Investment Agriculture Foundation of British Columbia

Project Report

Project Title:	**Eco-Friendly Crop rotations**	**Project #:**	**A0573**
Recipient:	**Delta Farmers' Institutes**		
Reporting Title:	**Final Report.**		
Reporting Period:	**September 23, 2008 to September 30, 2011**		

TRANSMITTAL NOTICE:

"I, Robert Butler certify that the information contained in this report is accurate and that this project is being carried out/has been carried out in compliance with the terms of the Contribution Agreement and its Schedules. If this is a Final Report, I certify that the project is complete and that a full accounting of project revenues and expenses is enclosed. I certify that I am authorized to represent and sign on behalf of the organization.

Recipient's Designated Officer: _____ Robert Butler _____

(Signature) (Printed Name) (Date)

FOR THE FINAL REPORT ONLY:

Director of the Recipient: _____ John Savage _____

(Signature) (Printed Name) (Date)

Director of the Recipient: _____ Brent Harris _____

(Signature) (Printed Name) (Date)

Executive Summary: See Next Page – Final Report

Funding provided by:

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FINAL REPORT

Eco-Friendly Crop Rotations

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Other Project Participants
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Canada
Investment Agriculture Foundation of British Columbia
BCAC BC Agriculture Council
COABC Certified Organic Associations of BC
British Columbia The Best Place on Earth
Ducks Unlimited Canada Conserving Canada's Wetlands

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Eco-Friendly Crop Rotation Project: 2008-2011

Executive Summary

The overarching goal of this report is to provide our cooperating farmers, cooperating seed producers or suppliers, supporting funders, and broader sustainable farmland and land-use stakeholders of British Columbia with the key findings from our three-year Eco-Friendly Crop Rotations Project. We relied on keen interest and timely assistance from our cooperating farmers, both on and off the fields. Our collaboration of growers' groups, researchers, and generous sponsors included the Delta Farmers' Institute, UBC Faculty of Land and Food Systems, B.C. Agriculture Council (BCAC), Investment Agriculture Foundation (IAF), and Ducks Unlimited, Canada. Furthermore, the Dekaban Foundation and Organization of Economically Developed Countries (OECD) provided funding towards two fellowships (one year in total) for visiting scholars to work on our project. We would like to thank each of you, and present you with the overview, details, and summary from our investigation that spanned the 2008-2010 calendar years.

Soil Survey Results

In December 2009, we returned soil survey fertility reports from the soil nutrient survey (see Appendix A) and the first growing season results of our variety trials to the project's cooperating growers. These grower-focused reports also included a separate, individually tailored report for each grower with fertility results and interpretations of their field's soil test.

Over-application of granular fertilizers, manures or other composted materials may adversely affect yields, cause an increase in undesirable weed species and

disease, contribute to imbalances with available soil-plant nutrients, and negatively impact surface and groundwater quality. In 2001, approximately 53% of soils used for crop production in North America showed extractable soil P levels that were deemed high or excessive (PPI 2002 cited in MacDonald & Bennett, 2009). For our region, the Fraser Valley Soil Nutrient Study of 2005 reported 80% of all fields in the study were in the high to very high environmental risk class for P (Kowalenko et al 2007, p.11). For fall residual nitrogen (N), 93% of fields exceed environmental thresholds.

Our 2009 soil survey N, P and K group test results corroborate the findings of these past soil survey results, that is:

- The majority of fields in our survey returned soil tests with high or excessive levels of P (20 out of 22 fields).
- About half (10 out of 22 fields) of our surveyed fields tested had high or excessive levels of potassium (K).
- One quarter (5 out of 20 fields) of the fields tested for fall residual nitrates returned high or excessive levels, most of which were associated with fields receiving poultry litter fertilizer.
- For most fields in our survey the available P and K appear to be at levels at which profitable crop yield responses to additional inputs are not likely.

Ecological Risk Classes for Soil Test Interpretation

Nutrient	**Spring Available N**	**Fall Available N**	**P**	**K**
Method-Unit of Measure	NO3-N (kg/ha)	NO3-N (kg/ha)	Bray P1 (mg/kg)	*NH4-Acetate (mg/kg)*
Low/Yield increase expected	**<25**	**<50**	<50	<150
Medium/Caution	**25-50**	**50-100**	50-100	150-250
High/ Excessive nutrients already present	**>50**	**>100**	>100	>250

Soil Survey N, P and K Group Test Results 2009

Samples collected during April and October 2009 for spring and fall samples

Soil N-P-K

Field #	Spring Available N kg/ha	Std Dev	Fall Residual N kg/ha	Std Dev	Bray Available P mg/kg	Std Dev	Available K mg/kg	Std Dev
1	13	3	12	3	196	26	165	4
2	15	3	8	1	194	31	221	8
3	14	3	15	2	221	28	344	19
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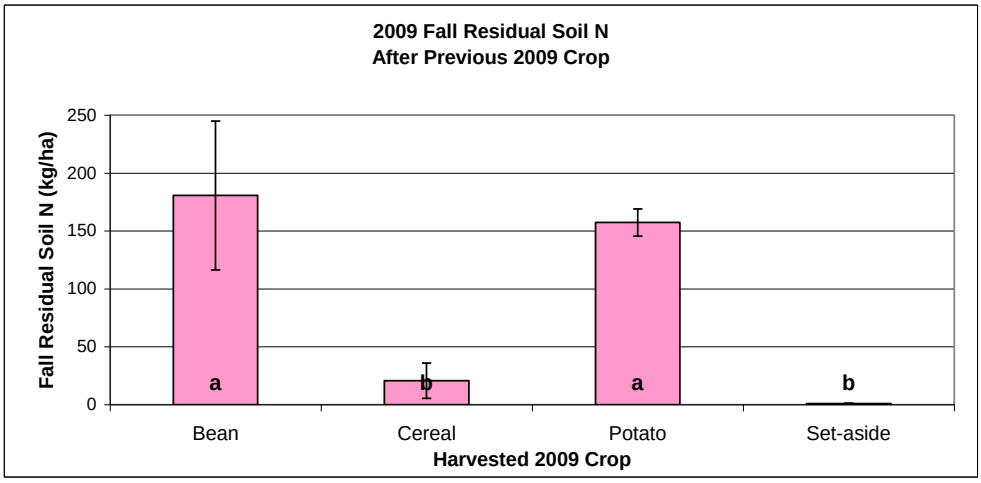
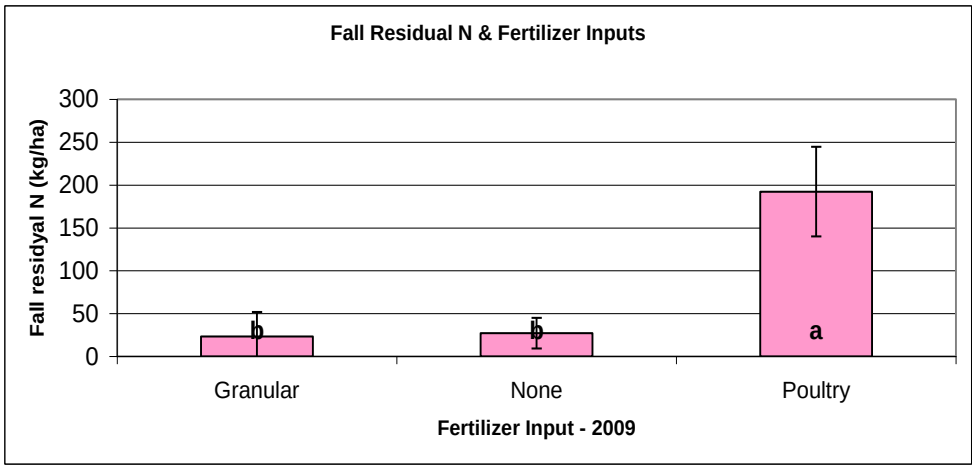
5	15	5	10	1	224	30	316	48
6	25	3	12	2	287	58	420	74
7	13	3	dns		252	30	198	46
8	40	10	216	23	213	21	218	20
9	25	10	238	36	135	17	246	45
10	25	3	44	12	150	5	221	10
11	31	6	48	16	162	10	393	35
12	20	3	157	12	195	15	336	15
13	8	2	dns		177	9	120	4
14	9	0	122	13	163	9	165	9
15	19	3	12	4	226	6	203	28
16	16	2	1	0	123	7	270	11
17	16	6	228	40	181	30	243	26
18	16	2	17	1	338	22	204	19
19	23	3	24	6	100	22	276	5
20	34	6	16	6	63	7	191	20
21	20	2	44	6	314	41	270	30
22	dns		99	9	428	55	428	45

Analysis of our field survey suggests that fall residual N levels are greatest after beans and potatoes; and are least after cereal crops and short-term grassland set-asides. Therefore, having low input cereals in the crop rotations appears to be an effective means to reduce, not only soil available P and K, but also fall soil residual N levels and leaching losses.



* After significant F-test (p<0.05) a Mean Separation (MS) was performed; means with the same letters are not significantly different

Our fall residual nutrient survey also showed that fields with no or low granular fertilizer inputs in the preceding spring had low levels of residual N. These low or no additional input fields' fall residual nutrient levels were well below 100 kilograms per hectare. In contrast, the fields with reported long-term annual poultry manure inputs generally exceeded 100 kilograms per hectare. According to the Fraser Valley Soil Nutrient Survey of 2005, this level of residual nutrients has potentially negative environmental impacts.



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We recommend that these growers reduce their poultry litter fertilizer inputs; and maintain manure application rates in line with agronomic recommendations (see Appendix B) which will contribute to better crop yields and profitable performance.

Many growers in our region, however, rely on paddle wheel type manure spreaders to apply poultry litter, and with this equipment, uniform application of recommended rates is difficult to achieve. To address some of the challenges associated with poultry manure inputs, we have included in this report (http://www.caf.wvu.edu/~forage/boxmod.htm; see page 16) a description of an inexpensive modification for paddle wheel manure spreaders. It has been reported that this box spreader modification will enable farmers to reduce application rates by 60-70 percent on crops.

In conclusion, N fertilizer inputs seem to be excessive on some crops, in particular beans and potatoes. Furthermore, many producers continue to apply significant quantities of P and K granular fertilizers upon soils which test high/excessive for these nutrients. From our discussions with growers regarding such soil test results we found that few either understood or appreciated soil testing as a means to assess fertilizer inputs upon their farm. As part of our continuing commitment to bridging the knowledge of our practicing farmers an integrated nutrient management pilot project was initiated in 2011. This project builds directly from our lessons learned in cooperation with the growers of this

region. ES Cropconsult has established benchmark fields with the cooperation of growers in the Fraser Valley. With the benchmark fields selected as representative of soil and cropping types, available nutrient management testing, monitoring, and planning tools have been applied in cooperation with growers in targeted efforts to reduce surplus nutrient inputs and input costs while maintaining harvest yields and quality. Conceptually, this "Integrated Nutrient Management" pilot project would work as an extension of the "Integrated Pest Management" services which are currently employed with many growers.

Cereal Grains Variety Trial Results

Small grain screening trials were established to monitor and compare available varieties of cereal grains as potential low-input break crops (i.e. demonstrate disease resistance in absence of pesticides; and yields under low fertilizer N inputs). New potentially suitable and available varieties of spring and fall planted cereals/grains were sourced from Eastern Canada/USA (Ontario, Quebec and Maritimes; Michigan and Indiana), Pacific Northwest (i.e. Oregon, Idaho and Washington State) and Europe/UK (see Appendix C). We would like to thank all the seed suppliers (listed in Appendix C) who have provided many of the cereal varieties for testing.

The criteria for selection were primarily based upon good yields and disease resistance, in particular, stripe/yellow rust resistance. Our analysis of the 52 grain varieties sourced from growing regions with similar biophysical conditions included: grain and straw harvest yield, height, total grain weight, grain protein percentage, and disease assessments.

- Of the 13 spring wheat varieties analyzed, our top 7 selections were: Glenlea, Lillian, Strongfield, Sable, Expresso, Cabernet, and Paragon.

- Of the 16 winter wheat varieties tested, our top 7 choices to date are: Monopol, Reaper, Harvard, Stanford, Norwest 553, Gladiator, and Warrior.

- All 5 winter barley varieties (Flagon, Winsome, Retriever, Suzuka, and Vanquish) we tested in 2010/11 provided relatively good disease resistance and yields of both straw and grain. The winter barley matured by mid-July, some three to four weeks earlier than winter wheat.

- Of the 14 spring barley varieties in our trials, the top 8 were: Island, CDC Bold, McGuire, OAC Kawartha, Baronesse, 95SR316A, Concerto, and Henley.

- Both of the spring oat varieties are nationally registered in Canada, and are recommended for South Coastal B.C. growing conditions.

Suggested List of Recommended Cereal Varieties for Registration and/or Planting for South Coastal BC

Spring Wheat	Winter Wheat	Spring Barley	Winter Barley	Spring Oats
♣ ♦ ¤ Glenlea - Hard red (HR)	§ ♦ ¤ Monopol - HR	♣ ¤ Island - 2 row/feed	♠ ¤ Flagon - 2 row/malting	♣ ¤ AC Baton - Hulless
(R) ♦ ¤ Lillian - HR	Reaper - HR	♣ CDC Bold - 2 row/feed	♠ ¤ Retriever - 2 row/feed	♣ ¤ Navaro - Hulless
(R) ♦ ¤ Strongfield - Durum	(R) § ¤ Harvard - HR	♣ ¤ McGuire - hulless/feed	♠ ¤ Suzuka - 2 row/feed	
(R) ¤ Sable - HR	(R) ¤ Stanford - HR	♣ ¤ OAC Kawartha - 6 row	♠ ¤ Vanquish - 2 row/malting	
♥ Expresso - HR	§ ♥ ¤ Norwest 553 - HR	♥ ¤ Baronesses - 2 row/feed	♠ ¤ Winsome - 2 row/malting	
♥ Cabernet - HR	♠ Gladiator - HR	♥ ¤ 95SR316A - 2 row/feed		
♠ ¤ Paragon - HR	♠ Warrior - Soft White	♠ ¤ Concerto - 2 row/malting		
		♠ ¤ Henley - 2 row/feed		

♣ Varieties which are registered in Canada and seed available to producers on South Coastal BC
(R) Varieties which have "regional" registration in Canada, but not on South Coastal BC; subject to CFIA approval
♥ Varieties registered in Washington/Oregon State, but not in Canada; subject to CFIA approval
♠ Varieties registered in UK/EU, but not in Canada; subject to CFIA approval
♦ Varieties which grew tall and susceptable to lodging
¤ Varieties which establish quickly and/or grew tall to exhibit relatively good weed control without the use of herbicides.
§ Varieties of winter wheat with a relatively good spring stand after intensive over-winter waterfowl grazing
For a complete list of varieties which are registered in Canada; and, procedures for registration of varieties in Canada, please refer to following CFIA web page:
http://www.inspection.gc.ca/english/plaveg/variet/proced/procede.shtml

Cereal Under-seeding with Clover as a Green Manure in the Rotation

A well established and nodulated clover crop on an adequately drained soil can provide many benefits: improved tilth and soil fertility, habitat for worms, wildlife forage, over-winter cover, and a subsequent green manure supply of nitrogen for cash crops.

