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Candidate session number			
Candidate name			
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Examination session (May or November)	MAY	Year	2013

Diploma Programme subject in which this extended essay is registered: ENVIRONMENTAL SYSTEMS AND SOCIETIES
(For an extended essay in the area of languages, state the language and whether it is group 1 or group 2.)

Title of the extended essay: TO WHAT EXTENT DOES POTATO MONOCULTURE ON PRINCE EDWARD ISLAND AFFECT BOTH THE LOCAL ENVIRONMENT AND ECONOMY?

Candidate's declaration

This declaration must be signed by the candidate; otherwise a grade may not be issued.

The extended essay I am submitting is my own work (apart from guidance allowed by the International Baccalaureate).

I have acknowledged each use of the words, graphics or ideas of another person, whether written, oral or visual.

I am aware that the word limit for all extended essays is 4000 words and that examiners are not required to read beyond this limit.

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Supervisor's report and declaration

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Name of supervisor (CAPITAL letters)

Please comment, as appropriate, on the candidate's performance, the context in which the candidate undertook the research for the extended essay, any difficulties encountered and how these were overcome (see page 13 of the extended essay guide). The concluding interview (viva voce) may provide useful information. These comments can help the examiner award a level for criterion K (holistic judgment). Do not comment on any adverse personal circumstances that may have affected the candidate. If the amount of time spent with the candidate was zero, you must explain this, in particular how it was then possible to authenticate the essay as the candidate's own work. You may attach an additional sheet if there is insufficient space here.

began with a very broad research question centered around agriculture and fast food. Due to our local dependence on the growth and distribution of potatoes he narrowed his scope to our Island. From the outset it was apparent that he struggled with the organization of his ideas and arguments. He did not spend an adequate amount of time on the research and writing of this essay. There was very little opportunity for the two of us to discuss direction, research and organization.

During the viva voce he was asked what he would do differently and he struggled for an answer. Although he was cautioned to choose a topic from within our school's areas of teaching, I must applaud his courage of conviction to choose a subject he displayed a genuine interest in.

This declaration must be signed by the supervisor; otherwise a grade may not be issued.

I have read the final version of the extended essay that will be submitted to the examiner.

To the best of my knowledge, the extended essay is the authentic work of the candidate.

I spent 2 ½ hours with the candidate discussing the progress of the extended essay.

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Assessment form (for examiner use only)

Criteria	Achievement level					
	Examiner 1	maximum	Examiner 2	maximum	Examiner 3	
A research question	1	2		2		
B introduction	1	2		2		
C investigation	2	4		4		
D knowledge and understanding	2	4		4		
E reasoned argument	2	4		4		
F analysis and evaluation	2	4		4		
G use of subject language	3	4		4		
H conclusion	1	2		2		
I formal presentation	3	4		4		
J abstract	1	2		2		
K holistic judgment	2	4		4		
Total out of 36	20					

Research Topic: An investigation of potato monoculture on Prince Edward Island (PEI) and its effect on the local economy

Research Question: To what extent does potato monoculture on Prince Edward Island effect both the local environment and economy?

Subject Area: Environmental Systems and Societies

Candidate Name:

Candidate Number:

Word Count: 3802

Abstract

The reliance on frozen foods in today's society has led to a decreased biodiversity in potato fields on Prince Edward Island. The most common use of potatoes is in the form of frozen products, such as French fries, which is in high demand. Since frozen potato products are produced from a few specific species of potato, to what extent does potato monoculture on Prince Edward Island effect both the local environment and economy?

To answer and support this, data and evidence about the practices of potato industry on PEI was referenced. As well, the direct effects on environmental aspects, such as river contamination due to pesticides were mentioned. Some specific examples of the increased use of pesticides on PEI farms were referenced, as well as a few direct consequences of the increased presence of pesticides. As well, the importance of the practice of monoculture was noted, most importantly the entire economic impact of the potato industry in relation to the entire province's GDP.

While it was found that there have been documented negative impacts of the practice of monoculture on Prince Edward Island, the overall importance of the practice outweighs the effects on the environment.

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Introduction

In Canada, the necessity of preparing home cooked meals from scratch is being replaced by the popularity of a meal prepared in under 15 minutes. Quicker meals are accessed via fast food restaurant or made using pre-packaged foods that can be heated quickly at home. Consumers indicate that their eating choices are largely dictated by convenience, rather than by price or nutrition. Frozen foods are a staple of the convenience food category, and French fries are one of the top five foods found in home freezers. (Consumer Corner- Eating Patterns in Canada). Their popularity of convenience foods can be observed by the amount of advertisement in our media as well by the number of fast food establishments. It is evident that the fast food industry has a significant role in today's culture.

