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Canadian Agricultural Adaptation Program Final Report

Adapt Project # PE0355

Using Sea lettuce as an Amendment in Potato Production on PEI

Prince Edward Island ADAPT Council

PEI Soil and Crop Improvement Association

PEISCIA

Project Partners

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Start Date: May 2012

Completion Date: Dec 2013

Fresh Sea lettuce

Sea lettuce, an issue on PEI:
Sea lettuce is a macroalgae with the latin name, *Ulva lactuca.* A macroalgae obtains its nutrients directly from the water as it does not have roots like true plants. The river systems are normally low in nitrogen and phosphorous. In recent years on PEI, with the higher nutrient loading of the inland waterways, sea lettuce has become a major problem in most river systems. Sea lettuce grows rapidly as the river warms in June, completes it life cycle in the early summer, dies and settles to the bottom where it decomposes. During the summer on PEI many rivers are experiencing anoxic events which are having significant impacts on the inland waterways. The water is warm, has less soluble oxygen and the decomposition of the mature lettuce removes the remaining oxygen from the water which causes an anoxic event or dead zone in the river. The area where the anoxic event occurred will have a foul odour for weeks, the water will often turn white and fish will die due to the lack of oxygen. Such events can happen more than once in a river system during the year. Besides causing anoxic events, the dying lettuce will ruin the river for shell-fishing, recreational activities and add to the overall nutrient loading of the river as it ties up nutrients preventing them from flowing to the sea. The dead rotting lettuce sinks to the river bottom throughout the late summer and fall smothering shellfish especially oysters and turning the traditional sandy river bottom into a gooey, black mess of decaying material. It is

during the summer period when the rivers are busy that the odour from the rotting lettuce reaches its peak. The odour was such an issue for the town of Summerside that they now have a program to gather up the lettuce that is left on the shore by the tides 2 to 3 times a week and have it trucked to a farm where it is spread on the land.

Various seaweeds including macroalgae have been a traditional source of fertility for those farming close to the sea for generations. There were many places where seaweed such as kelp, rockweed, Irish moss along with lobster and fish were commonly used as a fertility source for the local farming community. Compared to Irish Moss, Kelp or Rockweed it is different than these as it is not storm tossed, contains more water (95% vs 80%) and is found mainly in the river systems not the ocean. It grows in the inland waterways and as such can often be found in the tidal zones of most rivers on PEI during the summer. Sea lettuce moves with the river waters and can be quite elusive throughout the summer. These characteristics make it hard to gather and remove from the river systems. Sea lettuce continues to be a larger problem each year on PEI. In 2011 the Dept. of Environment staff estimated there could be as much as 36,000 metric tonnes of sea lettuce (dry matter) available each year on PEI.

Harvesting Sea lettuce:
In 2011, a PEI business purchased a sea lettuce harvester and conducted a trial harvest in Covehead Bay and Mill River during late June and July. This was done in conjunction with the PEI Shellfish Assoc. and the provincial Dept. of Environment. There was a small amount of material harvested in Covehead and a significant amount of material removed from the Mill River. A load of fresh lettuce was accepted at the Agriculture and Agri-Food Canada's Research Farm in Harrington and composted by staff during the summer. The material harvested from Mill River went to a commercial composter and a potato grower, Jeff Smallman of Oleary. He was unfamiliar with the material, and since he had no experience with composting he stockpiled the lettuce in a sod field.

The harvester is designed to cut off the growing lettuce in the river, collect it and take it to the shore. The harvester only works when the lettuce is growing vertically near the water surface during the month of June and early July. The timing of the lettuce harvest is one of the issues with the lettuce harvester. By mid – June and July on PEI there is limited available arable ground as all seeding has been completed and as such there are few opportunities for direct land application. Direct application is always the most cost effective method to use organic waste but if it is not an option then the material has to be composted or stockpiled. Stockpiling the waste can create run-off and odour issues. Depending on when and how it was harvested, the sea lettuce can be equal if not higher in nitrogen compared with animal manure and thus has a real potential to create both run-off and odour if significant care is not taken when it is stockpiled. This material can be successfully stockpiled in a sod field provided the material is placed a distance from a residence and waterway. It can be put in a manure pit as well. An ideal option for fresh harvested lettuce is to compost the lettuce with straw and then apply the compost later.

