[led to] different forms of ecological stress" (Agenda 21: 67). Agriculture contributes to serious global environmental problems, including soil degradation, deforestation, biodiversity loss, water contamination by toxins, eutrophication of waterways, particulate pollution, smog, ozone depletion, and climate change (Point, 2008). For future sustainability and resilience to the impacts of climate change and economic vulnerability, it is essential to examine the agro-ecological efficiency of agricultural systems and diversify energy inputs.

Soil degradation is another serious global issue as soils play a supporting role for most terrestrial life. As a result of unsustainable agricultural practices, seventeen percent of global soil (mostly in Africa and Asia) is "strongly degraded" — it cannot be farmed without significant restoration efforts (ISRIC, 2007). Soil degradation results from various processes, including prolonged extraction of nutrients, salinization from irrigation (a highly energy-intensive process), and compaction from machinery (Goldsmith in McKillop & Newman, 2005). Soil compaction, particularly sub-soil compaction, is becoming an increasingly serious problem in agriculture, and is becoming an issues in blueberry fields. It occurs when large machines pass over fields. Compacted soils have fewer pores, affecting the amount of air and water in the soil and also the surface run-off. There can be cascading effects if chemical inputs are used on the compacted field (University of Minnesota Extension, 2001). Soil compaction can also inhibit plant growth, increase vulnerability to diseases and increase greenhouse gas (GHG) emissions (Beata, 2008). For example, using nitrogen fertilizers on compacted soils increases the generation of nitrous oxide compared with un-compacted soil (Situala et al, 2000; Warren et al, 2008). Soil compaction can be mitigated by adopting certain farming strategies, such as permanent field tracks, and paired or wide area low pressure tires (Scott & Cooper, 2002), which could be implemented as one measure to help secure future yields.

The increases in global food yields in recent decades can be viewed as temporary if new production paradigms are not developed and rapidly implemented because current yields depend on large fossil fuel inputs — particularly crude oil derivatives — and fossil fuel supplies are limited. Estimates suggest peak oil — the period when half the world's total oil reserves are extracted — has already occurred or will occur in coming decades (Witze, 2007, McCluney, 2005). Though the exact timing is debatable, the point is peak oil is inevitable (McCluney, 2005). Oil supplies will be increasingly hard to find and extract since they will be in remote locations (Campbell, in McKillop &Newman, 2005). This means available supplies will dwindle and prices will increase, and this will have repercussions on food availability (Committee on World Food Security, 2008). Taking these factors into account, along with the increased human population and the manifestations of multiple environmental problems, most notably climate change, and the need for a new paradigm is evident.

Climate change is arguably the most crucial problem facing humanity; there is overwhelming consensus within the scientific community that anthropogenic climate change is occurring and that it has serious repercussions for life forms around the world (Monbiot, 2007). Agriculture accounts for approximately 10 to 12% of global greenhouse gas emissions (Smith et al, 2007), most significantly carbon dioxide, methane, and nitrous oxide (IPCC, a, 2007). The emissions are contributing to rising average global temperatures and sea levels, and changes in local weather patterns, which will become more pronounced. The IPCC predicts "the resilience of many ecosystems is likely to be exceeded this century by the unprecedented combination of climate change, associated disturbances (i.e. flooding, drought, wildfires, insects, ocean acidification), and other global change drivers (i.e. land-use change, pollution, over-exploitation of resources)" (IPCC, b, 2007: 11). The world is already committed to a certain amount of warming, but there is a need to drastically reduce emissions within the next few years to prevent the total increase above the threshold 2 degrees Celsius that scientists warn would result in massive changes (European Union, 2008). Every sector needs to try to reduce emissions be re-examining its use of fossil fuels.

As mentioned in the introduction, the Nova Scotia government is aware of the importance of climate change and the province is now legally bound to reduce greenhouse gas emissions. In January 2009, the government released its 2009 Climate Change Action Plan, warning that "Nova Scotia is particularly susceptible to [climate] changes (NSDE, b, 2009). The plan's two goals are to reduce emissions and prepare for the unavoidable future changes in climate. The province also released its Energy Strategy in January 2009, which advocates the precautionary principle of supporting immediate action to address climate change, but acknowledges that "energy is central to almost everything Nova Scotian's do" (NSDE, a, 2009: 4). The strategy paper discusses the implications of variability and increase of fossil fuel price.

It is important to note the significant socio-economic changes, which are too complex to be examined in any detail in this paper, that have accompanied the increased dependence on fossil fuels. The inputs of energy contribute to underemployment in rural and under-developed regions (Gajaseni, 1995; Black, 1971). The industrialization of agriculture has also had gender implications, by masculinizing agriculture and substituting traditional women's roles with machines (Weis, 2007). Furthermore, the declining number of business farms (as opposed to hobby-farms) in Canada has altered social capital in rural communities and this affects farmers' abilities to adapt to and address environmental problems related to agriculture (Warren et al, 2008).

iii. Future production systems

With such dire predictions about the future, people have been active in developing future scenarios, including for food production. The IPCC believes there is "significant potential" for greenhouse gas mitigation within the agricultural sector (Smith et al, 2007: 500). They say the least expensive changes can be made in tillage and fertilizer practices, whereas land-use changes are more costly. Greenhouse gas mitigation strategies need to be evaluated for each agricultural system on a case-by-case basis (Smith et al, 2007). Blueberry fields are not tilled but fertilizer use could be a targeted area.

The array of proposed solutions for the agricultural sector is vast. Among others, they include; the adoption of bio-fuels (i.e. ethanol and bio-diesel) as a substitute for oil (Krishmann & Thovaldsoon, 2000); principles of biodynamic farming (Krishmann & Thovaldsson, 2000; Reganold, 2006); urban agriculture (Smit & Nasr, 1992), no-till farming, organic farm methodologies, and better irrigation systems, (Martin et al, 2007). Weis (2005) notes that "modern science" is needed to move agriculture into the future and reduce dependence on fossil fuels and chemical inputs.

More 'modern' systems of farming include the concept of vertical farming, proposed by Dickenson Despommier from Columbia University. He says 18-storey vertical farm buildings located in cities and occupying a block could feed up to 50,000 people (Nelson, 2007). This would reduce the amount of land appropriated for agriculture, which currently occupies approximately 40% of the earth's land (FAO, 2007). To produce yields to feed the additional projected 3 billion people by 2050, an area the size of Brazil would need to be added to cultivation (Nelson, 2007). Similarly, Gordon Graff of the University of Waterloo has developed the notion of a Skyfarm for Toronto, which would produce half of its electricity from its own biogas (Whyte, 2008). Though possible for more conventional fruit and vegetable crops, these modes of production would likely not be feasible for blueberry production, but their adoption could make more land available to blueberry production.

Another newer technique that is highly mechanized is precision agriculture and its conception was driven principally by economic and environmental concerns (Denis, nd). Denis (nd) defines precision farming as a “systems approach to optimise crop yields through systematic gathering and handling of information about the crop and the field…. [that increases] efficiency, improves farm economy, and reduces environmental impacts” (p. 30). This is achieved by integrating computers to manage pests and yields, improve quality and help in decision making (Krishmann & Thovaldsson, 2000). In addition, there are developments in environmental monitoring to incorporate geo-references data for water quality and to establish systems of traceability, which would allow consumers to know where and how crops are grown (Wang et al, 2006).