Not only is the fast food restaurant industry becoming more prominent in today's culture, it is also one of the most profitable industries in Canada. Between 1961 and 1986, the number of fast food establishments in North America has increased by fifty percent. In this time period, the economic impact in sales has increased from \$797 million annually to over \$12 billion. "People are spending almost five times more of their money in restaurants than they did a generation ago" (Reiter 47-48). But with the increase in demand comes the evident increase in supply needed. This essay will focus on how potato growers produce their potatoes in the interest of an increased yield designed to meet society's current demands for the product, as well as the economic and environmental effects of the agricultural practices used to meet these demands. The hypothesis is that there is a small variety of potatoes grown on PEI in order to take advantage of the high demand for frozen potato products to suit the desire for convenient food sources for today's consumer. This is done despite any negative impact on the environment that may occur due to this agricultural approach.

Monoculture – the growing method used to meet demand

The main practice used to yield more of a certain species of potato is called monoculture. A monoculture is defined as an agricultural environment in which only a single species of a type of plant are grown within an open system, There are known pros and cons to

the practice of monoculture, and reasons why the cons might be overlooked in the Prince Edward Island potato industry. Prince Edward Island is known for its potatoes, and is in fact, Canada's largest producer of potatoes. But how is such a small island capable of producing such a great amount of potatoes? The answer is monoculture of a specific species of potato, predominantly used for the production of French fries.

The Potato Industry, French Fries and the PEI Economy

The fast food industry and other convenient food sources have become a huge part of modern society. Between the years 1960 and 1976, the consumption of frozen potatoes at home and in restaurants has increased from 6.6 pounds to 36.8 pounds a year per person in Canada (Jackle and Sculle 22), and that trend has been continuing to this date. Because of the increase in demand for frozen potatoes, the entire industry of potato agriculture has been becoming more and more profitable, and this has greatly benefited the farmers on PEI.

Of the multiple potato companies on the island, Cavendish Farms is one of the largest and most successful potato growing and distributing companies on Prince Edward Island. They have processing plants on P.E.I. and use potatoes that they grow in specifically designated fields of those farmers who are under contract. In fact, Prince Edward Island is Canada's leading potato province, responsible for around one-third of Canadian production (CavendishFarms.com). The potatoes that are grown on PEI are not all meant to be used the same way, but for three specific markets: seed, table potatoes, and processing. Seed potatoes are sold to commercial potato growers and home gardeners to produce next year's crop; table potatoes are produced for the retail and food service sectors; and processing potatoes are manufactured into French fries, potato chips, and other processed potato products (CavendishFarms.com). The potatoes that are grown in PEI are used in many different types of recipes and cooked in many different ways, including pan frying, mashing, roasting and baking. Despite all of the unique ways a potato can be cooked and preserved, by far the most common and popular way to eat potatoes is in the form of French fries. In fact, more than sixty percent of potatoes grown on PEI are used by the processing industry, including companies like Cavendish Farms and McCain Fries. The majority of the potatoes are processed into frozen

potato products, which are exported all across Canada and to around 30 countries around the world (CavendishFarms.com).

The Prince Edward Island potato is the province's number one cash crop. The economic impact of this agricultural industry for the island is significant. A rough estimate of the total economic impact was quantified in the year 2012 in a study which revealed that the total worth of potatoes is around 10.8 percent, more than \$1 billion of PEI's total yearly economic output. The entire sector of potato growing and selling creates over \$245 million in household income and consists of about 12.1 percent of the total provincial employment (about 8,283 full-time jobs annually), both directly and through spinoff effects, such as the advertisement sector. (MacDonald). Since the industry is such an important component of the province's entire economy, how much focus goes into the environmental impacts of the production process?

The potato industry, French fries and the environment

The Process of Potato Production

Currently, there is one species of potato that is considered to be the perfect potato for French fries, called the Russet Burbank. But what makes the Russet Burbank the preferred potato species for fries? The appeal of the Russet Burbank by fast food companies lies in its qualities (Pollan), which include its density, color and its texture after deep frying. Over a span of decades, potato farmers who supply French fry companies around the world have relied on this single species of potato, creating a monoculture in their fields.