- Early planting dates with cereals in our region delivered the best results.
- Inoculated red or white clover seed was broadcast at a rate of 10 kg/ha when the cereal crops were beginning to tiller.
- Good stands of clover followed the cereal harvest provided that the straw was baled and minimal barley seed was left on ground after combining.
- These stands of under-seeded clover were ready to provide a soil fall cover crop or green manure crop the following spring.
- For soils already rich in available P and K - and many of our cultivated soils in Delta are in that category – many crops typically planted within our region would require little additional inputs of either composted-aged poultry manure or granular fertilizer NPK.
- Nitrogen from the green manure clover crops was mostly available three weeks after plough-down in early May; the clover crops provided close to 70 kg per hectare of available N.

- Most of the N content of the white clover had mineralized and roughly 50% of the N in the red clover had become available in time to support the subsequent cash crops.

Education and Outreach

- Signage was erected at all of our variety trial site locations. Layouts were submitted to IAF and funding was acknowledged.

- The research team participated in the Certified Organic Associations of British Columbia (COABC) annual meetings and workshops in 2009, 2010 and 2011. Power point presentations were made and funding acknowledge.

- We held two open house field days to invite participation and input from regional growers and farm service providers in July of 2009 and 2010. Invitation sent and submitted to IAF. Funding was acknowledged.

- Delta Optimist article web link announcing our 2010 field days: http://www.delta-optimist.com/Field+trials+underway+Delta/3276063/story.html

- For our open house field day in July 2010, we prepared and circulated a factsheet with varietal background, disease, and yield assessments to date. Factsheet hand out was submitted to IAF. Funding was acknowledged.

- In December 2009 and January 2011, we returned results from the soil nutrient survey and our variety trials to the project's cooperating growers. These grower-focused reports included nutrient management and poultry litter factsheets, as well as a separate, individually tailored report for each grower with results and interpretations of their field's soil test. Funding was acknowledged; See Appendix A of this report; and past reports to IAF.

- The COABC published we blink to our 2009 and 2010 reports: http://www.certifiedorganic.bc.ca/contacts/extension.php - Funding was acknowledged.

- Our collaborative research network included the Vancouver Grains Cooperative, UBC Faculty of Land and Food Systems student groups, and the Delta Farmland and Wildlife Trust. With their support, we contributed to educational outreach targeted towards developing regionally adapted grains for bread making, and clover under-seeding for soil and wildlife conservation.

- The Canadian Farm Business Management Council Website published a brief article on our project as a feature story, November 29, 2010.

http://www.farmcentre.com/Features/ScienceInnovation/Article.aspx?id=ab9dee77-b092-4524-bdd6-c15fbea59300

- In 2010, as a consequence of our cooperative field trial work using under-seeded clover, the Delta Farmland & Wildlife Trust (DF&WT presented the results of our work on cereal underseeding work to the Delta Farmers' Institute in March 2010 and 2011; and, implemented a cereal under-seeding with clover program with cooperating producers in Delta. This project is part of DF&WT's Greenfields cover crop program. We collaborated in the production of a DF&WT factsheet regarding their program (see Appendix D).

- The DF&WT published an article on our research and the cereal under-seeding with clover stewardship program now available to growers in Delta – see Dec 2010 DF&WT Newsletter (Vol. 16. No. 2). http://www.deltafarmland.ca/ http://www.deltafarmland.ca/page/newsletters/ ; and July 2011 DF&WT Newsletter (Vol. 17. No. 1). http://www.deltafarmland.ca/admin/files/July%202011%20Web.pdf

- As part of our continuing commitment to bridging the knowledge of our practicing farmers; and, in discussions with David Poon and Orlando Schmidt of the BCMAF's BC Nutrient Management Working Group (BCNMWG); and Heather Meberg of ESCropconsult, we initiated an "Integrated Nutrient Management" (INM) pilot project in 2011. This pilot project is now in progress and is building directly from our lessons learned in cooperation with the growers of this region. Benchmark fields were established in the spring 2011 by ESCropconsult with the cooperation of growers that include the Fraser Valley and South Coastal regions. With the benchmark fields selected as representative of soil and cropping types, we would apply the available nutrient management testing, monitoring, and planning tools with the cooperating growers in targeted efforts to reduce surplus nutrient inputs and input costs while maintaining harvest yields and quality for the market.

- COABC published a brief article on our project as a feature story in their "BC Organic Grower" magazine, spring 2011; Volume 14, Issue 2. http://certifiedorganic.bc.ca/publications/bcog/issues/Vol14N2.pdf

- Country Life of BC published an article on our project as a feature story, February, 2011. http://www.countrylifeinbc.com/

- Ducks Unlimited Canada published a brief article on our project as a feature story in their "Conservator" magazine, February 17, 2011. http://www.conservator.ca/2011/02/western-region-british-columbia/

- Delta Optimist “Eco-Friendly Crop Rotation Article – August 12, 2011 (see http://issuu.com/pmcommunity/docs/delfri20110812

- In spring 2011 we established “outreach” trials with two Vancouver Island producers from the Comox Valley. A cereal under seeding clover trial was established with Bruce Beacham (dairy producer); and a wheat/oats/barley trial was established with Zoe and Rick Norcross-Nu'u (organic producer).

- A Factsheet on was prepared (see Appendix C) for “Recommended Cereals South Coastal B.C.” Funding was acknowledged.

Preface

At this time, we have now completed the major milestones in our three-year Eco-Friendly Crop Rotations Project. A regional soil nutrient survey with 22 fields and 11 cooperating farmers in the South Coastal-Fraser River Delta region was completed. Two spring cereal grains variety demonstration trials from May 2009 and 2010 to August 2009 and 2010 and two over-winter trial from September 2009 and 2110 to August 2010 and 2011 were completed. We assessed 52 varieties of spring wheat, barley, oats, and winter wheat and barley varieties in our side-by-side demonstrations. Our education and outreach efforts included two open house field days in July of 2009 and 2010, and additional collaborative research with the Vancouver Grains Cooperative, UBC Faculty of Land and Food Systems student groups, three Vancouver Island producers and the Delta Farm and Wildlife Trust.

Our collaboration of growers' groups, researchers, and generous sponsors included the Delta Farmers' Institute, UBC Faculty of Land and Food Systems, B.C. Agriculture Council (BCAC), Investment Agriculture Foundation (IAF), and Ducks Unlimited, Canada. In the pages that follow, we present detailed results of these project milestones. The report appendices include relevant sections from our soil nutrient survey or growers' report, and factsheets which have been distributed to producers.

Introduction

The desired outcome of this project is to help Delta farmers deal with "clearly identified gaps and priorities in understanding of environmental sustainable production practices" through the development of "eco-friendly crop rotations" as Best Management Practices (BMPs). BMPs would include a "holistic" eco-system approach to the crop rotations using low input "break" crops - such as cereal grains; legumes and/or other cover crops – to help improve profit margins through reduced fertilizer use and/or, the conservation and recycling of soil nitrogen.

Intensive cereal management research was conducted in the region about 20 years ago, however, new, more appropriate grain varieties are now available, prices are much more favourable and organic production systems have rapidly expanded. Our project seeks to improve the economic sustainability of vegetable crop rotations via increased incomes from newer low input and disease resistant cereal varieties used as break crops and reduced input costs for fertilizers. In conjunction with improved cereals in crop rotations, we wish to capitalize on the Fraser Valley Soil Nutrient Survey that showed most of our soils to be well supplied with P and K by reducing the need for external and expensive fertilizer

inputs except for N. Furthermore, cereal break crops under-seeded with clovers may be useful in providing available N to supplement N available from soil organic matter.

Soil Nutrient Survey

In the winter and early spring of 2009, we communicated with the Delta Farmers' Institute and Fraser River Delta growers in an effort to invite their participation in our soil nutrient survey and overall Eco-Friendly Crop Rotations Project. We secured 22 fields and 11 cooperating growers for the regional soil nutrient survey. This survey built on the preliminary lessons and methodology of a 2005 federal and provincially funded soil nutrient assessment of the broader geographic area encompassed by British Columbia's Fraser Valley.

The sampling method for the spring and fall soil survey was as follows: we took four replicate samples and a ten-core sample composite grid within an accessible and representative area of the field. We also monitored and recorded soil temperatures for the spring and fall survey. Individual field numbers presented as results in the tables that follow are the mean of the four replicate composite samples. We sampled to a depth of 30 centimeters in most cases, though we sampled to 60 centimeters depth on four benchmark sites to capture information for the fall residual nitrates, available P and K. This was the method followed in the Fraser Valley Soil Nutrient Study of 2005.

The laboratory method for extraction and units of measure are noted on the tables. Not all soil-testing laboratories follow the same testing procedures or use the same units to calibrate results, so some caution is needed when using these results to compare with previous soil test reports. Also, soil sampling depths of 15 to 20 cm may give different results from our deeper samples. See Kowalenko & Poon (2010) for an excellent historical summary and updated analysis on the suitability of selected extraction methods for British Columbia. We have a long-standing, working relationship with the commercial soil laboratory utilized (Pacific Soil Analysis Inc.), their methods are calibrated to area soil types and local farmers and agribusinesses have commonly used their services.

The 22 field sites represented 6 distinct soil types found in the study area: Delta, Crescent, Guichon, Ladner, Spetifore, and Westham soils. In December 2009, each producer received individual soil test results and our overall growers' report with the key to comparing their field number with other fields in the area. For a complete review of the 2009 soil test results and interpretations for nitrogen (N), phosphorus (P), potassium (K), soil acidity (pH), calcium (Ca), magnesium (Mg), sodium (Na), and salinity (EC) see report Appendix A.

Field Soil Test Results

In December 2009, we returned soil survey fertility reports from the soil nutrient survey (see Appendix A) and the first growing season results of our variety trials

to the project's cooperating growers. These grower-focused reports also included a separate, individually tailored report for each grower with fertility results and interpretations of their field's soil test.

Over-application of granular fertilizers, manures or other composted materials may adversely affect yields, cause an increase in undesirable weed species and disease, contribute to imbalances with available soil-plant nutrients, and negatively impact surface and groundwater quality. In 2001, approximately 53% of soils used for crop production in North America showed extractable soil P levels that were deemed high or excessive (PPI 2002 cited in MacDonald & Bennett, 2009). For our region, the Fraser Valley Soil Nutrient Study of 2005 reported 80% of all fields in the study were in the high to very high environmental risk class for P (Kowalenko et al 2007, p.11). For fall residual N, 93% of fields exceed environmental thresholds.

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Soil Survey N, P and K Field Test Results 2009

Soil N-P-K

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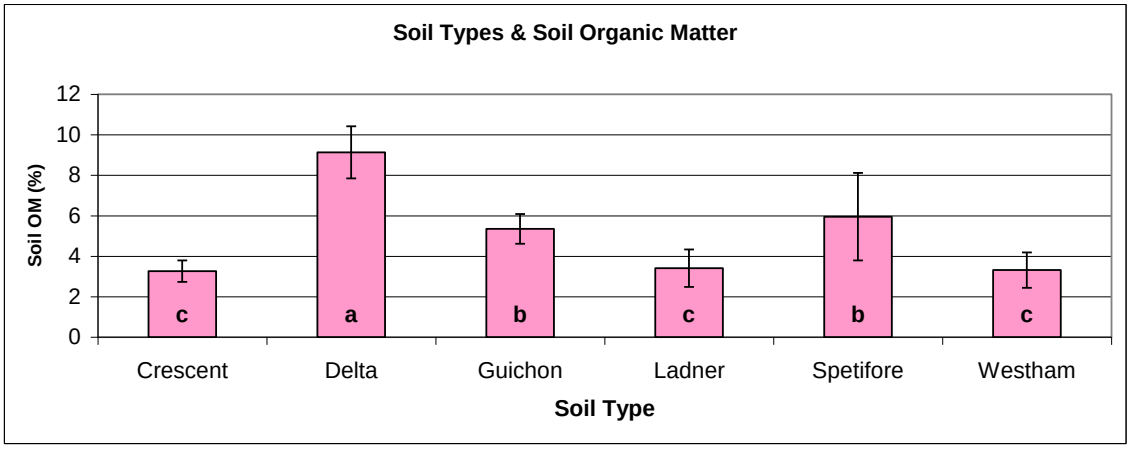
21	20	2	44	6	314	41	270	30
22	dns		99	9	428	55	428	45

Samples collected during April and October 2009 for spring and fall samples

Inherent and Cultural Effects on Soil Nutrient Survey Results

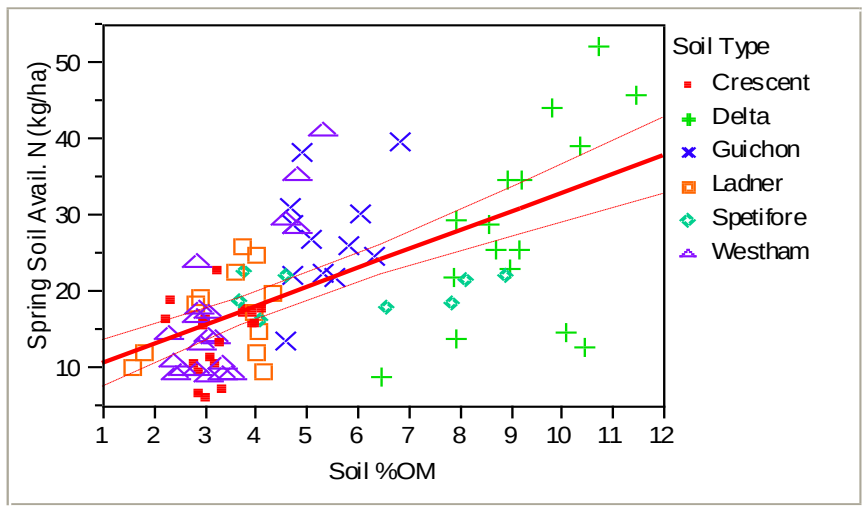
In most cases with our field site soil survey, **the soil test results above strongly indicate that available P and K are at levels at which profitable crop yield responses to additional inputs will be unlikely**. Therefore we have focused on inherent soil properties and cultural practices that may lead to improved understanding of soil available N and better precision and accuracy in the use of N inputs.