Weis (2007) stressed the need for research, guided by the interest of farmers, public health and the environment, to understand how agro-ecosystems functions. Ziesemer (2007) states we should conduct more studies on energy use in “all sectors of the food system in different countries and different production systems [because this] knowledge about energy use in agriculture and the food system is essential in developing sustainable food production systems” (p. 6). Biophysical accounting techniques provide an alternative set of tools to traditional economic measures, to assess the flow of materials and energy. Biophysical accounting tools, such as life cycle assessments, energy analyses and ecological footprints (Tyedmers & Pelletier, 2007), can provide quantitative measures of environmental problems (Jiun-Jiun, 2007). The results can be used by governments to target policies and address problems at the source to ensure the environmental problems are not simply transferred (Scientific Applications International Corporation, 2006). These biophysical ecological tools should be coupled with social research to obtain inputs from stakeholders. This will increase the likelihood of effective policy implementation.

b. Low-bush blueberry industry

As mentioned earlier, in the global context, it is important to examine local production systems to move them individually towards reduced energy use and environmental impacts to achieve a collective and significant positive change. Nova Scotia’s low-bush blueberry industry is a prime candidate for examination because of its significant and growing importance to the province’s economy, as detailed in the introduction (Nova Scotia Department of Agriculture, b, 2007; McIssac, 1997).

Vaccinium angustifolium is the dominant species of low-bush blueberry that is cultivated; blueberries are among a small number of indigenous crops grown commercially (McIssac & Reid, 2000) in a limited region of the world (Figure 2). Energy (and corresponding monetary) costs associated with creating blueberry fields include clearing forests, removing debris, building roads, and irrigation systems.

Figure 2 - Global distribution of commercially viable wild-blueberry growing regions. Map from Oxford Frozen Foods, taken November 8, 2008 from: http://www.oxfordfrozenfoods.com/map.htm

Blueberry fields operate on a two-year cycle so only half of the total acreage produces each year. Fields are pruned during the fall after harvest or in the spring of the fallow year, to encourage new growth and improve yields during the producing/harvest year. The fields are pruned either by mowing or burning; most growers currently mow (McIssac, 1997).

Blueberry growers tend to use both naturally and chemically derived additives to enhance soil and control pests (herbicides, insecticides, and fungicides) (McIssac, 1997; Warman, in Campbell, 2004). The amounts and methods of applications are site-specific. Some fertilizers containing potassium, phosphorous, and nitrogen are applied to boost yields (Percival & Jeliazkova, 2003). Fertilizer is not only energy-intensive to produce, but nitrogen fertilizers are also emission sources for nitrous oxide (IPCC, a, 2007).

Chemicals are also applied to control pests. The synthetic insecticides used include azinphos-methyl, phosme, bacillus thuringiensis, carbaryl, methoxychloris, malation, diazinon, prpiconazole, and fungicides include triforine, benomyl, captan, chlorothanil, and iprodine (Bell, Yarborough, & Dill 1999). Also, because blueberries are a perennial crop and fields are not tilled, weeds can negatively affect yields. Herbicides that have been used — and some still are — include 2-4-Dichloropenoxyacetic acid, glyphosate, clethodium Fluazifop-P butyl, Sethoxydim, and hexazinone (Bell, Yarborough, & Dill 1999). These chemicals can have negative effects on the ecosystem, on both the soil structures and run-off and affect other ecosystems, including aquatic environments (BC Ministry of Agriculture and Lands, nd). Their use can also affect population numbers of pollinators, most importantly bees that are crucial for blueberries (Drummond, 2002). The negative impacts of their use can be mitigated by the timing of applications and methods of application (Drummond, 2002).

Certified organic blueberry growers are not permitted to use many of the chemical additives employed by traditional producers (Campbell, 2004). The organic low-bush blueberry industry in Atlantic Canada in 2004 was worth approximately CAD 10,000 to 20,000 and most farms were less than 10 acres (4 hectares) (Campbell, 2004). Certified organic soil fertility supplements include animal manure, rock phosphate, gypsum dust, manure and compost teas, yard waste, and wood ash (Warman in Campbell, 2004). Certain growing techniques can also be employed, for instance, reducing soil pH with vinegar can reduce weed numbers. News national organic agricultural standards are coming into effect on June 30, 2009, for all producers who wish to be certified under the Organic Products Regulations portion of the Canadian Agricultural Products Act (CFIA, 2009). It is important to note that organic methodologies alone do not address many of the environmental problems associated with agriculture, such as deforestation, soil erosion from in tilled-agricultural land and emissions (Krishmann & Thovaldsson, 2000; Trewavas, 2001).

The majority (over 85%) of blueberries in Nova Scotia are currently harvested mechanically (NSDA, a, nd). Approximately 2% are sold fresh, a tiny percentage processed directly. The remaining (~95-95%) of the harvested berries are transported by road to processing plants in the province (i.e. Oxford Frozen Foods and Rainbow Farms) or in other berry-producing regions (i.e. Maine, New Brunswick, PEI). They are frozen using the IQF method (NSDA, a, nd) immediately after harvest. This processing therefore lasts for about 4 to 6 weeks in the late summer. The same cooling engines, however, are used to cool the warehouses where the berries are stored until they are transported elsewhere for further processing (preserves, baked goods, dairy etc). The distribution of blueberry exports from Nova Scotia is roughly equally divided between North America, Europe (UK, Germany, and France) and Asia (Japan). Within North America, the frozen blueberries are transported on freight trucks. To Asia and Europe they are shipped in refrigerated containers.

4. Methods

a. Sampling methods

Data were collected from primary and secondary sources. Eleven stakeholders in the blueberry industry, including growers, processors and workers from industry and government, consented to be interviewed. The sample was non-probabilistic and made use of both purposive and snowball techniques (Palys, 1997). Potential participants were initially identified through the Wild Blueberry Producers Association of Nova Scotia (WBPANS), internet websites, and personal contacts and some participants provided other people's contact information. This study is not-representative however, and despite efforts to acquire a broad range of views in the eleven respondents, it is likely interviews with a different cohort could provide an alternative set of responses.

Once stakeholders were identified they were contacted (by phone or email), given a brief description of the project, and asked if they wanted to participate. The interviews were conducted at the point of first contact or arrangements were made for a future interview. Telephone interviews are a standard research methodology employed by many disciplines (Palys, 1997). Participants were asked a series of open-ended questions (Appendix 1). The quality of the data obtained in the interview was dependent on the types of questions asked: did they relate to the objectives and were they reasonable? Efforts were made to ensure the questions were relevant and addressed the purpose of the study to contribute to the project's validity. Were this study to be repeated with the same stakeholders it is believe similar issues would arise from the interview responses. However, the projects' objectives were slightly modified after the interviews were conducted, but responses relating to the updated objectives were selected from the interviews.