The successful monoculture in the potato industry on PEI has been accomplished through the replication of ideal potato seeds, through a process known as the Elite Seed program, first introduced in the 1980s. The Elite Seed is an advancement in crop seeds, which enables growers to recreate, or clone, one specific species of seed which has genetic traits that are ideal for its use. For example, an apple Elite Seed would likely yield an apple that has firm skin, a sweet taste and is a decent size to suit the consumer. In the P.E.I. potato industry, not only does the Elite Seed program ensure the replication on a large scale of enough potatoes to meet the high demand, it also ensures the basis for the multiplication of disease resistant

quality potatoes across the province (Driscoll 237). To this day it is the main practice among island potato growers. It is valued among farmers for other reasons, including low cost insurance coverage (economically beneficial), and the provision of a clean, low virus seed potato (Driscoll 238). As a result of the Elite Seed program, PEI potato growers have been able to continue the growth of potatoes that yield a valuable crop, but at the price of biodiversity in their fields. Since the increase in potatoes that can be successfully harvested, the industry as a whole on the island has prospered greatly. In fact, as of 1986, there was approximately 70,000 acres of land and 650 farm units on PEI (Driscoll 1). But, while there are many good reasons as to why monoculture is practiced, there are some negative impacts that a lack of biodiversity can have in both nature and human society.

Environmental Impact - The Pros and Cons of Monoculture

The effects of monoculture in today's agricultural practices have had a drastic effect on the biodiversity present today. Biodiversity "is a term used to describe the variety of life on Earth. It refers to the wide variety of ecosystems and living organisms: animals, plants, their habitats and their genes" (IUCN). There are many factors that rely on healthy ecosystems, such as oxygen, food, fresh water, fertile soil, protection from storms and floods and stable climate. While obviously not as diverse as the Amazon rain forest, PEI has had moderate species displacement due to loss of habitat. In relation to the 1.4 million acres of land on PEI, approximately 594,000 have been cleared for agricultural use as of 2009 (Agriculture on Prince Edward Island). In order to create the vast amount of farm land, areas such as forests and wetlands were destroyed. The animals that rely on the wooded and wetland areas are forced into a smaller habitat area and must therefore have greater competition for the food and shelter available to them, leading to the loss of species.

In PEI's past, we had a more diverse agricultural landscape. For example, there were more apple growers, more diverse crops in fields. With the potato industry being profitable, many farmers have given up fields used for other crops in favor of the potato. It is not uncommon to see the red island soil running off of fields in heavy rains in the spring, for example, or for the snow surrounding fields to be red with topsoil. While this isn't a potato

field problem, the greater acreages that are now open with less protection has created a greater loss of valuable topsoil.

Another consequence of monoculture is the increased requirement of insecticides and pesticides in order to protect the crop against pests. While the use of the Elite Seeds on PEI farms has provided a seed potato designed to be resistant to specific types of viruses and fungi, no potato is immune to all disease. When a narrow range of species are grown in an area, they all share very similar genetic coding. The use of Elite Seeds almost guarantees that the crop will have identical genes. While this ensures a crop that is consistent in firmness, color and size, the danger is that these plants are all at risk of being killed by a single fungus. An example is the potato wart disease, caused by a microscopic soil-borne fungus (Hampson). The potato wart is contracted by a potato through the absorption of water in the soil, which then enters the plant and disrupts the process of photosynthesis. Once introduced to a field where there is a narrow range of potato species, the potato wart is capable of destroying a large percentage of the crop. In 1991, it was estimated that in the US, the cost of pesticides and insecticides for crop protection exceeded well over \$4 billion annually (Pimentel et al., 1991). Although financial pesticide expenditures on PEI were not available, it is known that between 1993 and 2007, agricultural pesticide use had grown by 571 percent (Labchuk). The cost of growing a select few species of crop comes from an increased risk of an unexpected disease wiping out a majority of the crop.

Disease that can wipe out a non-diverse field would have a major economic impact to food distributing industries because of the loss of valuable crop, as well as a major impact on the people who are dependent on the food industry. If an unsuccessful crop occurs, those who are economically dependent on the profits will suffer severe losses. The environmental impact is the potential for this disease to spread to other fields which, without a large variety of plants, are equally susceptible. On PEI, there have been many cases of disease spreading among potato fields, such as during October of 2000, when potato wart was discovered in a single field on the island. While potato wart fungus proves no threat to humans through consumption, the fungus makes potatoes unmarketable, due to rotting. Action was taken to prevent the spread of the fungus, including the closing of the U.S. border to PEI potatoes. As a result of the halt of

all PEI potatoes to the United States, the impact on the local economy was devastating (MacPhee).