Composting work with Sea lettuce:
Composting trials were conducted by Agriculture and Agri-Food Canada and Oceanside Seaweeds a commercial composter. Sea lettuce composts quickly, does have significant potential for odour during the initial 2 weeks of the composting process and will require some dry type of carbon source as the lettuce is wet. It does produce an excellent final product. The

compost trials at Harrington Farm used straw for the carbon source. The mixes were put together, allowed to heat up and then turned 3-4 times over a 2 month period. The material was then stockpiled and allowed to cure and used the following season or hauled to the cooperating farmer and applied to the demonstration plots.

Need for the study:
As the possibility existed that a significant amount of lettuce could be harvested in the future and the material, if not used properly, could cause odour issues and possible leachate concerns, the PEI Soil and Crop Improvement Association with funding from the ADAPT Council conducted a 2 year study to evaluate the best ways to handle the material raw, composting options and compared it to beef manure in an on-farm fertility trial. Should significant amounts of material be harvested there would be people on PEI with an understanding of the best ways to handle it and use it in an agricultural setting.

Project design and implementation:
It was decided to test the various amendments on a potato crop. If it worked in the potato rotation there would be greater land available for direct application and it is important to know if potential problems exist when used on potatoes. Jeff Smallman of Oleary expressed interest in trying the product on his crop, given he has a cottage on Mill Riiver he is well aware of the issues in the estuaries. Jeff and Jason Smallman are contract growers for Frito-Lay. A trial area was selected in one of their fields. In the spring of 2012, the plots were set up in a conventionally treated potato field under a 3 year rotation (potatoes, grain, and hay) that has been in such a rotation for 10 years or more. The cooperating producer maintained the plots as part of his normal potato production practices. Project staff oversaw the application of the amendments prior to potato planting; monitored the crop during the growing season, measured yield and quality of the potatoes under each management system. The various fertility treatments compared were:

1 – control (no amendment applied), conventional production practices only
2 – fall applied sea lettuce + conventional production practices
3 – fall applied sea lettuce compost + conventional production practices
4 – fall applied beef manure + conventional production practices

The beef manure though it is not a check/control, is a common amendment in potato production and is generally recognized as a beneficial amendment especially in dry years. The addition of the manure in the experiment allowed one to accurately compare the various sea lettuce treatments to a common organic amendment used by the industry. The beef manure was applied at a rate of 2 tandem loads/acre (approx. 24 tons/acre) which is an accepted rate currently used in the potato industry. The raw sea lettuce and sea lettuce compost applications were adjusted for moisture and applied at a similar amount of material per acre. The control plot which did not receive any organic amendment would serve as a check on the yield that could be expected without any amendment. A 40 ft strip of potato row in each treatment was dug to determine the various treatment yields. In addition to total and marketable yield, the samples were rated for common scab, rhizictonia, silver scurf and tubers greater than 3 inches were cut to determine hollow heart.

The 2012 growing season on PEI was very dry. We experienced a 30 year drought event that summer as there was no rain in the Oleary area from July 15 to August 20th. This put the potato plants in severe stress for much of August. There were visual differences between the different treatments by August 15th with the treatments receiving the various organic amendments displaying larger more vigorous plants with more overall top growth. The best treatments did achieve row closure of the potato vines in the field prior to harvest but the check plots did not reach row closure. When the rain did come the control plots had died down that it was unable to come back.

Results in 2012:
All treatments receiving an organic fertility had a higher yield of marketable potatoes when compared to the control (see Table 1 and Graph 1). The differences between treatments were quite large for potato research. Given there were only 2 replications of each treatment a difference greater than 50 cwt/ac is required to achieve statistical significance. Potato yield were significantly higher where manure and raw sea lettuce had been applied compared to the control; sea lettuce compost being intermediate. There were no issues with tuber diseases or hollow heart in any of the treatments.

Table1. Total and marketable yield as influenced by the various organic amendments in 2012.

	2012 Yield Cwt/ac	
	Total Wt	**Pay Wt**
Control	**225 A**	**215 A**
Compost	**275 AB**	**265 AB**
Sea lettuce	**298 B**	**289 B**
Manure	**321 B**	**312 B**

Means followed by the same letter are not statistically different at P<0.05.