Participants were asked questions relating to their opinions on the blueberry industry's current energy use, what needs to be done to move the industry into the future and their vision for the industry's future. Issues not relating to energy use specifically were not directly identified in the questions but, because the questions were open-ended, these were mentioned by respondents. The respondents' answers were also further explored on a case-by-case basis depending where the conversation went. Following the interview the participant was sent an electronic copy of the interview notes so they could review them to prevent misinterpretation. Ten people were interviewed on the phone and one person emailed their response.

b. Data analysis

An *a posteriori* coding scheme was used to identify the major themes that emerged from the interviews. Information was colour coded in relation to different themes and subsequently organized in tables. The information obtained from the interviews was compared and contrasted, based on the respondents' opinions about the current situation of the blueberry industry, what they believed needed to be done, and their views for the future. The benefits and drawbacks of the contrasting visions for the future of the blueberry industry were examined with reference to its position in Nova Scotia. The responses from the interviews were integrated with information from the literature to determine what could be done to initiate improvements to the industry.

c. Ethics

Ethics were required for these interviews (Appendix 2). The respondents were guaranteed confidentiality for participating in this project. The respondents were all stakeholders in the industry and there is the potential they could be negatively affected were their identities revealed.

d. Limitations and delimitations

The purposeful targeting of initial participants, it is believed, served to minimize bias arising from all the participants sharing similar viewpoints. This is because a diverse group of people were specifically identified initially, primarily through Google searches. Interviews were used during this research because of their versatility (Palys, 1997). For reasons of convenience, time and money, all interviews were conducted over the telephone, which meant that visual cues between the interviewer and interviewee were lost. However, the phone interviews had the advantage of minimizing potential reactive bias (Palys, 1997).

Due to a setback with the failure of survey responses to the previously proposed energy analysis project, the interview portion of this study faced severe time limits. There were only two weeks available to conduct interviews (March 4th to 16th, 2009), only eleven people responded and only a small number of stakeholders to the industry were able to be targeted.

5. Results

a. Energy inputs survey

An energy inputs survey for an energy analysis project (Appendix 3 and 4), designed with the help of Dr. Peter Tyedmers, a Professor at Dalhousie University in the School for Resource and Environmental Studies, was distributed by email to blueberry growers on mainland Nova Scotia through the Wild Blueberry Producers Association. Because only one survey was completed and returned, this portion of the project was discarded.

b. Areas for improvement (with a focus on energy inputs)

Interviewees were asked whether current energy use in the industry is a concern, some respondents answered 'yes' immediately whilst others asked for clarification. These members were asked if energy use was a concern in relation to the industry's past or in comparison to other agricultural industries in Nova Scotia generally (Table 1). Four of eleven respondents said energy use was a concern, one said it was not, and four thought "not really" or "it depends". One respondent gave no answer.

Table 1 - General perceptions on energy inputs

Is the blueberry industry reliant on energy inputs (in relation to the industry's past and/or other agricultural sectors)?	**# of respondents (and who)**
Yes	4 (1,2,10, 11)
No clear answer ("it depends/not really")	4 (3, 4, 6, 7)
No — low energy inputs	1 (9)
N/A	1 (5)

Areas identified as being of particular concern were pruning methodologies (mowing versus burning), the reliance on chemical inputs, mechanization, and the monetary costs (particular as they related to yields) (Figure 3).

Six respondents (1, 4, 8, 9, 10 and 11) identified pruning as an area where improvements could be made. Some comments regarding pruning were the trade-off and secondary effects that can occur when a field is mowed instead of burnt. These include increased pesticide, herbicide, and fungicide applications and more soil compaction. Two respondents believed the use of furnace oil, propane and/or diesel to burn fields requires a lot of energy — more than mowing. On the other hand, respondent 4 said the shift toward mowing has lowered overall energy inputs.

Five respondents (4, 6, 8, 9 and 10) indicated chemical inputs were an area for improvement. One respondent indicated the fertilizer manufacturing likely requires more energy than the entire growing stage. Another said that although conventional blueberry growers use substantial amounts of chemicals, these are typically lower than those used for other crops. The industry's current focus is on chemical inputs, particularly to address pests and weeds, because these are the most detrimental to yields. The use of chemicals was identified by some respondents as a concern, and one person mentioned the negative impacts on soil biotic communities. However, one respondent said the industry is increasingly using environmentally friendly inputs.

Four respondents said energy use in the blueberry industry was lower than other agricultural industries during the growing stage. However, many interviewees agreed with respondent 7's statement that energy requirements in the blueberry industry are during the harvesting, processing and transportation phases are similar to other energy use in other agricultural sectors.

Nine respondents (1, 2, 3, 4, 6, 7, 8, 10 and 11) identified the need for improvements in the industry's mechanization, including more efficient tractors and better transportation systems. Some respondents suggested that if growers formed cooperatives they could transport berries in larger loads and hence reduce total fuel use. Respondents indicated that very few berries are sold and available locally; most are transported to processing plants and then shipped in roughly equal proportions to the rest of North America, Europe (UK, Germany and France) and Asia (Japan). An interviewee said the berries are all frozen immediately after harvest, up to 2 million pounds (about 907,000 kilograms) daily for four to six weeks, but can be stored frozen up to two years in the warehouses using the same cooling engines. One respondent said the energy required during the IQF process was “probably huge” and the electricity came from Nova Scotia Power.

Some respondents said improvements to energy use in equipment were needed in addition to increases in yield per acre. Respondent 3 said “everything comes down to yield per acre”. All the respondents except 2, 5, and 6, indicated, directly and indirectly, that all decisions growers make depend on daily costs.

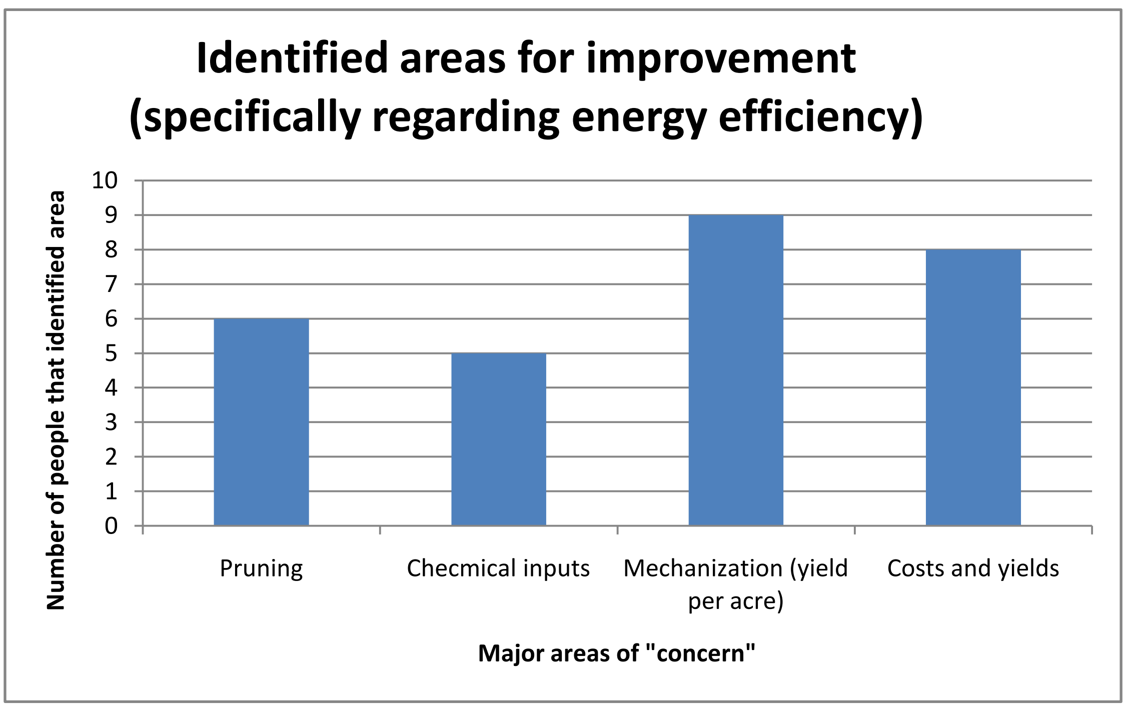

Figure 3 - Identified areas for improvement (particularly relating to energy-efficiency) in the blueberry industry

Respondents also provided feedback relating to the general strengths and weaknesses of the blueberry industry (Table2).