There are many other types of threats to potato crops besides potato wart, such as pests. An example of a pest to potato plants is the Colorado potato beetle, which is combatted by farmers with pesticides. While initially the pesticides are highly effective in killing the potato beetles, the rate of effectiveness goes down over time. The reason can be explained through the process of reproduction of the potato beetles. Initially, farmers will spray their fields with pesticides in order to control the amount of crop destroyed by pests, which is done in order to make more money. The first population of Colorado potato beetles that feed on the plants sprayed by these toxins will suffer a great percentage of fatalities. This is because there are very few beetles that have immunity against the toxin, while the majority of them are susceptible. However, when the potato beetles that are immune reproduce with each other, the genes that grant them immunity from the pesticide are passed on to the offspring, creating a new generation of Colorado potato beetles that are immune to the specific pesticide used in an environment. Therefore, although the farmers may decide to increase the use of pesticides, which would cost them more money, there will be little to no effect on the potato beetle population because of their newly gained genetic resistance. The significance of the pesticide resistance of the Colorado potato beetles is that even though the effectiveness of the pesticides gradually becomes less, the use of high amounts of pesticides continues, which can have unintended, yet devastating side effects.

Large Scale Farming and the impact on the water systems of PEI

Given the practice of monoculture with potatoes on PEI we have a double edged environmental sword. The use of pesticides has, as mentioned earlier, increased greatly. In addition, the increased acreage of potato fields has lead to problems with run-off, and in particular, pesticide run-off into our stream system. In the summer of 2007, over the course of only a month, it was documented that nine rivers were infected with agricultural pesticides. The result was the death of thousands of fish, snakes, frogs and other aquatic life. The source

of the toxins that caused the death of wildlife was pesticides from multiple potato farms across the island. As a direct result of the increased use of pesticides, there was a significant negative impact on the local environment. These types of fish kills, due to the runoff of pesticides from farms bordering bodies of water are occurring almost on a yearly basis, and continuing their damaging effects on the environment.

Is it all bad?

Despite the negative effects of monoculture, it is important to remember the role that monoculture plays in today's society. The reliance on a select few species of crop in order to sustain larger numbers of people allowed for major developments in our world. The Industrial Revolution, which began in the late 1700s, marked the beginning of agriculture on a much larger scale than in the past. The creation of the food distribution industry created many new jobs for people. On PEI, the potato industry provides financial success for farm suppliers, financial institution, marketers, transporters and many others (Driscoll 76). In the table below, the total production of potatoes in four regions in centum weight (CWT) shows how far ahead PEI is in comparison to regions on the east coast of North America.

“Table 1. Changes in Potato production and prices from 2000 to 2002.

Region	Production (1,000 CWT)			% Change	
	2000	2001	2002	2000/2001	2001/2002
Year					
Maine	17,920	16,430	16,960	-8.31%	3.23%
Prince Edward Island	29,160	18,404	30,100	-36.89%	63.55%
New Brunswick	14,025	14,350	15,030	2.32%	5.09%
Quebec	10,460	10,569	10,072	1.04%	-4.70

(Cheng)

Monoculture vs. Biodiversity

Over the past decade, there have been an “estimated 3,000-30,000 species extinct per year” (Allendorf 4). Although every year, species go extinct without the impact of human civilization, there are many reasons why species go extinct which are directly caused by human activity. Some include the destruction of a species’ habitat, overhunting, and the destruction of food sources. But one reason that may not be as obvious is the introduction of monoculture within our agricultural environments. Since the Neolithic Revolution between the years 10,000 BC and 5000 BC (Barker 378), human civilizations have shifted from their reliance on hunting and gathering to the practice of agriculture in order to meet their needs for food. Agriculture has seen many changes over the centuries, from the equipment and methods used to keep the crops alive to the number of crops grown within an ecosystem. For example, the introduction of monoculture within large distributors of potatoes has replaced biodiversity seen on the smaller plots of land of the past. The following crops are widely distributed around the world, but rely on a very narrow range of diversities. Only six varieties of corn represent 46 percent of the entire world’s corn crop. Nine varieties of wheat account for around half of the wheat crop worldwide and only two types of peas make up 96 percent of the world’s pea crop. As well, one variety of potato makes up more than half of the world’s potato crop, called the Russet Burbank, which is widely used by most fast food companies, including McDonalds (Merck).