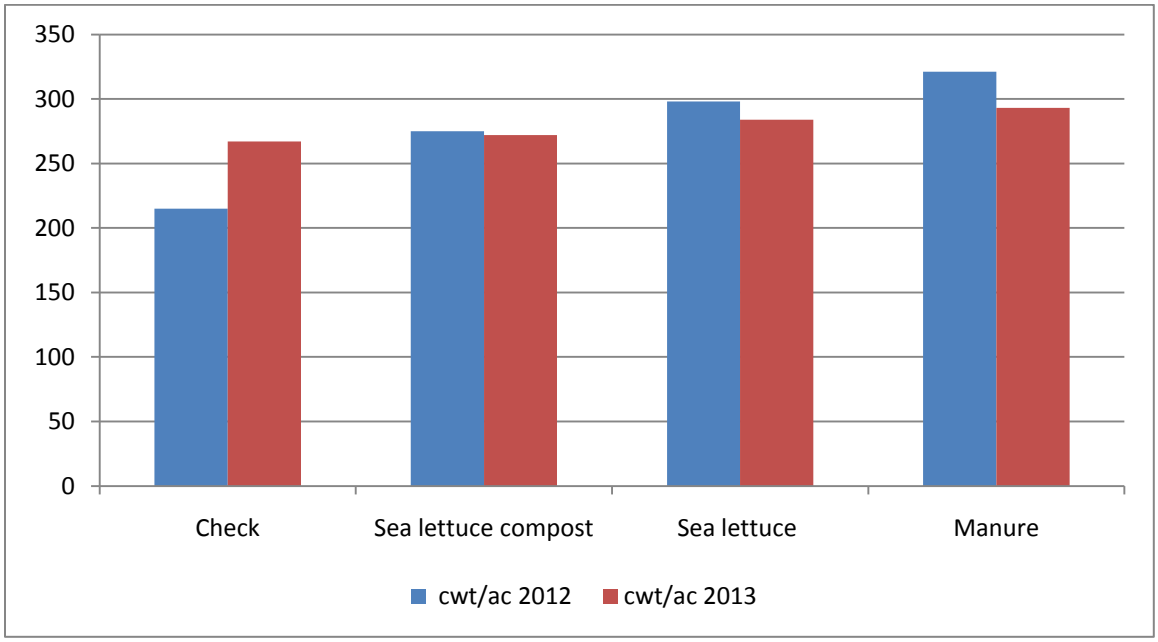
Results in 2013:
The field Jeff provided in the 2013 year had been in the 3 year potato rotation for 3 cycles. The plots were marked out and the amendments were applied the same as the preceding year. This field had a history of periodic manure application and was an overall more productive field than the one used in 2012. The 2013 season was a near perfect growing season for potatoes in the Oleary area, there were no extremes of disease or weather that would stress the growing crop and reduce yields such as was experienced in 2012. The yields of the various treatments in 2013 were not statistically different from each other as well the overall differences from the highest yield to the lowest was less. However it should be noted that the order for the treatments was similar to 2012 and there were more marketable tubers from the raw sea lettuce and the beef manure treatments compared with the control.

Table 2:
Total and marketable yield as influenced by the various organic amendments in 2013.

	2013 Yield Cwt/ac	
	Total Wt	**Pay Wt**
Control	**296 A**	267 A
Compost	**295 A**	272 A
Sealettuce	**307 A**	284 A
Manure	**314 A**	**293 A**

Means followed by the same letter are not statistically different at P<0.05.

Bar Graph Comparing the Yields for Each Treatment over the 2 Years



Reduced Fertilizer Trial: The sea lettuce growth in the island estuaries is related to the amount of free nutrients in the various river systems. If we reduced the amount of nutrients in the rivers we would impact the sea lettuce growth. One of the best ways to reduce the amount of sea lettuce in the estuaries is to reduce the amount of nutrients leaching into the groundwater which feed the springs and the rivers. Previous surveys of island wells have shown a high correlation between nitrates in the groundwater and the amount of potatoes grown in the area. As a result of this

information the project partners were interested to determine if the current rate of fertilizer used on the Smallman farm could be reduced and still achieve the same yield.

The Smallman farm has been growing chip-stock potatoes for 14 years. Initially they used 1300 lbs /acre of a 13-20-20 fertilizer. They have slowly reduced the amount of fertilizer applied to 1100 lbs /ac of a 13-18-18 mix on their average fields and 1000 lbs of the same mix on their better fields.