Table 2 - Identified strengths and weaknesses of Nova Scotia's blueberry industry

Strengths	**Weaknesses**
Unique product, very few blue-coloured fruit	High-priced commodity, potential for consumer resistance
Multiple health benefits (minerals, vitamins, antioxidants)	High use of chemical (pest/herb/fungicide) control inputs (working towards addressing this currently by adopting traceability measures and precision agriculture techniques)
Strong processing infrastructure in wild blueberry producing regions	Soil compaction tractor trips over fields
Strong international marketing infrastructure (WBANA)	Mechanization and corresponding fossil fuel dependence
Relative to other agricultural crops, fuel inputs are lower during the growing stage in the blueberry industry	Returning to hand harvesting is impractical due to large acreage and low number of workers.
Crop developed from wild bushes	Limited alternative pest management strategies (i.e. tillage and crop rotation not feasible)
Isolated growing region: only commercially viable to grow low-bush blueberries in Eastern North America (Maine, QB, NS, NB, PEI)	Specialized industry — most new developments are exclusive to the blueberry industry, which is self-sponsored and self-developed
Little international competition	Little support for organic berry production
Perennial crop and harvested bi-annually, lower energy demand	Input costs will rise as energy prices rise (for blueberries and other crops)

c. *What should be done*

Respondents had numerous and sometimes divergent ideas about what should be done to move the blueberry industry into the future (Table 3). According to Respondent 1, the industry needs to ask itself how it wants to be perceived in ten years and base its action on the answer. Respondent 1 also believed that the present time, with the global economic situation, provides a perfect opportunity to promote energy efficiency as a way for industry members to lower costs and save money.

Table 3 -What needs done? (A selection of comments)

What should be done to guide the industry?	Respondent
Growers need to increase yield per acre ("productivity") — need research to learn how to increase yields but reduce monetary and energy costs	1, 3, 4, 6, 7
Adoption of precision agriculture and establishment of traceability systems	7, 9, 10
Government's continued role investing in research and market development	2, 3, 7, 10
Need a shift away from the current research focus on chemical inputs and move to bio-pesticides and other naturally derived products	8, 6, 4
Improve tractor fuel efficiency	1, 4
Simplify production tools, such as calibrating sprayers	1
Need more research to develop guidelines for growers to let them know when to apply additives and how much to apply	1
Research to develop a standard for energy use in various industries to allow for comparisons	3
New technology and more research, that focuses on regional situations and fits regional needs	10

Research entire production process to facilitate decision making	8
Research microwave technology as an alternative pruning method	10
Not possible to "go green" in processing unless Nova Scotia Power "goes green"	3
Policies are wrong and we need to change them; i.e. better incentives to encourage people to invest in renewable energy such as wind	2
Government and industry support towards less invasive and lower energy approaches in blueberry growing	6
Government cannot do anything to make the industry more efficient	3
Increased efforts to develop domestic markets	10

d. Visions for the industry's future

Many respondents did not provide clear responses when asked what their vision for the blueberry industry was for approximately 25 years in the future (Table 4).

Table 4 - Visions for the industry's future (~25 years)

Vision for/comment about future	Respondent
Fuel efficient technologies and environmentally friendly pest management strategies	4, 10
Would like to see "*sustainability*"	8
Industry will be energy efficient	1
Powered by a hybrid of wind and biomass and biodiesel	2
Future will be similar to now	3
An understanding of the total energy inputs and environmental effects (especially regarding inputs and pruning methods) of the blueberry industry that guides decision making	8
More larger farms, probably fewer small farms because no longer	4

economically viable	
More organic farms and farms with reduced chemical inputs	6

6. Discussion

a. Failure of the energy inputs survey

There are many potential for the failure of the energy analysis surveys. Mail-out surveys are characterized by low responses (Palys, 1997). Timing might have been an issue, the surveys were emailed February 3rd, 2009 and a follow-up was sent February 18th. Growers were asked to complete it before March. This may not have been enough time and/or growers were busy with taxes and preparations for the upcoming season. Also, it is possible growers did not have the information easily available or were unwilling to divulge it, despite confidentiality statements.

b. Areas for improvement and what should be done

Though this study is not representative of all blueberry stakeholders, this cohort provided a sense that the blueberry industry's reliance on energy inputs for yields can be considered a concern and can be improved. Only Respondent 9 definitively said energy use was not a concern; the discrepancy might be attributable to a different interpretation of the question. Respondent 9 said the fuel used in the industry is "less than would be required to manufacture the fertilizer[s that growers apply]"; others respondents included this fuel input in their answer. The near consensus on the need to increase energy efficiency and address fuel use shows a need for action. This is positive action is imperative that industries move, and soon, to adopt energy efficient practices and the Nova Scotian government recognizes this,.

Respondents felt the blueberry industry's energy use was low compared to other agricultural industries because of the blueberry's unique properties: it is a perennial crop that produces every two years. This perception could be verified and differences quantified with research using biophysically accounting tools such as energy analyses or life cycle assessments. Biophysical assessments are important tools that can be used move industries toward sustainability (Over Arup & Partners, 2007; Tydemers & Pelletier, 2007; Rebitzer et al, 2003; Ramirez, 2005). Furthermore, there is a call in the literature for more biophysical assessments to be conducted on agricultural systems to facilitate the transition of food production systems toward more sustainable practices (Ziesemer, 2007). Research from such studies could determine whether, and to what extent, the blueberry industry's energy inputs are lower than inputs in other agricultural sectors. Either way, adopting energy efficient practices now would provide the blueberry industry with a greater advantage over other crops in the future and add to its list of strengths.

Many of the blueberry industry's advantages stem from the fruit's unique properties. Not only is it unique to grow, is one of the few blue fruits, and it only grows in an isolated region of the world (meaning it has little competition), but it has numerous health benefits and strong infrastructure for international marketing. Strong and efficient infrastructure networks can reduce the impacts stemming from international transportation (Point, 2008); however infrastructure for domestic markets should also be encouraged. There is a need to improve local marketing and distribution — almost none of the berries are sold locally. As respondent 7 indicated, approximately 95% of the blueberries harvested are immediately frozen and almost all of them are shipped elsewhere and are not available in local grocery stores. There has been a recent consumer trend toward buying local because it this strengthens local economies and less energy is required for transportation (Goldsmith in McKillop & Newman, 2005). It would be beneficial, in both the short and long term to develop local markets. Blueberries are already a higher-end commodity, if fuel prices increase, transportation costs will rise and so will the price of berries. As one respondent said “there is the potential for consumer resistance”.

It is important to note that recent studies have indicated food miles alone are not necessarily an adequate proxy for a food’s environmental impact because they do not account for other environmental impacts throughout the food’s life cycle, nor necessarily differentiate between modes of transportation. Rail and sea are much more efficient per kilometre tonne than transportation by plane or truck (Point, 2008). Blueberries are either shipped either by sea or by truck. Nova Scotia is initiating a new pilot project under its 2009 Climate Action Plan that aims to reduce emissions from trucks by slowing their speeding and doubling their load (NSDE, b, 2009). This could potentially reduce emissions associated with berry transportation in future.