The results of the spring and fall soil surveys, showed a relationship between the soil series and soil organic matter (OM). Soils found within the Delta and Spetifore soil series showed higher levels of soil OM compared with the Ladner, Crescent, and Westham soils. Higher soil OM levels, whether from inherent properties within a soil series, or from the dynamics of routinely applied manures, appear to have an effect on residual nitrate levels.



* After significant F-test (p<0.05) a Mean Separation (MS) was performed; means with the same letters are not significantly different

To best understand why fall residual N levels are so high on some soils one needs to appreciate the contribution of the soil itself to provide such nutrients in absence of any fertilizer inputs. The graph above shows the relationship between spring available N and soil OM. These samples were gathered in mid-April 2009, before soil temperatures were above 10°C. Statistically, the correlation has a high probability of significance; however, there is a lot of scatter along the line itself[1].

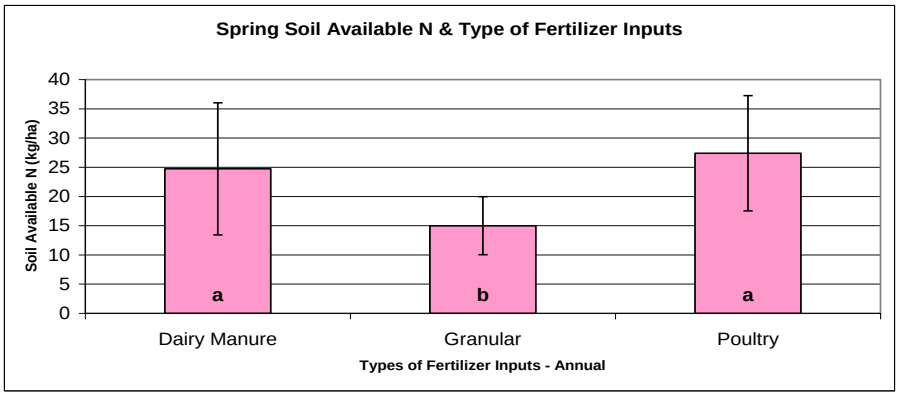


Linear Fit

Spring Soil Avail. N (kg/ha) = 8.17 + 2.46 Soil %OM
RSquare 0.388267 p-value <.0001

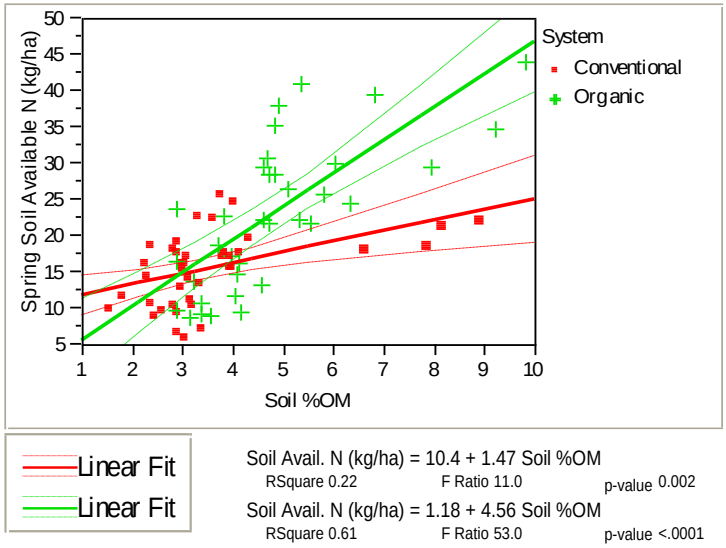
We found the highest levels of spring soil available N on fields with an input history of long-term, annual applications of dairy and poultry manure. Growers in our soil survey who routinely applied poultry manure-based composts followed certified organic production practices. In contrast, our 'conventional' grower-cooperators tended to rely on granular fertilizer inputs.

[1] This 'scatter' is expressed as a low R square value.



* After significant F-test (p<0.05) a Mean Separation (MS) was performed; means with the same letters are not significantly different

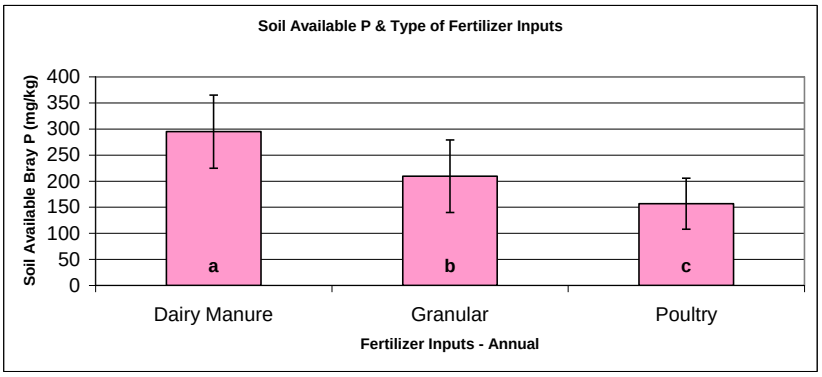
The next graph shows the relationship between our two crop production systems with respect to spring soil available N levels. In the Fraser River Delta region where we conducted our soil nutrient survey, organic crop producers manage fields with a wide range of soil OM levels. Our conventional producers tended to manage fields in areas with relatively lower soil OM levels. We did not have enough sample data to provide a meaningful correlation with dairy manure



inputs, though we did observe on the fields in our survey with these inputs, that their soils tended also towards high soil OM levels. We found a relatively strong statistical correlation between spring available N levels and soil OM levels for the organic production systems in our survey. The correlation was not as strong for the conventional production systems. Its not clear in the table which equation is for organic and which is for conv. Spring soil available N averaged close to 15 kilograms per hectare for fields in a conventionally managed system, and as high as 50 kilograms per hectare on organically managed fields with high soil OM levels. We observed and documented two probable factors with respect to these

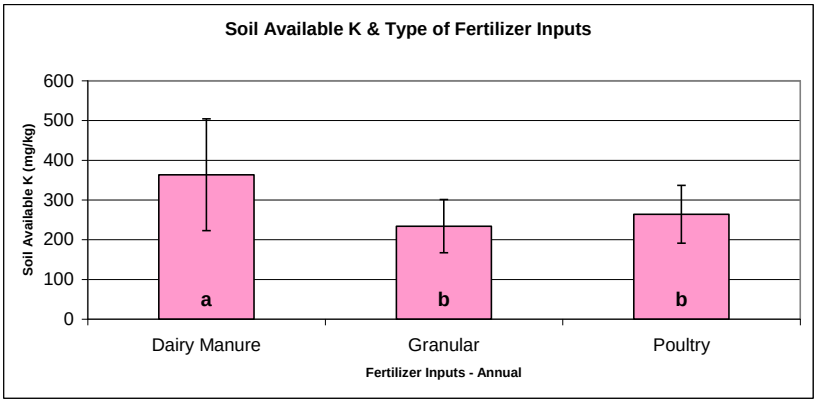
higher spring N levels: 1) cover cropping practices of the organic producers and 2) long-term annual inputs of poultry manure-based composts.

We found that fields in our survey with the highest test levels of soil available P received long-term, annual application of dairy manures. On average, granular fertilizers returned the second highest levels of soil available P, followed by the fields with poultry manure inputs. Our grower-cooperators followed different input strategies for different crops across the various managed fields and soil types, though we did see some similar strategies and rates of application with some of the fields and crops in our soil nutrient survey.



* After significant F-test (p<0.05) a Mean Separation (MS) was performed; means with the same letters are not significantly different

Soil available K levels were also highest upon those fields which had long-term inputs of dairy manure. On average, fields which received granular fertilizer or poultry manure had slightly less soil available K.

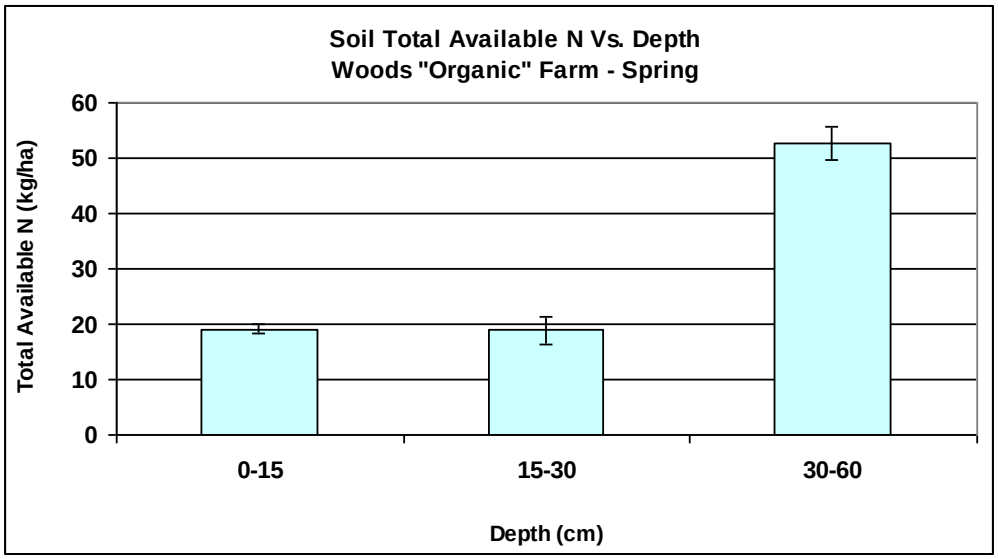


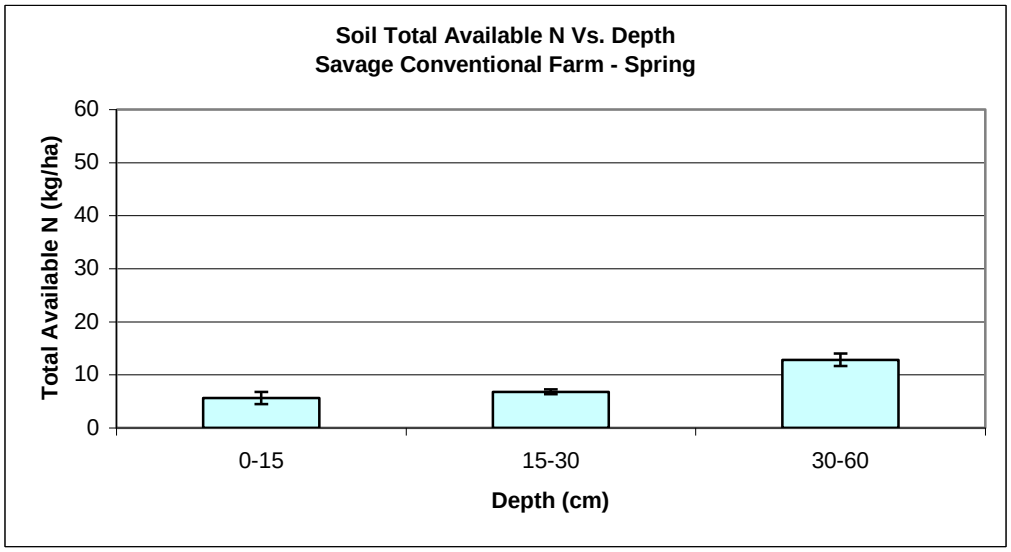
* After significant F-test (p<0.05) a Mean Separation (MS) was performed; means with the same letters are not significantly different

Spring-time Soil Available NPK Levels Associated with Depth for a Organic & Conventional System

Benchmark sites were established upon an “organic” and a “conventional” crop production field; and soil sampled in the spring at three depths, including 0-15cm, 15-30cm and 30-60cm. The organic field had received only poultry litter as a fertilizer for the past 10+years; and before that was an abandoned dairy farm or grass field. The conventional field only used granular fertilizers for the past 40+years. Both fields have been cropped to bean, pea, potato, corn and cereals.

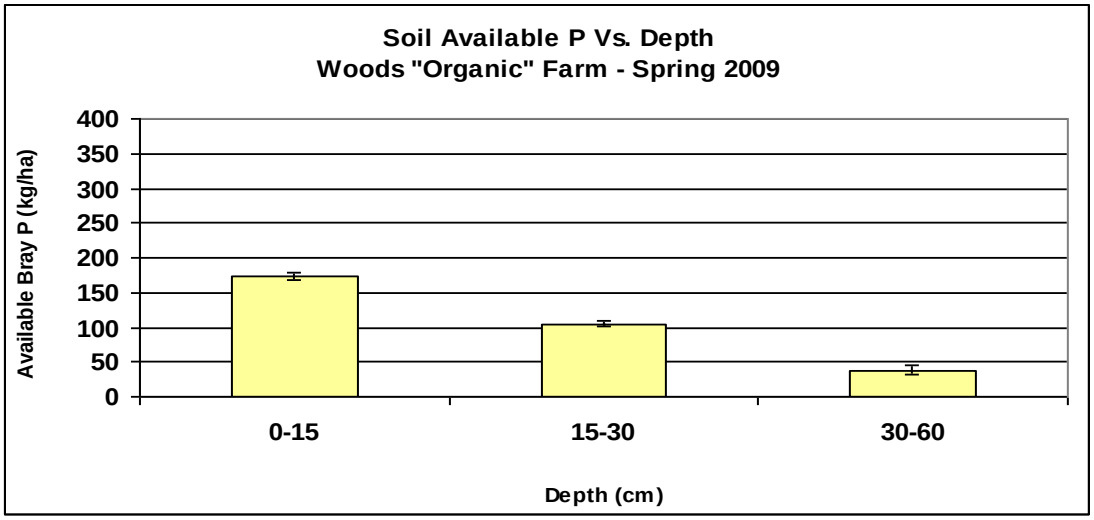
Spring Available N Levels: Little of the spring-time available N was ammonium–N with 80 to 90% of the soil available N as nitrate-N. Ammonium-N levels were highest in the surface 0-15 cm than at depth. In general spring available N levels were low in surface 0 to 30 cm soil depth. This is to be expected as winter