With many large scale food growers turning their focus to crops of reduced biodiversity, sometimes resulting in monoculture, biodiversity in the field is becoming less and less common as large scale food distributors grow and prosper.

Social Dependence on Monoculture

Based on the evidence of negative impacts of monocultures on the environment, why do the large agricultural companies of today’s world decide to rely on the practice of monoculture instead of having a more bio diverse crop? The answer lies in the dependence that our society has grown on large amounts of a select few species of potatoes instead of a more equal balance of species. The best example of this is the use of a small number of species of potatoes which are used to make French fries, which are sold in fast food restaurants and frozen in grocery stores across the world. The fast food industry has been rapidly growing over

the years worldwide, including the United States, where by the end of 1998, sales in fast-food restaurants in the US rose to \$116 (Ritzer 8). The rise in the profits of the fast food industry has continued dramatically to this day with many franchises, including the largest fast food franchise in the world, McDonalds.

The McDonalds Company has rapidly become the single largest fast food industry in the world, "with approximately 1.8 million employees working for them and over 5,000 franchisees, thousands of committed suppliers and the more than 69 million customers who visit every single day in 119 countries" (aboutMcDonalds.com). With these stats, it is no surprise that in order for the company to sustain this great level of productivity, there is a great need for a large amount of their products, which include a lot of beef for their burgers, wheat for their buns and potatoes for their French fries. The amount of products that McDonalds purchases is a large component of the food industry as a whole, as "gross world sales for McDonald's alone were \$17.3 billion annually by 1989, more than the entire Canadian restaurant industry. In Canada in 1988, McDonald's grossed over \$1.4 billion. This one company accounted for over 30% of the market share for fast food restaurants in the country." (Reiter 48). Such a major contribution to the world economy is essential for such businesses to prosper. As well, it is believed that in the United States and Canada, no matter what McDonald's location you eat at, whether it be in New York, Los Angeles, Charlottetown or Vancouver, your meal will be very similar to that of another location across the country because of the ingredients used to make it. While the potatoes for the French fries from the same farm aren't used in two locations in different provinces or states, the taste is similar due to the same species of potato being used. Every day, McDonald's serves around 9 million pounds of their fries around the world. The key to the success of their fries, according to the company's director of sensory science, is their taste and consistency (Patton 20-22). The consistency of their 'world famous fries' is accomplished by purchasing their potatoes from monocultures.

Potato monoculture not only helps large distribution companies meet their financial needs, but Prince Edward Island, being Canada's largest distributor, is heavily reliant on the potato industry for much of its GDP. Despite PEI being the country's smallest province in terms of square kilometers, its output of potatoes is unmatched by any other province. Shown in the

table below are the outputs of potatoes by each province in comparison to the national amount in 1985.

Province	Production (million cwt.)	Percentage of Production
Newfoundland	98	.1
Prince Edward Island	19,080	31.0
Nova Scotia	861	1.4
New Brunswick	11,880	19.3
Quebec	9,039	14.7
Ontario	7,525	12.2
Manitoba	5,829	9.5
Saskatchewan	456	.7
Alberta	4,675	7.6
British Columbia	2,093	3.4
Total Canadian Production	61,536	100.0

Source: PEI Department of Agriculture, Prince Edward Island Potato Statistical Summary 1985, Table 3.

From comparing the national output of potatoes by province, it is evident that Prince Edward Island's contribution to the potato industry is an essential of its local economy, as well as a contributor to the Canadian potato industry as a whole

Despite the negative effects of monoculture, the prospect of being able to focus mainly on the few species of potatoes that are consumed in the largest quantities is much more valuable.

Conclusion

Based on the findings of this essay, there is sufficient evidence that the practice of both monoculture and un-diverse agriculture have devastating effects on the environment, but the

possibility of not having a narrowly focused food industry would not fulfill the needs of today's society. The agriculture industry of today is far from perfect, as there are many faults, which have consequences that will become a big problem for humankind, such as the dangers of monoculture and the overuse of pesticides. Nonetheless, it seems as if the progression of society and its need for fast foods and very few species of crops outweighs the need to preserve our fields with reduced pesticide use and more bio diverse crops. The social aspects of agriculture in today's world are valued above the preservation of our environment despite the real dangers of losing biodiversity.

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