Globally, total transportation only accounts for a total 11% of greenhouse gas (GHG) emissions and Weber and Matthews (2008) argue that dietary changes to reduce meat consumption achieve greater GHG reductions than simply eating locally. This is positive for the blueberry industry since globally even consumers aware of environmental issues can, and probably will, continue buying berries without feeling guilty.

The blueberry industry, already a niche, higher-end market, could change its approach and capitalize on the growing number of environmentally and socially aware consumers (Sustainable Marketing, 2005). A marketing study in the United States discovered five key areas that influence consumers are: health and safety; honesty; convenience, relationships; and doing good (Bemporad & Baranowski, 2007). The blueberry industry could appeal to these building local relationships and reducing its environmental impact.

Furthermore the blueberry industry could take advantage of local markets by promoting the health benefits of blueberry consumption. Consumption of blueberries and other fruits and vegetables could be promoted as one of the many strategies that will be needed to curb obesity and improve the health of the Canadian population. In the United States, research is underway to determine what roles wild blueberries could have in childhood development and specifically obesity prevention (Wild blueberries, nd). Preventative health measures such as adopting alternative lifestyles with better nutrition could considerably reduce healthcare expenditures, which were CAD 4.5 billion in Nova Scotia in 2007 (CBC News, 2009). If healthier foods are subsidized, as proposed by Cash et al (2005), this would benefit lower income families, overall population health, and agricultural producers, including blueberry growers. Promoting blueberry's health benefits and reducing energy required for transportation are two reasons favouring the development of domestic markets — what a few respondents indicated should be done.

Respondents disagreed whether burning or mowing was less energy intensive (i.e. mowed fields often require more chemical inputs, hence more fuel is used for tractor passes and there is increased soil compaction). Burnt and mowed fields and the subsequent field practices should be investigated to determine the least energy intensive and environmentally detrimental practices to help growers decision making. Soil compaction, from tractor passes over fields, can be addressed with fewer field passes, and adopting reduced ground pressure system (Scott & Cooper, 2002) .Research into new microwave technologies, identified by one respondent, could be valuable to the industry in future.

As indicated in the literature review, chemical inputs are costly in monetary and environmental terms. Lots of energy is used to manufacture them and their use can create GHG emissions (i.e. nitrogen fertilizer becomes nitrous oxide) (Scott & Cooper, 2002). In addition, chemicals can run-off and contaminate aquatic environments (BC Ministry of Agriculture and Lands, nd). Chemical inputs are the blueberry industry's major present research focus, but respondents said there is a move towards more 'environmentally friendly' inputs. Another option for reduced chemical inputs is organic production. Organic blueberry growing can be difficult on a large scale, however, because blueberries are a succession crop weeds need to be intensely managed. One respondent indicated the Canada's new certification standards makes organic blueberry growing much harder because it limits the ability to move fields in and out of organic production. However, as mentioned before, moving the entire industry to adopt naturally derived inputs could provide be a marketing advantage, especially if the industry decided to market itself as 'green'.

Eight of the eleven respondents said the industry's mechanization has room for improvement. More fuel efficient technologies are needed, but some can be adapted from other sectors. Respondent 4 said, however, "all new technologies are exclusive to the blueberry industry" and are developed self-funded with help from government and universities.

Regarding processing, it was indicated the only way to reduce emissions is if Nova Scotia Power changed its electricity sources.

Respondents also indicated returning to human labour is not feasible. This was not further investigated but could be because blueberry fields today are much larger and there is a general shortage of labour — the current economic crisis might change this. Results from other agricultural sectors indicate mechanization has contributed to rural under-employment (Gajaseni, 1995); this is an area that required further research in relation to the blueberry industry.

Monetary costs in relation to yields influence almost everything decision currently made in the industry. Therefore, any changes need to be cost-effective to be successfully implemented. Government policies might need to provide financial mechanisms to make new strategies cost-effective. According to the GPI Atlantic, net income for farmers in Nova Scotia is decreasing, production margins are falling, and farmers have become more dependent on government payments (Scott, 2001). Scott (2001) found the dairy and poultry industries' supply-side controls and organic producers' who market their crops directly to consumers were less affected by these trends. It is unclear where the majority of the blueberry industry currently stands in relation to Scott's findings and this could be investigated in future.

Despite current costs, changes in fuel use in the blueberry industry (and other agricultural sectors) will eventually occur because fuel prices will rise. However, with warnings about climate change and the necessity of present emissions reductions, we do not have the luxury of waiting. As with all food production systems, the blueberry industry's yields depend on the stability of the natural environment (Entsua-Mensah et al, 2005). It in the industry's best interest to mitigate environmental effects because they will be affected, like other agricultural sectors, by climatic instabilities.

The clearest and most important finding from the interviews was the urgent need for research. It appears stakeholders have developed methods of action that best fit their needs based on current market conditions and energy prices. These are subject to rapid and dramatic change in the future (as is demonstrated by the current economic situation). Though stakeholders know their industry, there is little information available for people not directly involved in the industry or for policy makers. Policy needs to be guided by science and resource management to support future agriculture (Ethsua-Mensah et al, 2005); this includes Nova Scotia's blueberry industry, no matter how small it is.

c. Thoughts about the industry's future

This question was difficult to answer because most people involved in the blueberry industry are concerned with the daily operations and might not be involved in 25 years. However, Respondent 1 said the industry needs to ask how they want to be perceived in ten years and work toward that. This is important because the industry should have a vision if it wants to move into the future and be prepared for potential instability.

Some respondents indicated the desire for sustainability. Sustainability can have multiple interpretations, but a dialogue between stakeholders could help achieve a consensus. The respondents also indicated in future the industry will be energy efficient; this would benefit growers directly by reducing farm expenditures (and in the long term would achieve a small, but necessary playing reduction in GHG emissions, which contribute to climate change that could significantly affect blueberry yields). The desire for energy efficiency is a goal shared by the stakeholders and the Nova Scotian government and work is already in progress.

Adopting precision agriculture techniques (or site-specific management) that incorporates Global Positioning Systems (GPS) and Geographic Information Systems (GIS) could greatly reduce the amount of chemical additives required while increasing yields. Research is already underway and more of these systems will likely be incorporated by blueberry growers in the near future. These technologies are initially costly, which hinders their implementation by small to medium sized growers (USDA, 2009). Leasing machinery or sharing technological investments between growers can reduce costs and increase accessibility. Prices for these technologies are also falling.

Future food production systems such as vertical farming are not suitable for blueberry production. Their adoption in could free rural lands that could be re-forested or converted to blueberry production (and prevent more forested areas from being cleared). However this is likely a longer-term scenario.

7. Conclusions and recommendations

The low-bush blueberry industry is important to Nova Scotia's economy. The industry has been highly mechanized and is dependent on energy inputs in the form of fuel, electricity and chemical additives. There is room to improve energy efficiency in multiple stages of the blueberry industry's production cycle. This study asked open-ended questions to eleven stakeholders in Nova Scotia's low-bush blueberry industry to obtain their opinions about energy use, what needs to be done, and their visions for the future.