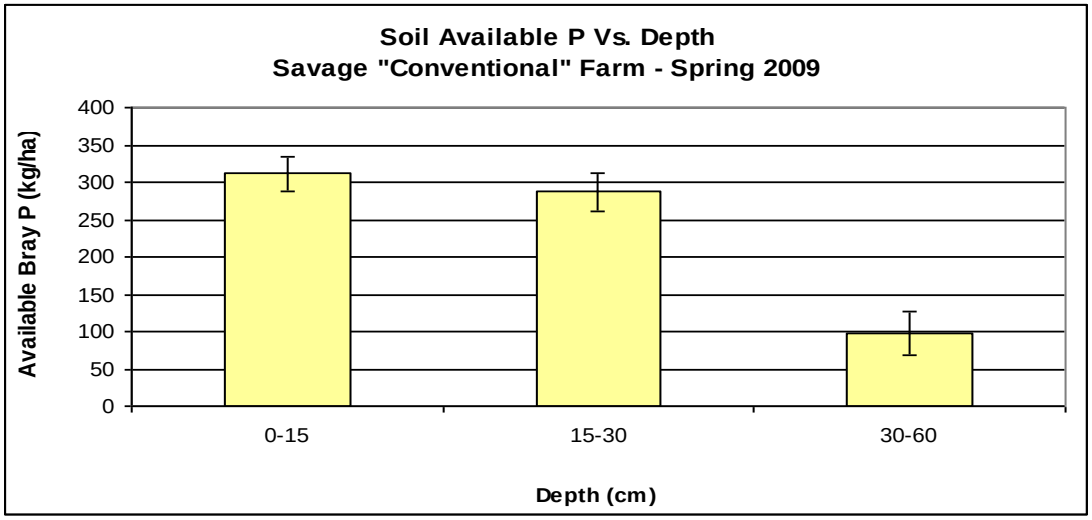




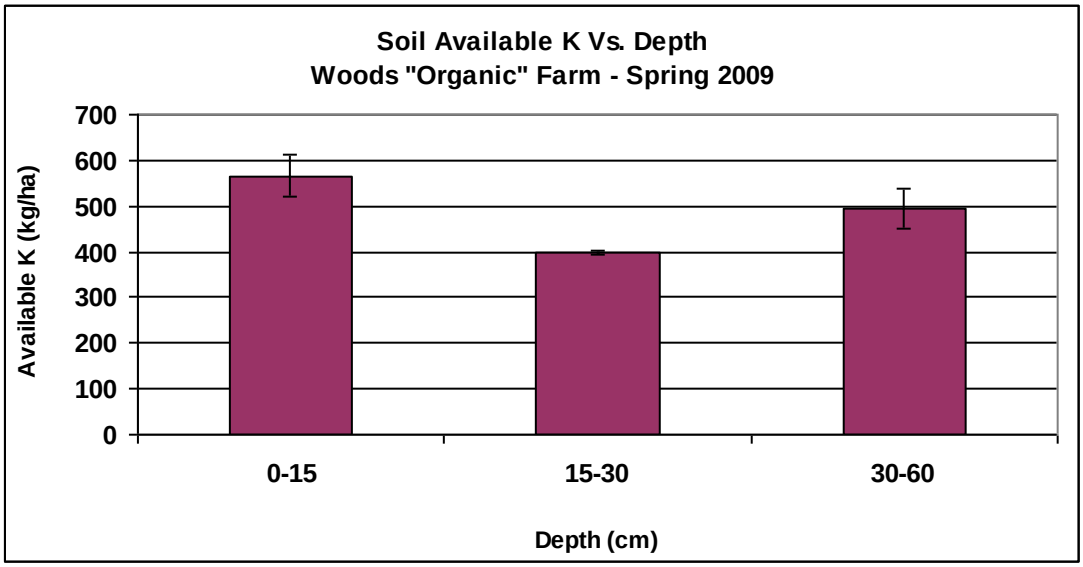
precipitation will have leached excessive or fall residual nitrates to lower depths or groundwater (i.e. Woods Farm 30 to 60 cm depth). The soil surface levels of nitrates that are there is probably more a reflection of fall cover crop N retention and spring release.

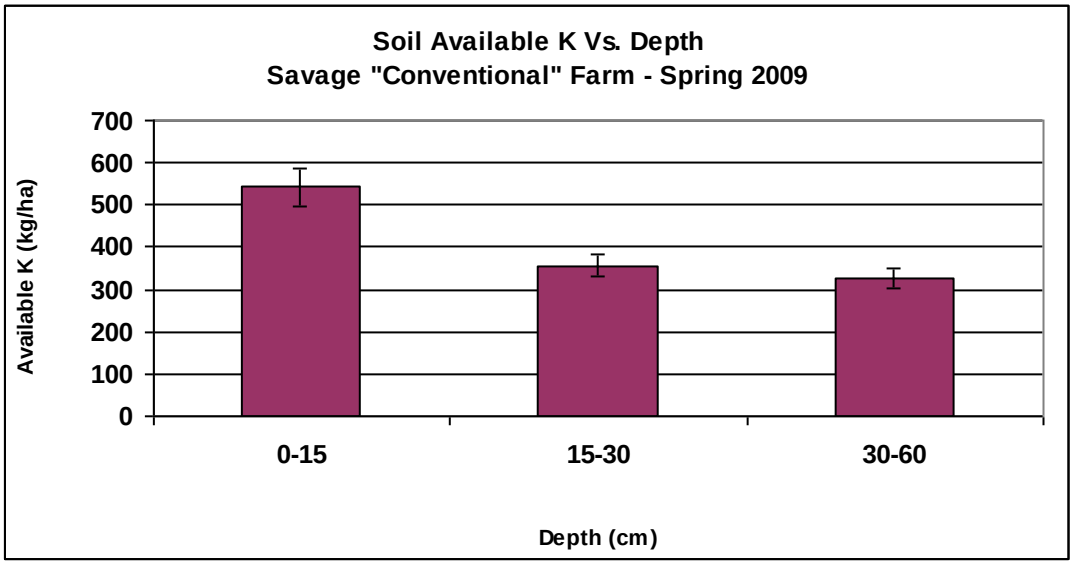
Spring Soil Available P Levels: Relative to the “organic” field, spring available P levels were much higher – nearly twice as high - under the “conventional” cropping system which had received high levels of P fertilizers for the past 40+ years. These high levels were also detected at depth to 60cm which suggests P leaching.





Soil Available K Levels: For both the organic and conventional cropping systems the soil available K levels were excessive through the soil profile depth of 60cm. This suggest that fertilizer applied K levels are excessive and have leached.





Footnote: Effects of Annual Weather Conditions on Soil Nutrient Status

Weather conditions also play a critical role in determining the timing of available nutrient supply, uptake by crops, and the extent of mineralization. In a similar 3-year study on sandy soils in Germany, researchers concluded that crop rotations, the return of K after harvest, the proportion of clovers, and weather conditions had significant impacts on yields, N leaching, and soil nutrient status (Kayser, Muller, & Isselstein, 2010). While we selected our spring and fall field sampling dates for similar average soil temperatures (<10°C) and conditions, both farmers and field researchers found the 2010 weather conditions particularly challenging! The unprecedented rainfall in late-summer 2010 led to flooding; and, neither fall soil sampling nor late crop harvests (i.e. bean, cereal and potato) were possible.

Ways & Means to Reduce Soil Nutrient Loading & Increase Profits

Our soil survey results indicate excessive levels of P and K are common in the majority of field sites. In addition to economic losses, excess nutrient loading from agricultural sources is linked to widespread problems in coastal and riverine ecosystems. The impacts include alteration of food web structure, loss of biodiversity, and harmful algae blooms (Diaz, 2001; Howarth, 2008). Each impact carries associated risks to human and ecosystem health, and nearly all are well documented and regulated across Canada, Europe, and the United States (Maguire, Rubaek, Haggard, & Foy, 2009).

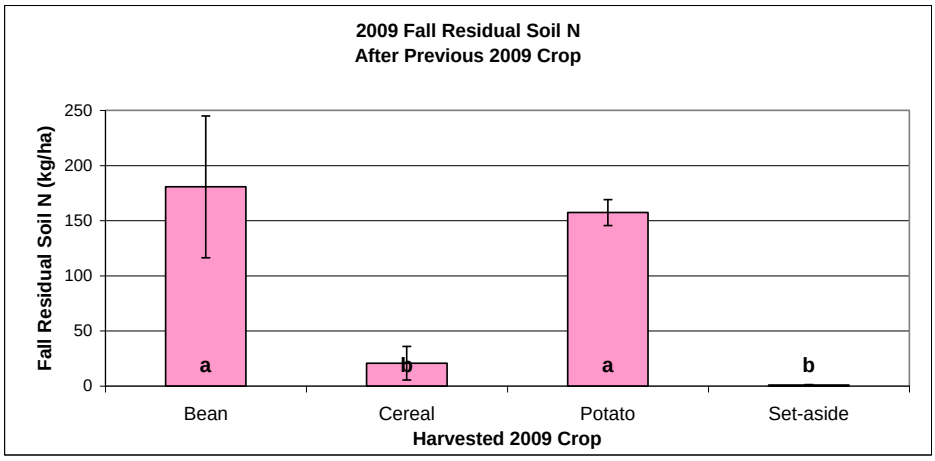
In response, many regions have adopted agricultural policies ranging from voluntary to mandatory to regulate nutrient applications. In the United States, for example, 47 out of 50 states have established Phosphorus (P) Index levels to assist with management and assessment (Sharpley, et al 2003; Maguire, et al 2009). Regionally, both Washington and Oregon utilize a P Index and a published guideline to assess source and transport factors (Sullivan and Stevens, 2003; Sharpley et al 2003; Marx et al 1999).

There are several management options to reduce the potential for P loss from the field to aquatic environments (Adapted from Sullivan and Stevens, 2003 (p.3)):

- Decrease P applications to levels supported by agronomic recommendations. In almost all of the soils tested in our survey this means applying no P and K. Soil test P levels are slow to change because of soil buffering capacity for P. Many years of reduced P inputs are usually required to significantly reduce soil test P levels. A positive spin on this is that residual P and K can be treated like “money in the bank “an account that can be drawn upon until soil tests again indicate fertilization is justified.

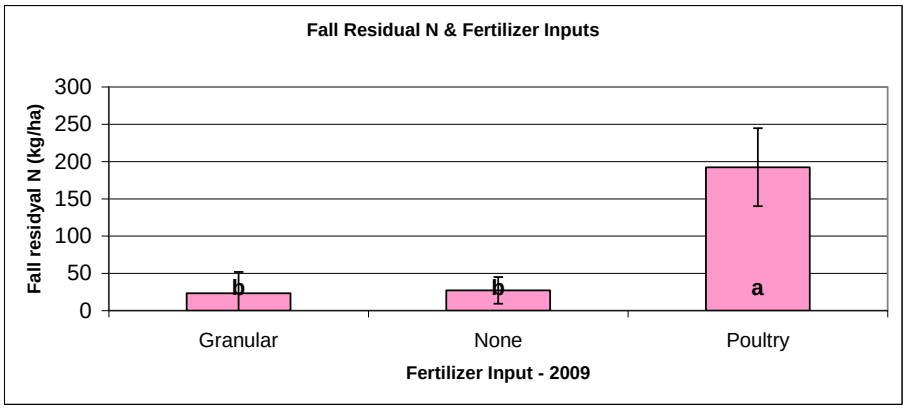
- Increase the amount of crop biomass removed from the field. To increase P removal, consider winter cover crops or cereal grain crops as a break in the rotation, relay or double cropping. Harvesting grain removes substantial amount of soil P. For example, wheat grain will remove about 13 kg of P per tonne or about 90 kg of P in a yield of 8 t/ha. Removal of crop biomass via harvesting hay or silage is more effective than livestock grazing for reducing soil test P and K.

Our field survey suggests that fall residual N levels are greatest after beans and potatoes; and are least after cereal crops and short-term grassland set-asides. Therefore, having low input cereals in the crop rotations is an effective means to reduce, not only soil available P and K, but also fall soil residual N levels. Growers will benefit by reducing production costs, as well as reducing long term, negative environmental impacts.



* After significant F-test (p<0.05) a Mean Separation (MS) was performed; means with the same letters are not significantly different

Observed from the results of fields in our fall residual nutrient survey receiving no or low granular fertilizer inputs the preceding spring had low levels of residual N. These low or no additional input fields' fall residual nutrient levels were well below 100 kilograms per hectare. In contrast, the fields with reported long-term



* After significant F-test (p<0.05) a Mean Separation (MS) was performed; means with the same letters are not significantly different

annual poultry manure inputs generally exceeded 100 kilograms per hectare. From the Fraser Valley Soil Nutrient Survey of 2005, this level of residual nutrients has potentially negative environmental impacts. From an environmental impact standpoint, a reduction of poultry manure inputs is advised.

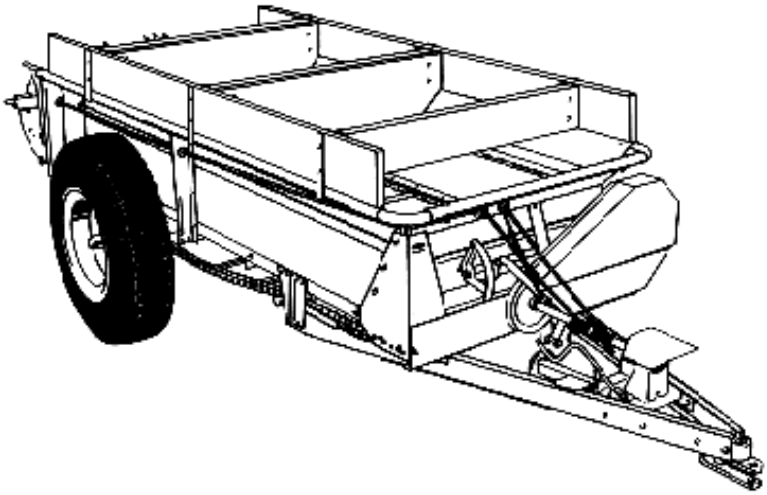
Outreach: Insert for Manure Box Spreaders to Reduce Application Rates and Costs

Maintaining manure application rates in line with agronomic recommendations contributes to better crop yields and performance. Over application of manures or other composted materials may adversely affect yields, cause an increase in undesirable weed species, contribute to imbalances with available soil-plant nutrients, and negatively impact surface and groundwater quality. Growers would benefit by reducing fertilizer input production or application costs, as well as reducing long term, negative environmental impacts.

Many growers in our region rely on paddle wheel type manure spreaders, and with this equipment, uniform and the recommended lower-rate applications are difficult to achieve. We've heard from many of our cooperating producers that their current means to reduce the amount of applied manures is simply to increase their traveling speed with the spreading equipment. However, even at such high speeds, over application of poultry manure is still a concern. Conventional box and paddle wheel type spreaders typically are designed for use with cattle and dairy manures at application rates of 17 to 22 t/ha (8 to 10 tons per acre). When poultry litter is applied at recommended agronomic rates of 2 to 9 t/ha (1 to 4 tons per acre), conventional spreader effectiveness, in terms of uniform application, is reduced.