A trial was established to compare a reduced fertilizer rate to the current level of fertility used on the Smallman potato crop. Given the field chosen for the study was a better field in Jeff's opinion the rate of 1000 lbs/ acre was chosen. A simple way to reduce fertilizer amount, in farm scale trials, is to reduce the concentration of fertilizer in the mix and not change the application rate. This way one uses the same spreader setting and tractor speed on each test area so that both areas received the same amount of fertilizer since one had fewer nutrients per tonne so there was less total fertility applied to one test area. The trial compared a traditional potato fertilizer mix, of 10-10-10 to the 13-18-18 farm standard mix. Changing the mix would mean a reduction of 30 lbs of N, 34 lbs of phosphorous (80 lbs of P_2O_5) and 66 lbs of potassium (80 lbs of K_20) per acre. This amounted to a saving of $90 per acre in fertilizer cost using the 10-10-10 fertilizer.

The lower nutrient fertilizer did not negatively affect yield. The reduced fertilizer plot had a similar marketable yield with fewer hollow heart tubers compared to the 13-18-18 mix.

Reduced Fertilizer Trial 2013

- Montecellio chipstock
- Fertile land, high soil P and K levels
- Applied 1000 lbs /ac of each fertilizer

	Cost /tonne	CWT/ac #1's	% of Oversize hollow	N Lbs /acre	P &K Lbs/ac
Triple 10	$440 ($183)	283	20%	100	100
13-18-18	$623	279	35%	130	180

Final Discussion:
This work has shown that raw sea lettuce behaves similar to animal manure in many respects. It has a similar nutrient content when excess water is drained off. It can be handled successfully with farm equipment, stockpiled or composted to produce a good fertility product for PEI agriculture. As well the nutrients are quite leachable or easily lost to the air when applied to the

soil surface during the hot sunny days. Like manure, to maximize the available nutrition in the sea lettuce, care should be taken when it is stockpiled or spread.

This work showed the value of the sea lettuce when applied to average ground in what turned out to be a drought year; the raw sea lettuce increased the marketable yield of potatoes by 75 cwt per acre which was in the same ballpark as beef manure. Yield increases of this magnitude will result in $650 - $1000 more per acre of gross income at the current chipstock price. Sea lettuce whether applied raw or composted would be a good fertility and organic matter source for PEI soils.

As with many natural fertility options in agriculture there is usually a down side. The downside to using sea lettuce in agriculture is the overall process and cost to remove it from the rivers. The window for mechanical harvesting is short, about 6 weeks; it is an expensive undertaking and would involve working with the tides and winds of PEI so there is an element of unpredictability to the harvesting as well. Once the lettuce starts to sink it is not able to be mechanically harvested. There is a portion of the lettuce that washes ashore with the tides but the bulk of it will sink to the river bottom and decompose thus increasing the nutrient loading in the river and fouling up the river bottom for aquaculture.

Until recently, sea lettuce was not a major component of the macroalgae mix on PEI. However the increase in nutrient loading of the estuaries on PEI has led to exponential growth in sea lettuce on PEI. Although harvesting is a short term solution to the issue of nutrient loading in Island waterways, there potentially could be significant amount of this material harvested annually. The removal of the lettuce would make a difference in any river it was harvested as it would remove the source of the anoxic creating conditions in our waterways. The real long term fix is to reduce the nutrient loading of the estuaries which means to reduce the amount of nutrients getting into the groundwater and washing into the streams and rivers. This very preliminary work indicates there may be room to reduce the fertility on much of the acreage surrounding the rivers and thereby reduce the source of the food for the lettuce. This work has shown again the value of organic fertility in potato production as well as possibility of reducing the fertilizer application rate on some of the potato acreage. There is a need for direct work with the producers (extension) to evaluate each farm and see how the nutrients applied to the land can be better used and reduced where possible. This will be a challenging task and one many farmers will not undertake without support and guidance but it is one that would have tremendous ecological benefits and long term financial benefits for the watershed residents and business.

Should an initiative be undertaken to address sea lettuce such a group would have a greater chance of success if they:

1. Chose 1 or 2 river systems only in supportive communities.
2. Mechanically harvested during the entire harvesting window
3. Developed an extension plan to work with all farmers in the watershed with an emphasis on managing organic and chemical fertility inputs in the watershed over the long-term
4. Utilized all methods of reducing run-off and stabilizing the soil in the watershed.

Lettuce harvester approaching shore

Spreading fresh lettuce