It was discovered the industry's most important current need is for research to clarify divergent opinions and inform policy members and the public. Different energy uses and environmental impacts associated with burning and mowing as pruning methodologies are a priority for future research. There was confusion between respondents as to which method was less energy intensive when the subsequent field passes and environmental effects are taken into consideration. Research is also needed to develop new, more efficient technologies. Technologies are often specific to the blueberry industry because of the bush's unique traits. Findings from research should be used to develop policy and guide future practice to become more energy efficient and less environmentally detrimental.

Any policies or recommendations for future practice must be cost effective if they are to be adopted by growers and successfully implemented. Governments can play a role by providing financial support to promote environmentally friendly industry practices by helping make them cost effective. Focusing government and industry funding on alternative naturally derive inputs over chemical inputs could significantly speed the development and wide-spread implementation of alternative pest-management strategies. This could also potentially reduce costs associated with the growing stage.

The industry, through the Wild Blueberry Association of North America, has strong international marketing infrastructure. Local markets are weak, however, and the industry would benefit by strengthening domestic markets. One way to promote local consumption is to market the berry's health benefits, which has been done successful in international markets. Blueberries are a higher-end product but an innovative idea suggested by Sean Cash (2005) from the University of Alberta, would be to for governments in Canada to subsidize healthier food options. This would require government support but would be beneficial to the blueberry industry. Developing domestic markets would also serve to strengthen rural economies and reduce the fuel necessary for transportation. Domestic market development and energy efficiency measures also improve the industry's resilience. However local, and international, markets are developed, increases in production should be achieved without additional energy use or further environmental costs.

This study was not representative and though efforts were made to acquire a diverse group of stakeholders for interviews this could be improved in future projects. Further research with a more representative sample of blueberry stakeholders, and perhaps members not directly involved in the industry, should be carried out in future. Alternative questions and more specific questions could be addressed in future to explore issues in more detail. Areas for future research include consumer perspectives on blueberries and the environment and their willingness to pay for less detrimental practices, and assessing the various impacts between burning and mowing.

The blueberry industry would benefit greatly from the use of biophysical assessment tools. These could be used to quantify energy inputs and environmental outputs. Once identified areas with large effects can be targeted for improvements. Biophysical assessments can be time consuming and require industry participation because obtaining data required industry members invest their time and energy. Methods to improve participation would be to include stakeholders in the project design; this would greatly contribute to the project's catalytic validity. Had stakeholders been contacted prior designing the energy analysis it is likely a project of more significance to the industry stakeholders would have been developed and the response rate might have been higher. Results from this study indicate that an energy analysis to compare mowing and burning techniques would have been much more beneficial to blueberry growers. There is a need for much more research into the blueberry industry to guide policy development.

In future studies, industry stakeholders need to be consulted to ensure research is relevant. The stakeholders also need to be included in policy design to ensure they are effective and reasonable. Policy also needs to incorporate qualitative findings from stakeholder consultations with quantitative ecologically-based research to create policies that increase the industry's resilience as it moves toward a future of potential uncertainty.

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9. Appendices

a. Appendix 1: Telephone interview questions

The general outline for the questions, respondents were generally asked variations of these questions and conversation was allowed to flow.

Do you think the low bush blueberry industry is reliant on energy inputs? If asked: compared to other agricultural industries?

If yes: does this concern you?

(Respondents were asked to identify aspects of “concern” that could be improved”)

From your perspective, generally what do you think are the weaknesses or strengths of Nova Scotia’s low bush blueberry industry?

What needs to/should be done to move the blueberry industry into the future/ what do you think the blueberry industry needs?

What is your vision for the future of Nova Scotia’s blueberry industry?

b. Appendix 2: Ethics application

ENVIRONMENTAL PROGRAMMES
FACULTY OF SCIENCE
DALHOUSIE UNIVERSITY
APPLICATION FOR ETHICS REVIEW OF RESEARCH INVOVLING HUMAN PARTICIPANTS
UNDERGRACUATE AND IN NON-THESIS COURSE PROJECTS

GENERAL INFORMATION

1. **Title of Project:** Nova Scotia's blueberry industry: A reflection on energy use, visions for the industry's future, and how to get there"

2. **Faculty Supervisor(s)** **Department** **Ext:** **e-mail:**
Dr. Tarah Wright **Enviro Science** **tarah.wright@dal.ca**
Dr. Deborah Buszard **Enviro Science** **Deborah.buszard@dal.ca**

3. **Student Investigator(s)** **Department** **e-mail:** **Local Telephone Number:**
Anna-Sarah Eyrich **Environmental Science** **an458318@dal.ca** **446 2917**

4. **Level of Project:**
Non-thesis Course Project [ ] Undergraduate [X] Graduate Specify course and number: ENVS 4902

5. a. **Indicate the anticipated commencement date for this project:** **March 3, 2009**
b. **Indicate the anticipated completion date for this project:** **April 1, 2009**

SUMMARY OF PROPOSED RESEARCH

1. **Purpose and Rationale for Proposed Research**
Briefly describe the purpose (objectives) and rationale of the proposed project and include any hypothesis(es)/research questions to be investigated.

The purpose of this study is to identify the areas in Nova Scotia's low-bush blueberry industry with high energy inputs. The three objectives of this study are:

- to identify the areas in the low-bush blueberry industry in Nova Scotia from the field to the place of sale are the most energy intensive
- to identify what stakeholders think should be done to make the industry more energy efficient and mitigate its negative environmental impacts
- to provide recommendations for improvement for interested parties to take action.

Over recent decades there has been an increase in dependence in global agriculture systems on inputs of energy (directly and indirectly) that is primarily derived from fossil fuels. Not only does this increase in energy inputs harm on environmental systems but it also jeopardizes food security in the future. Rather than using conventional economic tools, there are calls for the need to assess global food production systems using biophysical accounting tools. This study has a tiny role to play in this global movement by beginning to preliminarily asses the blueberry industry, which can be expanded upon in the future.

2. **Methodology/Procedures**

a. **Which of the following procedures will be used? Provide a copy of all materials to be used in this study**..

[X] Survey(s) or questionnaire(s) (mail-back) ***Appendix 1***
[ ] Survey(s) or questionnaire(s) (in person)
[ ] Computer-administered task(s) or survey(s)]
[ ] Interview(s) (in person)
[X] Interview(s) (by telephone) ***Appendix 2***
[ ] Focus group(s)
[ ] Audio taping
[ ] Videotaping
[ ] Analysis of secondary data (no involvement with human participants)

[ ] *Unobtrusive observations*
[ ] *Other, specify* ____

b. **Provide a brief, sequential description of the procedures to be used in this study. For studies involving multiple procedures or sessions, the use of a flow chart is recommended.**

David Sangster of the Wild Blueberry Producers Association of Nova Scotia (WBPANS) emailed my survey to a list of blueberry growers (he could not release their names and information because of WBPANS confidentiality agreements). Growers who wished to participate in the study were able to complete the survey and return it. These surveys will be entered into the computer to be compiled. Interviews will be conducted on the phone with government representatives, growers, and industry members. They will be asked about statistics (i.e. how much energy does it take to for the Individual quick freeze processes, where are the berries exported, how are the berries transported). A list of inputs will be compiled, based on the survey information, for which energy equivalents will be retrieved from biophysical assessment tools databases. These will be used to determine the inputs. The interviewees will also be asked what they think the weaknesses of the industry are presently and what they think could/should be done to improve the energy efficiency and general environmental impact of the blueberry industry.