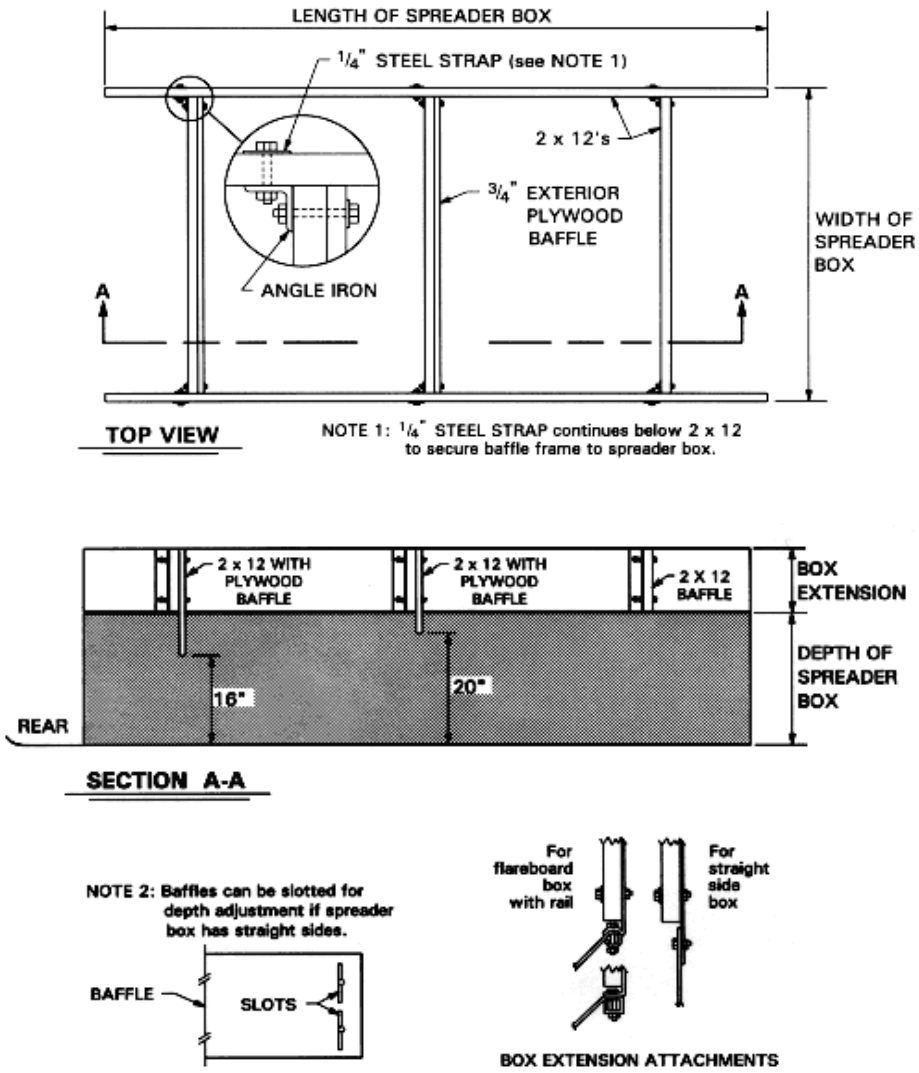
For producers considering a new spreader purchase or fabrication, our research into poultry litter spreaders demonstrated that several "spinner-type" spreaders to be much more efficient, precise and accurate then "paddle-type" manure spreaders (see: http://www.certifiedorganic.bc.ca/contacts/extension/p_litter.pdf).

The West Virginia University Extension Service contributed the modified design depicted here (http://www.caf.wvu.edu/~forage/boxmod.htm). We encourage producers to consider some form of modification of their existing "paddle-type" spreaders to help reduce their current poultry litter applications. This box spreader modification will



enable farmers to reduce application rates significantly on crop and grassland at a reasonably low cost. The modification will allow most spreaders to reduce manure application rates by 60-70 percent.

Producers can easily remove the modification when other manures or rates of application are desired. With treated lumber measured for a 200-bushel capacity box spreader, material cost would be about $135. Although treated lumber is not required, it would be the most desirable material for constructing a modification that will last longer. However, for organic producers the use of treated lumber would be prohibited.



Spreader calibration is necessary to determine actual application rate for a particular spreader after the modification is installed. Manure nutrient analysis is

recommended so that producers can more closely match application rates to their specific crop of forage needs.

Reduce Current Fertilizer Input Costs

The following is a comparison of fertilizer input costs between current "traditional" crop rotations and the project's proposed "eco-friendly crop rotation".

At this time, competing pressures of rising input costs, shifting, consumer-driven markets, and increasing demand for global and local food supplies are accelerating already challenging trends for agricultural producers. From 2006 to 2008, fertilizer and lime expenses reported by Lower Mainland-Southwest B.C. farmers jumped from $55.7 million to $75 million[2]. Bulk fertilizer costs for fertilizers such as urea (46-0-0), super-phosphate (0-45-0) and potash (0-0-60) were $600 to $700 per 1000 kg; and, as of spring 2011, these costs have now escalated to some $700 to $900 per 1000 kg.

	2008 Crop & Fertilizer Inputs			2009 Crop & Fertilizer Inputs			2010 Crop & Fertilizer Inputs		
Field #	**Crop**	**Fertilizer**	**Application**	**Crop**	**Fertilizer**	**Application**	**Crop**	**Fertilizer**	**Application**
1	Potato	8-18-22	1000 lbs/ac	Spring Wheat	18-19-19	450 lbs/ac	Bean	8-10-28 + 11-51-0	500 + 300 lbs/a
2	Beans	8-10-28 + 11-51-0	500 + 300 lbs/ac	Spring Barley	8-24-24	450 lbs/ac	Potato	8-18-22	1000 lbs/ac
3	Potato	Poultry	15 yds/ac	Spring Barley	None	0	Bean	Poultry	15 yds/ac
4	Spring Wheat	13-10-10	500 lbs/ac	Spring Barley	46-0-0	100 lbs/ac	Potato	8-18-22	1000 lbs/ac
5	Rutabaga	8-18-22	800 lbs/ac	Oats	None	0	Pasture	None	0
6	Potato	Dairy	unknown	Spring Barley	Dairy	unknown	Pasture	BYM	unknown
7	Pasture	Dairy	unknown	Pasture	None	0	Potato	8-18-22	1000 lbs/ac
8	Potato	Poultry	15 yds/ac	Beans	Poultry	15 yds/ac	Corn	Poultry	15 yds/ac
9	Potato	Poultry	15 yds/ac	Beans	Poultry	15 yds/ac	Potato	Poultry	15 yds/ac
10	Beans	Poultry	15 yds/ac	Barley	None	0	Potato	Poultry	15 yds/ac
11	Potato	Poultry	15 yds/ac	Spring Wheat	None	0	Bean	Poultry	15 yds/ac
12	Beans	Poultry	15 yds/ac	Potatoes	Poultry	15 yds/ac	Potato	Poultry	15 yds/ac
13	DFWT grassland	None	0	DFWT grassland	None	0	DFWT grassland	None	0
14	Corn	Poultry	15 yds/ac	Beans	Poultry	15 yds/ac	Bean	Poultry	15 yds/ac
15	Potato	8-18-22	1000 lbs/ac	Spring Barley	None	0	Potato	8-18-22	1000 lbs/ac
16	Potato/beans	8-18-22	1000 lbs/ac	DFWT grassland	None	0	DFWT grassland	BYM	unknown
17	Potato	Poultry	15yds/ac	Beans	Poultry	15 yds/ac	Bean	Poultry	15 yds/ac
18	Beans	8-10-28 + 11-51-0	500 + 300 lb/ac	Winter Wheat	46-0-0	300 lbs/ac	Potato	8-18-22	1000 lbs/ac
19	Spring Barley	8-24-24	450 lbs/ac	Spring Barley	46-0-0	100 lbs/ac	Bean	8-10-28 + 11-51-0	500 + 300 lbs/a
20	Beans	Poultry	10 yds/ac	Spring Barley	None	0	Pasture	Poultry	10 yds/ac
21	Potato	8-18-22	1000lbs/ac	Spring Wheat	46-0-0	150 lbs/ac	Pasture	None	0
22	Potato	8-18-22	1000 lbs/ac	Beans	8-10-28 + 11-51-0	500 + 300 lbs/ac	Spring Wheat	18-19-19	450 lbs/ac

Fertilizer type and inputs are based upon discussions with producers and/or fertilizer supplier.

The table below depicts our cooperators' 2008 to 2010 reported crops, fertilizer types and application rates for each of the 22 fields we surveyed in Delta.

With respect to the crop and fertilizer inputs, we found reported input levels for beans and potatoes in the rotations were typically high with respect to the high levels of soil available P and K nutrients as indicated by our field soil test results (see pages 17 and 18). For example, typical reported application rate for potatoes in the rotation was 1100 kg/ha of 8-18-22 blended fertilizer; and, for a bean crop a split application was reported as broadcast 550 kg/ha of 8-10-28 followed by 330 kg/ha of 11-51-0 applied with the seed drill. However, the findings from our soil nutrient study of these same 22 fields in the Fraser River Delta demonstrated that nearly all of the fields surveyed returned soil test results

[2] Statistics Canada, Canadian Farm Financial Database (CFFD) http://cansim2.statcan.gc.ca/cgi-win/cnsmcgi.exe

with high and often excessive levels of P. A sub-set of our survey fields returned high soil levels of spring K and fall residual nitrates as well.

To help reduce crop rotation costs most growers followed such high input bean or potato crops with a low or no fertilizer input wheat or barley crop. Several producers acted upon our recommendations of trying only urea (46-0-0) as opposed to their more typical applications for some 495 kg/ha of 18-19-19 upon wheat and 8-24-24 for barley.

Correspondingly, some of our certified "organic" growers planted barley with no additional manure-based compost inputs in rotation with either potato or bean crops. On-farm composted poultry litter cost about $16/t (approx. $4/yd) to produce; and, on average contains some 11 kg/t (approx. 7 lbs/yd) of available N in the first year of application and half that again in the second year after application[3]. Therefore, a typical 10t/ha (15yds/ac) composted poultry application cost approximately $160/ha (approx. $60/ac) in product; and to apply this product using a New Holland spreader costs some $140/ha ($60/ac) [4] giving a total applied fertilizer cost of close to $300/ha ($120/ac). This 10t/ha application would provide some 110 kg/ha of soil available N in the first year of application; and, an additional 55 kg/ha of N in the second year, which is enough N to adequately grow a barley crop with no fertilizer or composted poultry litter inputs. Currently, this is a cereal crop production practice implemented by several organic growers in Delta.

We observed high residual N levels after potato and bean crops which received an annual 10 t/ha (15yd/ac) poultry litter applications. With that being said, **a failure to appreciate or account for such residual carry-over of available N associated with poultry litter in the second year can lead to an over application of nutrients and high soil residual N levels in the fall.** Therefore, following several years of full composted poultry litter application, producers are also advised to reduce their composted poultry litter fertilizer inputs for bean and potato.

In cooperation with the Certified Organic Association of BC (COABC) we have posted upon their Website a publication for recommended poultry litter application rates for various crops
(see: http://www.certifiedorganic.bc.ca/contacts/extension/p_litter.pdf).

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[3] Poultry Litter & Compost Resource Stewardship on the Fraser River Delta – 2004 Final Report; Prepared by A.A. Bomke & W.D. Temple, UBC Faculty of Agriculture.

[4] Poultry Litter & Compost Resource Stewardship on the Fraser River Delta – 2008 Final Report; Prepared by A.A. Bomke, W.D. Temple & E. E. Milligan, UBC Faculty of Land and Food Systems

The table below presents the typical NPK granular fertilizer costs associated with the more traditional or “conventional” crop fertilizer NPK input practices.

NPK Fertilizer Type and Application Costs for Crops in Delta: Spring 2011

Fertilizer Type	Approximate Fall 2009 Cost $/1000kg	Approximate Spring 2011 Cost $/1000kg	Crop Recommended Fertilizer Application (kg/ha)				NPK Fertilizer Cost $/ha
			Bean	**Barley**	**Wheat**	**Potato**	
46-0-0	590	725					
11-52-0	800	900	330 (drill)				297
0-0-62	875	810					
Blends							
8-18-22	640	700				1100 (drill)	770
8-10-28	675	725	550 (broadcast)				399
18-19-19	740	830			495 (broadcast)		411
8-24-24	755	775		495 (broadcast)			384

As per Communications with Producers & Fertilizer Retailer Noel Roddick, April 2011

Typical Fertilizer Applications for Crops in Delta:
Potato Chip Mix is 8-18-22 @ 1000 lbs/ac - drilled
Beans 300 lbs/ac 11-52-0 drilled + 500 lbs/ac 8-10-28 + Sulpomag
Wheat 450 lbs/ac 18-19-19 broadcast
Barley 450 lbs/ac 8-24-24 broadcast

In terms of improving profits and reducing environmental risk many, if not all, of the fields we surveyed only required an application of N fertilizer to meet the crop NPK demands. Therefore, as a component of a “low-input” or “eco-friendly crop rotation” we calculated in the table below the crop input cost of only applying fertilizer N as urea; and as a comparison to the NPK costs of the previous table.

N Fertilizer Application Costs for Crops in Delta

Crop	Recommended N Application kg/ha	N - Urea Application kg/ha	N - Urea Fertilizer Costs $/ha
Bean*	36	79	57
Potato	88	191	139
Bean	44	96	69
Wheat	89	194	140
Barley	40	86	62

Furthermore, the table below calculates the significant spring 2011 saving that a producer could incur if only N as urea fertilizer was applied at the recommended rate as opposed to the typical NPK applications that are generally being recommended and applied. Urea is not approved for organic farmers and choices of alternate N sources with low associated P are limited.

N vs. NPK Fertilizer Savings for Crops in Delta

Crop	$/ha Savings When Only Urea - N Applied	$/ac Savings When Only Urea - N Applied	**Crop $/ac Savings When Only Urea - N Applied**
Bean*	240	97	
Potato	631	256	**256**
Bean	329	133	**230**
Wheat	270	109	**109**
Barley	321	130	**130**

*The starter N would be added to the broadcast N

So why are producers not reducing their fertilizer P and K inputs? From our discussions with growers we found that few either understood or appreciated soil testing as a means to assess fertilizer inputs upon their farm. Many growers either applied what "worked best in the past" or accepted the recommendations of those who are selling fertilizer.

Outreach: Integrated Nutrient Management Pilot Project

In 2005, a joint federal-provincial study of soil nutrient concentrations in the agricultural soils of the Fraser Valley established baseline data for the systematic evaluation of the Environmental Farm Plan and the Nutrient Management Planning subcomponent of that program. The general conclusions of this study directed attention toward accumulations of soil nutrients in the intensive agricultural environment of south-western B.C. As detailed in Appendix A and text of this report, our 3-year Eco-Friendly Crop Rotations Project, conducted with the cooperation of 11 practicing farmers in the Fraser River Delta, largely confirmed the findings of the 2005 regional nutrient study.

As part of our continuing commitment to bridging the knowledge of our practicing farmers; and, in discussions with the BCMAF's BC Nutrient Management Working Group (BCNMWG) and E.S.Cropconsult Ltd., we proposed and initiated an "Integrated Nutrient Management" (INM) pilot project in 2011. This pilot project is now in progress and is building directly from our lessons learned in cooperation with the growers of this region. Benchmark fields are being established by E.S.Cropconsult with the cooperation of growers that include the Fraser Valley and South Coastal regions. With the benchmark fields selected as representative of soil and cropping types, the available nutrient management tools; testing, monitoring, and planning tools are applied in consultation with the cooperating growers in a targeted effort to reduce surplus nutrient inputs and input costs while maintaining harvest yields and quality for the market.

Currently E.S.Cropconsult is providing an Integrated Pest Management (IPM) service to many producers in the region. It is hoped that their current IPM practice/service of monitoring pests and only using pesticide “on a need to apply basis” will also be advanced successfully towards “third party” soil testing/monitoring and subsequent fertilizer use/recommendations. The goal is to reduce fertilizer costs and/or increase profits for the producer; and, mitigate the risks to the environment from the overuse of fertilizers and manures.

For more information on this initiative, contact: E.S.Cropconsult Ltd.- Heather Meberg or DeLisa Lewis (604) 731-0294

2009 - 2010 Cereal Grains Variety Trials Results

For the variety trials planted during spring and winter of 2009 and 2010, we sourced 52 cereal grain varieties from geographic regions with similar biophysical conditions to South Coastal B.C. ***See Appendix C for a complete description of our variety selection criteria, seed sources, and planting method.*** Below is an overview description of our cereal variety trial methods and results.

In 2009, we trialed 6 varieties of spring wheat and 9 varieties of spring barley[5]. The following year, we planted 12 spring wheat varieties and 11 varieties of spring barley. Seeds for these grain trials came with cooperation of plant breeders working within the Pacific-Western region of the United States, and from the Canadian Prairies, Eastern/Great Lake and Maritimes regions. For the 2009-2010 over-winter cereal trials planted in September 2009, we established our demonstration plots with 16 varieties of winter wheat and 2 varieties of winter barley; and in 2010-2011 we planted 9 varieties of winter wheat and 5 varieties of winter barley. With the winter wheat and barley in these trials, in addition to the 4 regions represented in our spring trials, we added varieties sourced from the European Union (EU) and/or United Kingdom (UK).

At this time, several of our growers have begun importing and purchasing a number of the varieties we tested in our demonstrations. Of particular interest, are the following varieties: spring wheat, Glenlea, Norwell, Sable, Strongfield; and the spring barley Baronesse and CDC Bold. During our open house field demonstrations in 2010, a group of Vancouver Island growers visited our fields, and has since communicated their plans to include Glenlea and Monopol in their cropping systems. Similarly, growers from the Comox Valley and Haida Gwai (Queen Charlotte Islands) have been in contact and expressed interest in experimenting with cereal grains in their crop rotations and farm systems.

For the 2010 spring wheat demonstration trials, we added 5 spring wheat varieties and dropped 1 with poor stripe rust resistance from the Pacific Northwest. From 2009 to 2010, we trialed 17 distinct spring barley varieties. We planted 6 of the 2009 varieties again in the spring of 2010, and replaced 3 of these with 5 new varieties, again sourced from the Pacific-Western U.S., the Canadian Prairies-East Coast, and the U.K. In September 2010, we planted 9 varieties of winter wheat and 5 varieties of winter barley from these regions.

We focused our observations on those yield and quality characteristics measured by disease resistance, grain and straw harvest data, harvest heights, and grain test weights and percentage protein. In addition, we held open house field days in July of 2009 and 2010 in an effort to share our preliminary findings, and learn

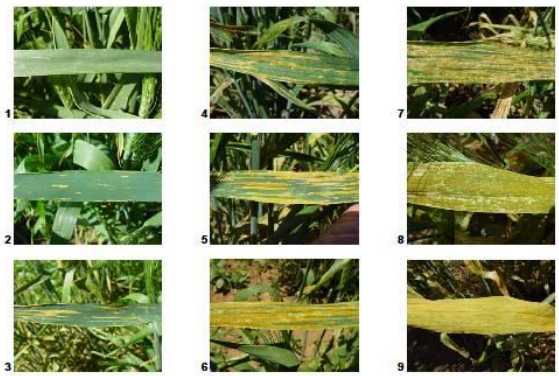
[5] Please see report appendices for a detailed overview of our grains selections with variety type and a summary of regional climatic data.

what impressed grain growers from Delta, the Fraser Valley, and the Islands on seeing the varieties side-by-side in the field. The sections that follow on spring wheat, spring barley, and over-winter cereals depict our results and graphically detail the variety-by-variety and year-to-year comparisons.

Techniques for testing cereal grain varieties are as follows. We targeted a seed density of 450 /m^2 for winter wheat demonstration trials. Each plot was 3 meters by 10 meters, arranged in a randomized complete block design with four replicate blocks (varieties randomly placed within each block). For spring wheat and winter barley, we targeted a seed density of 400 seeds/m^2. Our target seed density rate for spring barley was 350 seeds/$m^{2,}$ and for hulless oats, the rate was targeted at 500 seeds/m^2. The variety trials demonstration plots were seeded with a Vicon air seeder at 10 cm row widths.

We planted the 2009 and the 2010 spring crops as soon as conditions permitted in early May. Our planting dates for the 2009 spring trials were May 1st and 2nd, and in 2010, we planted the demonstration plots on May 5th. Our target planting date for over-winter cereals in both years of the trials was the first week of September. Our 2009 over-winter plant date was September 9th, and conditions in 2010 permitted winter grains planting on September 11th. Further discussion of the factors and impacts of planting dates for our region are detailed in the results section for over-winter cereals.

Compared with the 2009 growing season, 2010 was generally wetter and cooler. These cooler-wetter conditions were favourable for the spread of stripe rust, a disease of concern for grain growers in this region since the 1990s. This disease, known also as 'yellow rust' in the E.U., overwinters on cereals, adjacent crops, and grasses. In 2010, the incidence of stripe rust throughout the USA Pacific Northwest region was reportedly quite high. Below is the assessment key that we used to evaluate the incidence of stripe rust infections; and other diseases such as septoria and brown rust with respect to leaf area affected.



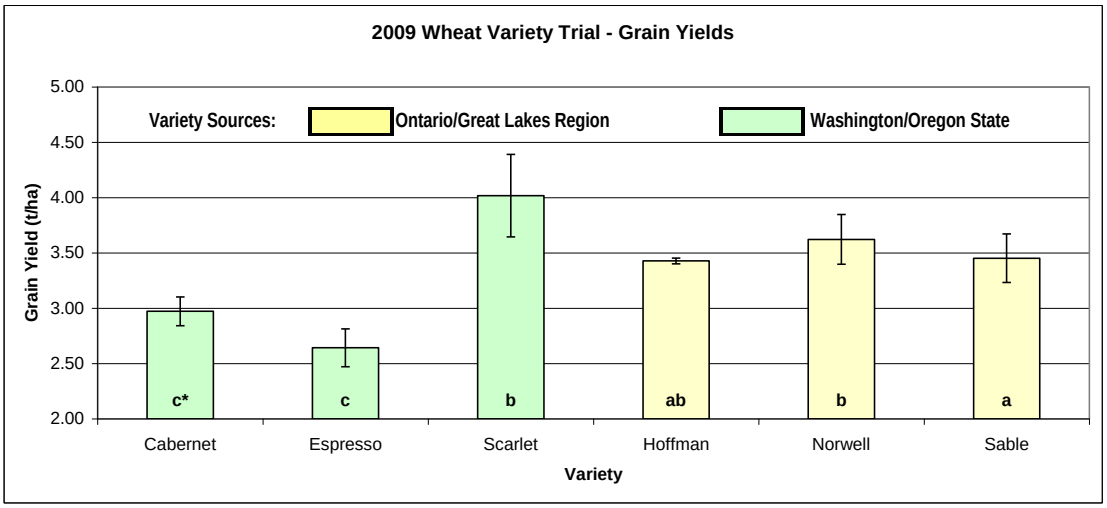
Score	Description
1	highly resistant: no visible symptoms
2	highly resistant: occasional symptoms of infection including necrotic flecks and small stripes without sporulation
3	resistant: symptoms evident and may include stripes with necrosis and chlorosis, limited sporulation, and affected leaf area up to 15%
4	moderately resistant: sporulating areas arranged in stripes, some chlorosis and necrosis, and affected leaf area up to 30%
5	intermediate: sporulating areas arranged in stripes with some chlorosis, and affected leaf area up to 50%
6	moderately susceptible: sporulating stripes and affected leaf area up to 70%
7	moderately susceptible to susceptible: sporulating stripes merging into broader leaf areas supporting symptoms; chlorosis and necrosis evident; leaf area affected up to 90%
8	susceptible: sporulation across the whole leaf surface with no stripes but with evidence of chlorotic areas
9	highly susceptible: abundant sporulation across the whole leaf area with no evidence of stripes
10	dead leaf

Pictured: *the harvest; our vintage Vulcan Iron Works (Winnipeg, Manitoba) stationary thresher – restored by Blake Lundstrum; collected grain; and a classic Pioneer "Clipper" dockage/seed cleaner.*

Spring Wheat Results: 2009 and 2010 overview and comparison

The following tables and graphs present results from the spring wheat variety trials with the grain and straw yields, grain protein, and disease resistance. While many of our farmer-cooperators tend to grow cereal grains for feed and straw markets, we are also looking for regionally adapted wheat varieties suitable to new marketing opportunities such as home and artisanal baking.

In 2009, an aphid infestation during the milk to early dough stage reduced our spring wheat yields. Looking more closely at the graphs, the Ontario sourced spring wheat, Hoffman, yielded within the average range, though it showed the least stripe rust disease resistance. Similarly, the Washington State spring wheat, Scarlet yielded well, but had relatively low stripe rust disease resistance near harvest. In contrast, Norwell, a variety from Ontario already planted by a few of our farmer-cooperators, performed well in all three categories of yield, crude protein % and disease resistance. Grain protein values appear to be inversely related to yield; possibly suggesting that available N at the test site was a bit low.



* After significant F-test (p<0.05) a Mean Separation (MS) was performed; means with the same letters are not significantly different
Note: heavy aphid – green, brown and black – infestation at milk stage; yields are considered relatively low

2009 Spring Wheat: Harvest Yields & Height

	Grain (t/ha)			Straw (t/ha)			Harvest Height (cm)		
Variety	**Mean**	sd	**MS**	**Mean**	sd	**MS**	**Mean**	sd	**MS**
Cabernet	2.97	0.13	c	2.62	0.42	bc	62	5	c
Espresso	2.64	0.17	c	2.28	0.34	c	60	5	c
Scarlet	4.02	0.37	a	3.21	0.98	ab	77	6	b
Hoffman	3.43	0.03	b	4.03	0.63	a	90	4	a
Norwell	3.62	0.23	ab	3.37	0.90	ab	75	9	b
Sable	3.45	0.22	b	3.55	0.28	a	73	5	b

After significant F-test (p<0.05) a Mean Separation (MS) was performed; means with the same letters are not significantly different
Note: heavy aphid – green, brown and black – infestation at milk stage; yields are considered relatively low

2009 Spring Wheat: Grain Quality Components

	Test Weight (kg/hL)			Protein (%)		
Variety	**Mean**	sd	**MS**	**Mean**	sd	**MS**
Cabernet	92	3	a	12.2	1.5	ab
Espresso	84	3	b	12.9	1.0	a
Hoffman	89	5	ab	10.6	0.2	b
Norwell	84	3	b	13.1	1.4	a
Sable	84	6	b	11.9	0.2	ab
Scarlet	91	3	a	11.5	1.1	ab

After significant F-test ($p<0.05$) a Mean Separation (MS) was performed; means with the same letters are not significantly different

Note: Minimum Protein content for Canada No. 1 is 10%

Note: Minimum test weight for Canada No. 1 is 75 kg/hL

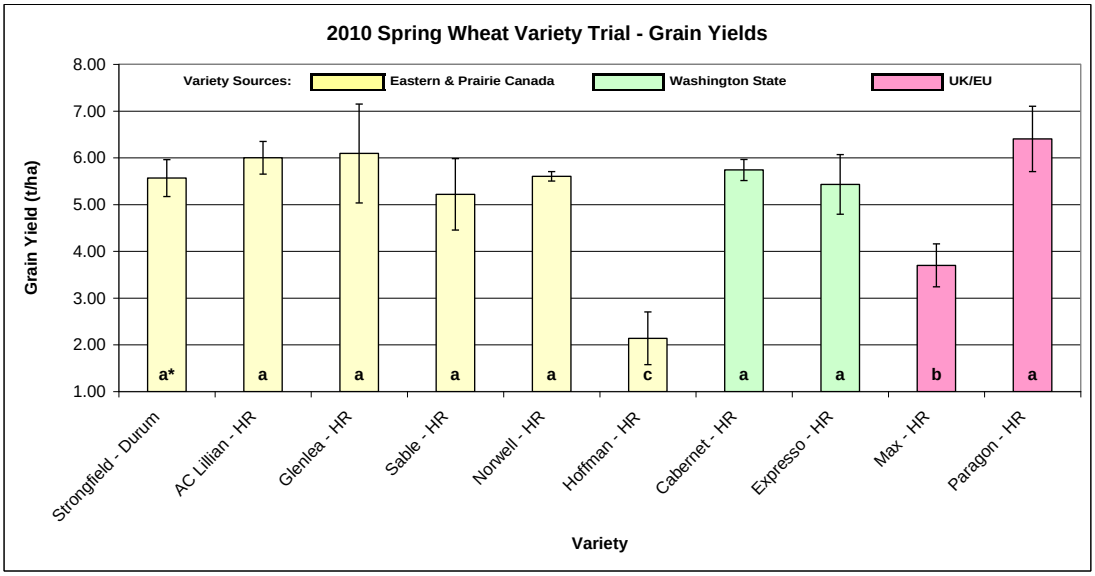
2009 Spring Wheat: Late Milk/Early Dough Disease Assessments/Ratings - GS 79 - 81

	Flag Leaf			Penultimate			Observed Disease	
Variety	**Mean**	sd	**MS**	**Mean**	sd	**MS**	**1° Disease**	**2° Disease**
Cabernet	4.0	0.5	b	4.3	1.2	b	Septoria	none
Espresso	3.6	1.2	b	3.0	1.1	b	Septoria	none
Hoffman	10.0	0.0	a	10.0	0.0	a	Stripe Rust	Septoria
Norwell	4.9	1.3	b	5.0	1.6	b	Septoria	none
Sable	4.2	0.6	b	3.9	0.6	b	Septoria	none
Scarlet	8.6	1.3	a	8.4	0.6	a	Stripe Rust	Septoria

After significant F-test ($p<0.05$) a Mean Separation (MS) was performed; means with the same letters are not significantly different

Note: At the time of assessment (late milk/early dough) the flag leaf for Hoffman was dead (rated 10) and for Scarlet the flag leaf was most susceptible to stripe rust. All other varieties demonstrated to be highly resistant to stripe rust; and their flag leaf ratings above are primarily related to incidence of Septoria. At this time all varieties were heavily infested with green, brown and some black aphids.