3. Participants Involved in the Study

a. ***Indicate who will be recruited as potential participants in this study.***

Dalhousie Participants:
[ ] Undergraduate students
[ ] Graduate students
[ ] Faculty and/or staff

Non-Dal Participants:
[ ] Children
[ ] Adolescents
[X] Adults
[ ] Seniors
[ ] Persons in Institutional Settings (e.g. Nursing Homes, Correctional Facilities)

[ ] Other (specify) _Members of government, blueberry growers, members of WBPANS, industry members (Oxford Frozen foods)__

b. ***Describe the potential participants in this study including group affiliation, gender, age range and any other special characteristics. If only one gender is to be recruited, provide a justification for this.***

The potential participants are blueberry growers who WBPANS sends the information too. It is possible there are more male members in this association and they will be the ones receiving the survey. The other participants include WBPANS members who are not growers and government and industry representatives.

c. ***How many participants are expected to be involved in this study?*** _*ten* __

4. Recruitment Process and Study Location

***a*.** **From what source(s) will the potential participants be recruited?**

[ ] Dalhousie University undergraduate and/or graduate classes
[ ] Other Dalhousie sources (specify) ________________________________
[ ] Local School Boards
[ ] Halifax Community
[ ] Agencies
[ ] Businesses, Industries, Professions
[ ] Health care settings, nursing homes, correctional facilities, etc.
[X] Other, specify (e.g. mailing lists) _WBPANS member mailing list________

b. ***Identify who will recruit potential participants and describe the recruitment process.***
Provide a copy of any materials to be used for recruitment (e.g. posters(s), flyers, advertisement(s), letter(s), telephone and other verbal scripts).

See Appendix 3,4 and 5

5. Compensation of Participants

Will participants receive compensation (financial or otherwise) for participation? Yes [ ] No [X]
If **Yes**, provide details:
I will email the final copy of my report to WBPANS so they will have the information and make use of it. They can distribute it to members if they wish. I will also email it to the survey participants if they provided me their contact information.

6. **Feedback to Participants**
Briefly describe the plans for provision of feedback and attach a copy of the feedback letter to be used. Wherever possible, written feedback should be provided to study participants including a statement of appreciation, details about the purpose and predictions of the study, contact information for the researchers, and the ethics review and clearance statement.

Note: When available, a copy of an executive summary of the study outcomes also should be provided to participants.

Dear _______,
I would like to send you a thank you note in return for your participation in your study. If you have any concerns or comments please feel free to contact myself or my project supervisor (Dr. Deborah Buszard) or course coordinator (Dr. Tarah Wright). I sincerely appreciate your time. I have attached a copy of the transcripts that I typed up during our conversation (in case you did not receive them prior), for you to look over when you have the chance and to make sure you were not misinterpreted and are not misrepresented. I am not using any names in my final project, simply “respondent 1”, “respondent 2” etc. If you are interested in reading my final report (which hopefully will be available by April 17, 2009), please contact me and I would be more than willing to send you a copy.
Thanks again,
Anna-Sarah Eyrich

(h) 902 446 2917
aseyrich@dal.ca
1960 Oxford Street
Halifax, NS
B3H 4A2
Dr. Deborah Buszard
deborah.buszard@dal.ca
Dr. Tarah Wright:
(office) 902 494 3683
tarah.wright@dal.ca

<u>POTENTIAL BENEFITS FROM THE STUDY</u>

1. **Identify and describe any known or anticipated direct benefits to the participants from their involvement in the project**.

If this project is successful I believe the outcomes will be of use to the participants indirectly, all of who involved in the blueberry industry in some way. Interested parties could make use of the recommendations to put the industry towards becoming more energy efficient, reducing its environmental impacts, and making it more stable.

2. ***Identify and describe any known or anticipated benefits to society from this study.***

With risks to society from climate change and the inevitable decline of reserves and increased price of fossil fuel sometime the future, humans will need to wean themselves off this energy source at some point. Whatever the rationale behind the move, it makes more sense to plan this transition ahead of time and get a ‘head start’ rather than being forced to scramble and find alternatives at the last minute which could cause massive instability within global societies.

<u>POTENTIAL RISKS TO PARTICIPANTS FROM THE STUDY</u>

1. **For each procedure used in this study, provide a description of any known or anticipated risks/stressors to the participants. Consider physiological, psychological, emotional, social, economic, legal, etc. risks/stressors**

[ ] No known or anticipated risks
Explain why no risks are anticipated:
[X] Minimal risk

Description of risks: The data will be destroyed once the study is completed. It is possible that interviewees could identify problems within the industry that could jeopardize people's livelihoods or they could make recommendations that might be unpopular and could result in making enemies.
Furthermore, it is possible that the time and effort it takes for the growers to complete the survey could be stressful to the participant who might not have the information or might have other, pressing, needs that require attention.

[ ] Greater than minimal risk

Description of risks:

2. Describe the procedures or safeguards in place to protect the physical and psychological health of the participants in light of the risks/stresses identified in Question 1.

Participation in voluntary. The growers will only be contacted by me once they have completed the surveys and only if they identify that they do not mind me contacting them. After the data are compiled, the surveys will be destroyed, both the electronic and paper versions. If more than one survey is returned the data will be compiled so it is not possible to identify individual participants. If only one survey is returned then and alternative solution will have to be established because it will be difficult to ensure confidentiality.

INFORMED CONSENT PROCESS

Refer to: http://pre.ethics.gc.ca/english/policystatement/section2.cfm

1. What process will be used to inform the potential participants about the study details and to obtain their consent for participation?

[ ] Information letter with written consent form; provide a copy
[ ] Information letter with verbal consent; provide a copy
[ ] Information/cover letter; provide a copy
[X] Other (specify) __The survey was emailed out twice and only growers willing to participate responded, they had the option to indicate if I had permission to contact them further in future. If I call people and ask for an interview and they decline, they have not participated. If they agree to talk I will transcribe the notes and send them back to the participant to gain their approval and ensure I have not made mistakes, before using the information in the report.

2. If written consent cannot be obtained from the potential participants, provide a justification.

I assume if people participate they have consented and if they do not want to participate they do not have to. I am an undergraduate student and there is no pressure for them to participate in this research because they are not risking anything if they do not.

ANONYMITY OF PARTICIPANTS AND CONFIDENTIALITY OF DATA

1. Explain the procedures to be used to ensure anonymity of participants and confidentiality of data both during the research and in the release of the findings.

I was never given the growers' contact information. Only if the growers reply do I have their information. I will destroy all the surveys once I have recorded the results. If I do not get more than one questionnaire back I will not be able to use the one I DO get back because I will not be able to compile the data and make it anonymous. If multiple surveys are returned I will compile the data into averages so no one's individual information is identifiable.

2. Describe the procedures for securing written records, questionnaires, video/audio tapes and electronic data, etc.

The phone conversations will be on my private phone, nothing will be taped. Notes will be taken and then transcribed and emailed back to the participant for approval. The surveys are emailed to my inbox and I am the sole person with the password or they are sent to my house by mail. All the files and information will be destroyed at the end of April, documents will be shredded and thrown away and electronic files deleted from all computers and storage devices.

3. Indicate how long the data will be securely stored, the storage location, and the method to be used for final disposition of the data.

[X] Paper Records
- [] Confidential shredding at the END OFAPRIL 2009
- [ ] Data will be retained indefinitely in a secure location
- [ ] Data will be retained until completion of specific course.
- [ ] Audio/Video Recordings
- [ ] Erasing of audio/video tapes after ______ years
- [ ] Data will be retained indefinitely in a secure location
- [ ] Data will be retained until completion of specific course.
- [X] Electronic Data
- [X] Erasing of electronic data AT THE END OF APRIL 2009
- [ ] Data will be retained indefinitely in a secure location
- [ ] Data will be retained until completion of specific course.
- [ ] Other

____

(Provide details on type, retention period and final disposition, if applicable)

Specify storage location: ____

ATTACHMENTS

(* these are attached as appendices in this final report)

Please **check** below all appendices that are attached as part of your application package:

[X] **Recruitment Materials**: A copy of any poster(s), flyer(s), advertisement(s), letter(s), telephone or other verbal script(s) used to recruit/gain access to participants.

[ ] **Information Letter and Consent Form(s)**. Used in studies involving interaction with participants (e.g. interviews, testing, etc.)

[X] **Information/Cover Letter(s)**. Used in studies involving surveys or questionnaires.

[ ] Parent Information Letter and Permission Form for studies involving minors.

[X] **Materials**: A copy of all survey(s), questionnaire(s), interview questions, interview themes/sample questions for open-ended interviews, focus group questions, or any standardized tests used to collect data.

SIGNATURES OF RESEARCHERS

____ Signature of Student Investigator(s)	____________________________ Date

FOR ENVIRONMENTAL PROGRAMMES USE ONLY:

Ethics proposal been checked for eligibility according to the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans

____

Signature Date

c. Appendix 3: Energy analysis: letter of project explanation

To Whom this May Concern,

My name is Anna-Sarah Eyrich. I am from Tatamagouche, Nova Scotia, and currently a fourth year student at Dalhousie University, doing an Honours program in Environmental Science with Dr. Deborah Buszard as my advisor. For my Honours project, I am conducting a survey on the energy inputs (oil, diesel, propane, electricity, etc) associated with Nova Scotia's Blueberry Industry. The purpose of this study is to identify areas of high energy use in the industry, from production on the farms to the processing and transportation. As you know far better than I, higher energy inputs also correspond typically with higher costs.

If you would be interested in taking a few minutes to participate in this research I would be most grateful. The questionnaire is attached and can be filled out online and returned by email or by regular mail - ideally before the end of February, as the results are due in March.

There are two surveys available. One can be printed off and filled in and mailed back (Blueberry Survey Print Version) and one can be filled out on the computer and emailed back as an attachment (Blueberry Survey Online Version). I can also post a hard-copy of the survey if you would prefer that, just let me know.

All of the information I receive will be kept confidential. The results will be compiled and analyzed anonymously. If you have any comments, questions, suggestions or concerns, please do not hesitate to contact me, by email, telephone or mail (my contacts are below). Though I spent my childhood summers picking blueberries casually around Tatamagouche and spent part of one summer cleaning blueberries, I realize I am a novice and any feedback is greatly appreciated!

I hope the results from this research will be useful to you. I will be happy to share the results of this research and my final report with anyone who is interested. I will try to give a copy to WBPANS.

Sincerely,

Anna-Sarah Eyrich

d. Appendix 4: Energy analysis survey (print version)

*<u>Please note</u>: **All the information given in this survey will remain confidential**. The data will be pooled before analysed. The **surveys will all be destroyed when this project is completed**. This study is trying to identify where energy savings can be made to reduce costs and to improve the overall environment. The results from this study will be made available in the future for anyone interested.*

Print out and fill in your answers. Please remember to indicate **units**! If possible, reflect on 2008; if it was atypical, please use average inputs. Leave blank if information is not available.

1. **<u>General</u>**
   1.1. Total harvest in 2008 (or representative year): __________ lbs
   1.2. Total area in production: ____________acres
      1.2.1. How many acres were harvested in 2008 (or representative year):_______________acres
   1.3. How long has your farm been in production: _____________years
2. **<u>Machinery</u>**
   2.1. Approximately how much fuel/energy did you burn for all operations? (Please use units most convenient to you, but indicate which ones: i.e. gallons, litres, KWh, Lbs) and what activities were these associated with:
      2.1.1. Diesel _________(Unit)____Pruning/mowing☐ Harvesting ☐ Transportation☐ Other: _________
      2.1.2. Gasoline________(Unit)____ Pruning/mowing☐ Harvesting ☐ Transportation☐ Other: ________
      2.1.3. Electricity _______(Unit)____Pruning/mowing☐ Harvesting ☐ Transportation☐ Other: ________
      2.1.4. Propane ________(Unit)____ Pruning/mowing☐ Harvesting ☐ Transportation☐ Other: ________
      2.1.5. Other__________(Unit)____ Pruning/mowing☐ Harvesting ☐ Transportation☐ Other: ________
   2.2. If you don't know any of the above, please indicated the activity and length of operation: ____
3. **<u>Nutrients /fertilizer inputs</u>**: Did you apply any chemical or natural soil enhancers? ☐Yes ☐No

3.1. If yes, in 2008, or a typical year, what did you apply and how much TOTAL of each (lbs or kg, please circle):

Type________________ Type________________

Amount_________(Kg/lbs) Amount_________(Kg/lbs)

Type________________ Type________________

Amount_________(Kg/lbs) Amount_________(Kg/lbs)

Type________________ Type________________

Amount_________(Kg/lbs) Amount_________(Kg/lbs)

4. **Weed, pest, fungus control**: Did you apply anything to control these? ☐Yes ☐No

4.1. If yes, what do you apply and how much TOTAL of each in 2008 or typical year:

Type________________

Amount_________(Kg/lbs)

Type________________

Amount_________(Kg/lbs)

Type________________

Amount_________(Kg/lbs)

Type________________

Amount_________(Kg/lbs)

Type________________

Amount_________(Kg/lbs)

Type________________

Amount_________(Kg/lbs)

5. **Transportation/Processing**

5.1. How far to transport to point of major processing: ___________________________

5.1.1. Type of vehicle: ☐large 18-wheel truck ☐smaller truck ☐ pick-up truck ☐ van ☐ tractor ☐ other:____________________________________

5.2. Do you process your own berries? ☐Yes ☐No

5.2.1. If *yes*, what is(are) the final product(s):____

5.2.2. If *no*, do you know what happens to your berries? ☐Yes ☐No

5.2.2.1. What is the final product?

____

6. Do you give me, Anna-Sarah Eyrich, permission to contact you in case clarification is needed? ☐Yes ☐No

6.1. If yes, preferred method of contact and address:

____

7. Are there any processes/activities that use a lot of energy that have not been included in this survey?

7.1. If *yes*, what are they?

____

7.2. Do you know approximately how much fuel/energy this represents (any units convenient to you):

____

Thank you, I really appreciate your time and effort in completing this survey. If you have any questions, comments, concerns, or suggestions, please do not hesitate to contact me. I can be reached by email (aseyrich@dal.ca), by phone (902-446-2917), or by regular mail at the address below.

Once again, thank you very much.

Anna-Sarah Eyrich
1960 Oxford Street
Halifax, Nova Scotia
B3h 4A2
Tel: 902-446-2917
Email: aseyrich@dal.ca

Please use the space below to add any additional comments or to note any concerns.