For the 2010 spring wheat variety demonstration, we added two varieties from the Canadian Prairies-East Coast and two varieties from the U.K. Hoffman, a variety from Ontario, which demonstrated poor disease resistance in our 2009 trial, again performed at the bottom of our 2010 disease assessment ratings. Norwell, another carry-over from Ontario in our 2009 trial, showed promise again as a candidate for bread making with its solid protein percentage results, yet showed relatively poor stripe rust resistance in our 2010 plots. However, grown



* After significant F-test ($p<0.05$) a Mean Separation (MS) was performed; means with the same letters are not significantly different.

on a field-scale in an adjacent area to our demonstration plots, we observed a stand of Norwell spring wheat that did not exhibit such high incidence of stripe rust. In our trials, Strongfield, Lillian, Glenlea, Sable, Cabernet, Expresso and Paragon were either resistant or highly resistant to stripe rust.

2010 Spring Wheat: Harvest Yields & Height

	Grain (t/ha)			Straw (t/ha)			Harvest Height (cm)		
Variety	**Mean**	sd	**MS**	**Mean**	sd	**MS**	**Mean**	sd	**MS**
Strongfield - Durum	**5.57**	0.39	a	**8.57**	1.51	ab	**110 - Lodged**	5	c
AC Lillian - HR	**6.00**	0.35	a	**8.62**	1.41	ab	**124 - Lodged**	2	b
Glenlea - HR	**6.09**	1.06	a	**9.79**	1.48	a	**137 - Lodged**	2	a
Sable - HR	**5.22**	0.76	a	**8.00**	1.13	ab	**110**	4	c
Norwell - HR	**5.61**	0.10	a	**8.77**	0.93	ab	**125**	2	b
Hoffman - HR	**2.14**	0.56	c	**6.34**	1.59	b	**113**	2	c
Cabernet - HR	**5.74**	0.23	a	**8.23**	0.91	ab	**87**	2	d
Expresso - HR	**5.43**	0.64	a	**7.35**	0.83	ab	**92**	1	d
Max - HR	**3.70**	0.46	b	**7.71**	0.51	ab	**110**	6	c
Paragon - HR	**6.41**	0.70	a	**8.43**	0.90	ab	**108**	2	c

After significant F-test ($p<0.05$) a Mean Separation (MS) was performed; means with the same letters are not significantly different.

In addition to those varieties depicted in the graphic results and tables here, we planted 2 varieties of hard, white, spring wheat from the Canadian Prairies: Snowstar and Snowbird. Both of these were highly susceptible to stripe rust and both of these varieties lodged in the field trials. Deemed unacceptable to our coastal conditions, neither variety was harvested. Three other prairie varieties, Lillian, Glenlea, and Strongfield, also grew tall and lodged after a heavy rain, late in the season. Unlike the Snowstar and Snowbird varieties, Lillian and Strongfield demonstrated the best resistance to stripe rust out of all 5 prairie spring wheat tested.

2010 Spring Wheat: Flag Leaf Disease Assessments/Ratings

	Stripe Rust - GS 50 to 60			Septoria - GS 70 to 75		
Variety	**Mean**	sd	**MS**	**Mean**	sd	**MS**
Strongfield - Durum	1.8	0.5	d	1.0	0.0	b
AC Lillian - HR	1.5	0.6	d	2.8	1.0	a
Glenlea - HR	3.5	0.6	c	1.0	0.0	b
Sable - HR	2.0	0.0	d	1.0	0.0	b
Norwell - HR	5.8	0.5	b	n	-	-
Hoffman - HR	8.8	0.5	a	n	-	-
Cabernet - HR	1.3	0.5	d	1.0	0.0	b
Expresso - HR	1.3	0.5	d	1.0	0.0	b
Max - HR	6.5	0.6	b	n	-	-
Paragon - HR	1.8	0.5	d	3.3	1.0	a

After significant F-test ($p<0.05$) a Mean Separation (MS) was performed; means with the same letters are not significantly different.

Note: Disease rating 1 (highly resistant) to 9 (highly susceptible); n, >90% flag leaf necrotic due to earlier stripe rust infections

2010 Spring Wheat: Grain Quality Components

	Test Weight (kg/hL)			Protein (%)		
Variety	**Mean**	sd	**MS**	**Mean**	sd	**MS**
Strongfield - Durum	90	5	ab	10.8	1.0	ab
AC Lillian - HR	93	2	ab	12.0	1.1	a
Glenlea - HR	93	3	ab	10.7	1.5	ab
Sable - HR	96	2	a	10.3	0.8	ab
Norwell - HR	90	3	ab	10.3	0.2	ab
Hoffman - HR	77	3	c	-	-	-
Cabernet - HR	89	3	ab	10.1	0.3	ab
Expresso - HR	93	5	ab	10.2	1.2	ab
Max - HR	88	1	ab	-	-	-
Paragon - HR	88	3	ab	9.4	0.5	b

After significant F-test ($p<0.05$) a Mean Separation (MS) was performed; means with the same letters are not significantly different.

Note: Minimum Protein content for Canada No. 1 is 10%

Note: Minimum test weight for Canada No. 1 is 75 kg/hL

AC Lillian, a widely used bread-making variety from the Canadian Prairies, had the highest grain protein, despite being one of the highest yielders. Its robust stripe rust resistance may have facilitated late season N uptake that contributed to grain protein development. Relative to 2009, grain yields in 2010 were up, while protein levels were down. All of the varieties in our trials demonstrated adequate protein for use as animal feed. To increase grain protein levels and obtain better harvest qualities for a bread-making market, we recommend attention to soil and fertilizer N levels. For the soil and climatic conditions of our region, growers on soils low in organic matter or not having a history of regular poultry-based compost-manure applications, may need to increase fertilizer N if the higher protein levels in the harvested grain are part of their marketing plans.

We recommend based on good stripe rust resistance, resistance to lodging, higher test weights, and comparatively high straw and grain yields the following spring wheat varieties: Sable, Glenlea, Lillian, Strongfield, Expresso, Cabernet, and Paragon. The ease of availability of the spring wheat seeds to our regional growers, currently favor Glenlea, which has national registration and Sable, Lillian, and Strongfield, which have regional registrations in Canada. For varieties limited to regional registration in Canada, producers or their local supplier would need to obtain Canadian Food Inspection Agency (CFIA) approval.

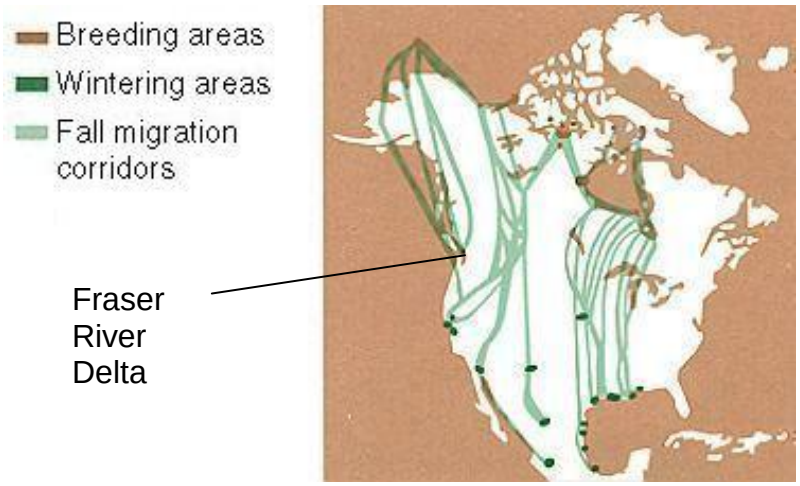
Winter Cereal Results: 2009/2010 overview

Over-winter cereals are said to be a preferred crop by many of our cooperating growers. This preference may be related to the relatively higher yields and early maturity of the crops, which are most often harvested in our region from late July to early August. Generally, this time-period within our climate zone tends towards limited rainfall and good drying conditions for harvest and baling straw. Winter cereals also provide good soil cover and an established spring crop for the frequently heavy precipitation and challenging early spring conditions of South Coastal B.C. We have found waterfowl grazing and soils with inadequate

drainage were considerable barriers to the establishment of over-winter cereal crops on the Fraser River Delta.

To put in context the biophysical conditions and wildlife corridor surrounding the Fraser River Delta where our demonstration trials were located, see the accompanying maps of Snow Goose and Widgeon winter migratory and staging areas. The Fraser River Delta is one of the largest estuaries on the Pacific North Coast, and this estuary provides habitat to Canada's highest density and diversity of wintering birds. Snow Geese and American Widgeon are over-wintering waterfowl common to our region, and these species make regular use of the upland habitat. Upland habitat in the Fraser River Delta is predominantly in use as farmland. Overwintering cover and cereal crops are frequently subjected to repeated grazing by migratory waterfowl.

Lesser Snow Goose Migratory Routes & Staging Areas



American Widgeon Staging Areas

The soils of the Fraser River Delta are heavy-textured and naturally poorly drained. Therefore, for winter cereals to survive waterfowl grazing and to over-winter successfully, the soils need subsurface and surface drainage. Standing water or poorly drained areas within fields tend to weaken overwinter crops and these fields are particularly vulnerable to heavy waterfowl use.

The total precipitation in South Coastal BC ranges from an average of 900 mm on the Fraser River Delta, to close to 1500 mm inland. The majority of this precipitation falls between the months of November and March. Air temperatures, averaging from 5-13C annually, are similar to that of the U.K[6].

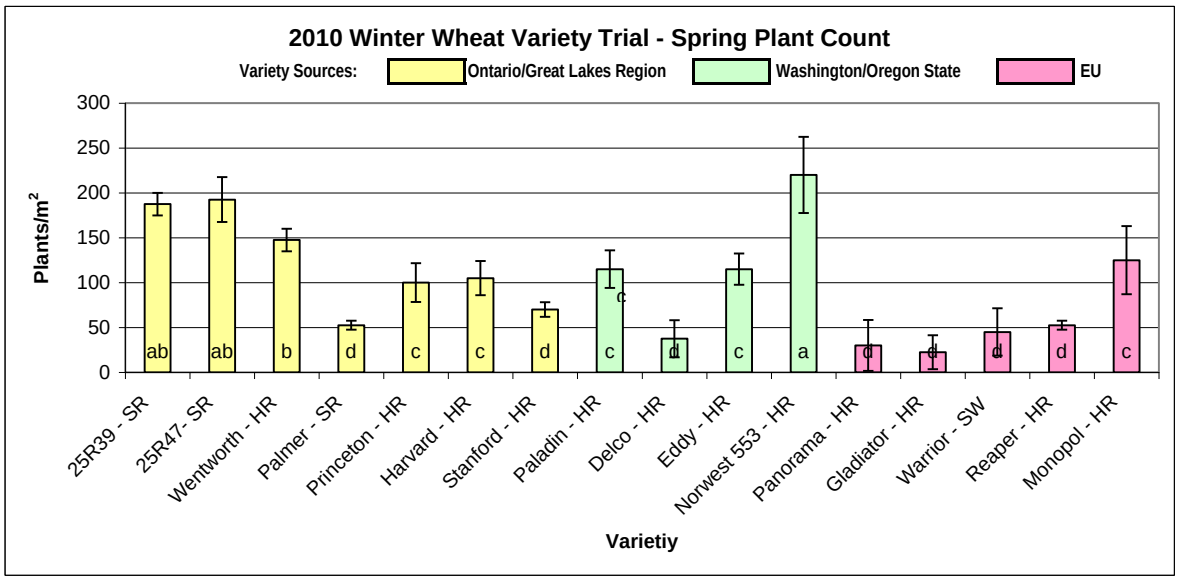
The photograph sequences depict our 2009-2010 winter cereal plots. Per the local wisdom on over-winter crop planting dates, we planted the 2009 and 2010 crops during early September. Crops planted later than this tend to have difficulties withstanding waterfowl grazing in our region. Those with no established crown stand little chance of re-growth after waterfowl grazing.

2009 Winter Cereal Trial: Before (Oct 25, 2009) & After Grazing (Nov 23, 2009) by American Widgeon

Winter Cereal Trial (March 26, 2010) After Over-winter Widgeon and Snow Geese

[6] Environment Canada, Canadian Climate Normals 1971-2000 (Delta-Ladner South Climate Station; Daily Minimum and Maximum Average Temperature for the Year) http://www.climate.weatheroffice.gc.ca/climate_normals/results_e.html?Province=ALL&StationName=Delta&SearchType=BeginsWith&LocateBy=Province&Proximity=25&ProximityFrom=City&StationNumber=&IDType=MSC&CityName=&ParkName=&LatitudeDegrees=&LatitudeMinutes=&LongitudeDegrees=&LongitudeMinutes=&NormalsClass=A&SelNormals=&StnId=761&start=1&end=13&autofwd=0

Over the 2009-early 2010 winter, Widgeon grazed the crop nightly. Once the hunting season was over, the snow geese began to graze the plots. With the waterfowl pressure and heavy rainfall, the soils also became compacted and sealed. By early spring, some varieties had a much-reduced stand, while others were somewhat more effective at surviving such intensive waterfowl grazing.



After significant F-test ($p<0.05$) a Mean Separation (MS) was performed; means with the same letters are not significantly different.

According to the Home Grown Cereals Authority (HGCA) of the U.K., a spring plant population close to 125 plants/m^2 is necessary to achieve a good potential grain yield [7]. Wheat varieties in our trial were well tillered and had a plant density of roughly 360 plants/m^2/ at the time of first grazing in late October 2009. By the spring of 2010, Norwest 553 had a stand greater than 200 plants/m^2. Wentworth, 25R37, and 25R47 closely followed this with stands between 150 and 200 plants/m^2. Varieties with stands close to 125 plants/m^2 -the cut-off point to achieve good grain production - included Monopol, Princeton, Harvard, Eddy and Paladin. Varieties with stands close to 50 or fewer plants/m^2 after over-winter grazing included: Palmer, Stanford, Delco, Warrior, Gladiator, Panorama and Reaper.

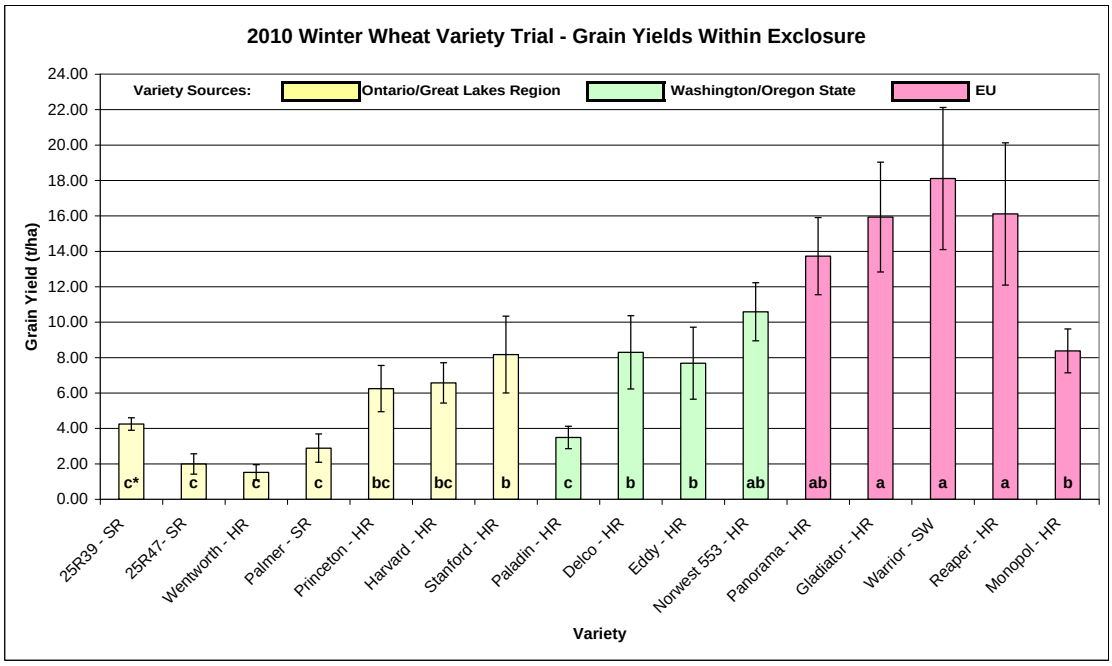
Why some varieties are able to withstand the intensive grazing more than others remains unclear. There was, however, a strong correlation (p-value <0.0001) between the fall height of the crop prior to grazing and the spring plant counts after grazing. This correlation suggests that stands which were close to 15 cm or greater in height prior to grazing in the fall also had spring stand densities close to 125 plants/m^2 or greater. Provided the soils were adequately drained, varieties that established rapidly and achieved heights of 15 cm or greater, demonstrated greater resistance to waterfowl grazing overall.

[7] http://www.hgca.com/content.template/0/0/Home/Home/Home.mspx

As previously mentioned, the effects of waterfowl grazing reduced the spring stands of many varieties. However, all plots had fenced enclosures positioned to provide a small sample area (0.50m^2) where grazing was prevented. The grazed areas for many plots subsequently became heavily infested with weeds. As a measure of precaution for the surrounding fields, we removed these weeds with a weed whacker. Therefore, the following discussion with respect to harvest grain and straw yields, height, test weights and protein levels are limited to the context of cereal varieties ***within the fenced enclosure areas***.

We planted two winter barleys, an Ontario variety called MacKellar, and an Oregon variety called Strider, in September 2009 for the winter grains variety trials. Both established much faster than the winter wheat varieties. MacKellar did not survive the winter, and this may have been related to the wet, over-winter soil conditions. For Strider, the spring stand in the waterfowl grazed area was only 70 plants/m^2. The heads were very small and sparse at maturity, and these plots were consequently not harvested. Although we did not harvest Strider, we did observe good stripe rust resistance, and would recommend it for its potential as a fast-establishing cover crop. The 2010-2011 over-winter cereal trial included 5 varieties of winter barley sourced from the United Kingdom (U.K.).

We observed a wide range of yields from the winter wheat varieties measured from within the fenced enclosures during the harvest of 2010. The grain and straw yields obtained with the U.K. varieties, Warrior, Gladiator, Panorama and



* After significant F-test ($p<0.05$) a Mean Separation (MS) was performed; means with the same letters are not significantly different

Reaper, were very high relative to the yields obtained with varieties from

2010 Winter Wheat: Harvest Yields & Height - Within Exclosure Area

	Grain (t/ha)			Straw (t/ha)			Harvest Height (cm)		
Variety	**Mean**	sd	**MS**	**Mean**	sd	**MS**	**Mean**	sd	**MS**
25R39 - SR	**4.25**	0.35	c	**9.02**	1.92	b	**89**	4	c
25R47- SR	**1.99**	0.57	c	**6.27**	0.40	bc	**79**	3	d
Wentworth - HR	**1.52**	0.43	c	**5.57**	1.11	c	**77**	3	d
Palmer - SR	**2.89**	0.80	c	**7.60**	1.23	b	**89**	2	c
Princeton - HR	**6.25**	1.30	bc	**9.42**	0.67	b	**100**	2	b
Harvard - HR	**6.57**	1.14	bc	**11.36**	3.03	a	**98**	2	b
Stanford - HR	**8.17**	2.17	b	**11.08**	2.47	ab	**87**	2	c
Paladin - HR	**3.49**	0.63	c	**10.20**	2.17	ab	**97**	4	b
Delco - HR	**8.29**	2.07	b	**13.77**	3.89	a	**100**	3	b
Eddy - HR	**7.68**	2.03	b	**10.15**	3.96	ab	**98**	4	b
Norwest 553 - HR	**10.59**	1.64	ab	**13.01**	1.51	a	**92**	1	bc
Panorama - HR	**13.72**	2.18	ab	**13.03**	0.95	a	**82**	2	cd
Gladiator - HR	**15.93**	3.10	a	**14.51**	1.28	a	**86**	3	c
Warrior - SW	**18.11**	4.01	a	**15.59**	2.19	a	**83**	4	cd
Reaper - HR	**16.11**	4.01	a	**16.98**	3.45	a	**99**	5	b
Monopol - HR	**8.38**	1.24	b	**13.75**	1.25	a	**114**	3	a

After significant F-test (p<0.05) a Mean Separation (MS) was performed; means with the same letters are not significantly different.

Ontario/Great Lakes region and from Washington/Oregon State. With the exception of Monopol, all other varieties were less than 100cm in height. Note that these yields from exclosure plots provide useful comparisons among varieties, but likely overestimate field scale yields.

There was a strong negative correlation (p<0.001) between grain yields, Thousand Grain Weights (TGW) and Test Weights with the incidence of stripe rust infections.

Winter wheat protein levels were highest with varieties obtained from Ontario, which included, Harvard, Stanford and, to a lesser extent, Princeton. Grain protein levels for Norwest 553, Monopol, Reaper, Warrior, Gladiator and Panorama were very low. This is most likely related to the low level soil N fertilizer application and very high yields that were obtained with these varieties.

2010 Winter Wheat: Grain Quality Components

	Test Weight (kg/hL)			Protein (%)		
Variety	**Mean**	sd	**MS**	**Mean**	sd	**MS**
25R39 - SR	89	7	a	-	-	-
25R47- SR	82	2	ab	-	-	-
Wentworth - HR	75	15	b	-	-	-
Palmer - SR	85	6	ab	-	-	-
Princeton - HR	83	1	ab	10.3	0.4	b
Harvard - HR	91	2	a	11.7	1.3	a
Stanford - HR	89	3	a	12.0	1.0	a
Paladin - HR	85	3	ab	-	-	-
Delco - HR	87	2	ab	-	-	-
Eddy - HR	87	3	ab	-	-	-
Norwest 553 - HR	87	3	ab	8.2	0.3	c
Panorama - HR	85	3	ab	7.3	0.8	cd
Gladiator - HR	84	2	ab	6.7	0.1	cd
Warrior - SW	83	1	ab	7.0	0.5	cd
Reaper - HR	82	1	ab	6.5	0.3	d
Monopol - HR	88	3	a	7.0	0.5	cd

After significant F-test (p<0.05) a Mean Separation (MS) was performed; means with the same letters are not significantly different.

Note: Minimum Protein content for Canada No. 1 is 10%

Note: Minimum test weight for Canada No. 1 is 75 kg/hL

Varieties with high stripe rust infections were not analyzed for protein.

As was the case with the 2010 spring wheat variety trail, the incidence of stripe rust on the flag leaf was quite high and occurred during the earliest growth stages. During grain development, we found a low level incidence of septoria on the flag leaf. Some incidental brown rust was also observed on the Monopol plots in our trials.

With the impacts on yield referenced above, we consider the selection of stripe-resistant varieties to be an essential component for the development of low-input grains for this region. Varieties with greater susceptibility to stripe rust can provide an over-winter habitat for spores, and subsequently infect other crops, such as spring wheat. Therefore, varieties such as 25R39, 25R47, Wentworth, Delco and Palmer, with observed high levels infection early in crop development, are not recommended for use in our region. Princeton and Eddy appeared susceptible to stripe rust infections at the later growth stages, and would be recommended with a note of caution.

2010 Winter Wheat: Flag Leaf Disease Assessments/Ratings

	Stripe Rust - GS 49 to 59			Septoria - GS 75 to 80		
Variety	**Mean**	sd	**MS**	**Mean**	sd	**MS**
25R39 - SR	5.0	0.0	ab	n	-	-
25R47- SR	6.8	0.5	a	n	-	-
Wentworth - HR	6.0	1.2	a	n	-	-
Palmer - SR	7.0	0.8	a	n	-	-
Princeton - HR	3.5	1.0	ab	6.0	0.5	a
Harvard - HR	2.3	1.0	bc	6.3	1.0	a
Stanford - HR	1.8	1.0	bc	6.5	0.6	a
Paladin - HR	3.5	1.0	ab	n	-	-
Delco - HR	5.0	0.8	ab	n	-	-
Eddy - HR	3.3	1.0	b	n	-	-
Norwest 553 - HR	1.3	0.5	c	3.0	0.3	b
Panorama - HR	1.0	0.0	c	3.5	0.6	b
Gladiator - HR	1.0	0.0	c	2.5	0.6	b
Warrior - SW	1.0	0.0	c	2.8	0.5	b
Reaper - HR	2.5	0.6	bc	3.5	0.6	b
Monopol - HR	3.0	0.8	b	3.8	0.5	b

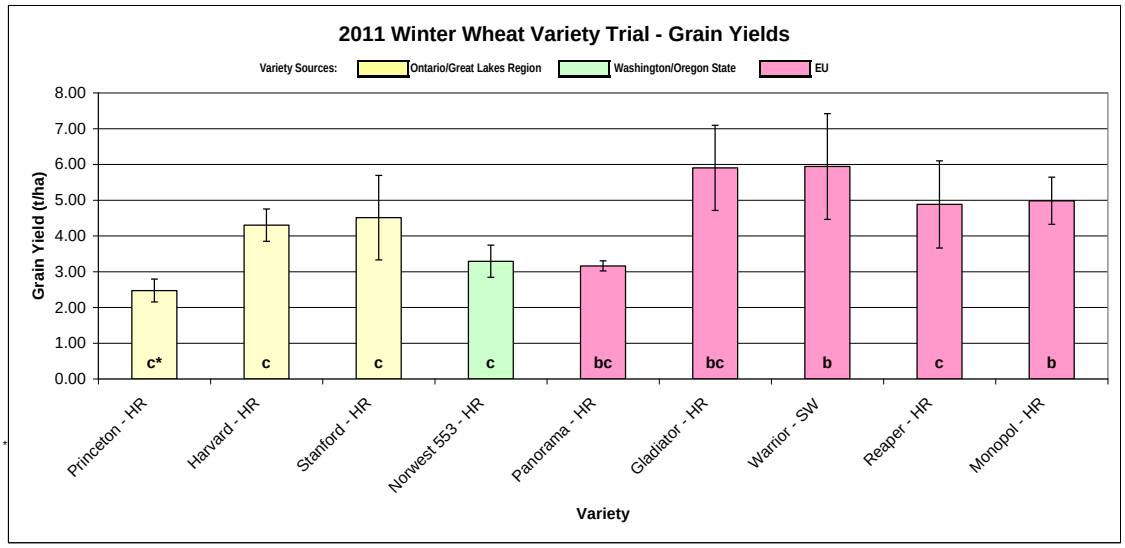
After significant F-test ($p<0.05$) a Mean Separation (MS) was performed; means with the same letters are not significantly different.
Note: Disease rating 1 (highly resistant) to 9 (highly susceptible); n, >90% flag leaf necrotic due to earlier stripe rust infections

The varieties with greatest resistance to stripe rust were: Norwest 553, Harvard, Stanford, Reaper, Monopol, Panorama, Gladiator and Warrior. The latter three varieties from the U.K. (Panorama, Gladiator, and Warrior) were the top performers with stripe rust resistance. Therefore, we would recommend this list of stripe-rust resistant varieties most highly for cropping within the South Coastal B.C. region. In areas subject to stripe rust *and* heavy, over-winter waterfowl grazing (i.e. Fraser River Delta) the best performers on the list were Norwest 553, Monopol, and possibly Harvard. We found these varieties need to be planted relatively early (target early September), and on adequately drained soils. This increases the likelihood that the crop will be well tillered and have a good crown to withstand the impacts associated with intensive over-winter grazing by waterfowl.

Currently, none of the recommended varieties above has national registration in Canada. Only Harvard and Stanford have regional registration for growers in the Ontario area. Availability for these varieties to South Coastal B.C. producers would be subject to CFIA approval.

Winter Wheat Results: 2010/2011 overview and comparison

Waterfowl grazing was not much of an issue for the 2010/11 winter cereal variety trial. However, the spring of 2011 was one of the coldest and wettest on record. This resulted in not only the late planting of many crops, but also limited the ability for growers to effectively apply fertilizer nitrogen and herbicides in a timely and/or effective manner to winter cereals. As a consequence, the yields within



After significant F-test (p<0.05) a Mean Separation (MS) was performed; means with the same letters are not significantly different.

2011 Winter Wheat: Harvest Yields & Height

	Grain (t/ha)			Straw (t/ha)			Harvest Height (cm)		
Variety	**Mean**	sd	**MS**	**Mean**	sd	**MS**	**Mean**	sd	**MS**
Princeton - HR	**2.47**	0.32	c	**9.46**	2.43	b	**113**	9	a
Harvard - HR	**4.30**	0.45	b	**11.08**	1.63	ab	**105**	4	ab
Stanford - HR	**4.51**	1.18	b	**8.42**	1.98	b	**90**	9	b
Norwest 553 - HR	**3.29**	0.45	bc	**9.23**	1.71	b	**88**	8	b
Panorama - HR	**3.16**	0.14	bc	**4.33**	0.97	c	**73**	4	c
Gladiator - HR	**5.90**	1.19	a	**9.11**	1.74	b	**84**	10	bc
Warrior - SW	**5.94**	1.48	a	**8.40**	1.11	b	**75**	7	c
Reaper - HR	**4.88**	1.22	ab	**8.66**	1.46	b	**93**	5	b
Monopol - HR	**4.98**	0.66	ab	**12.21**	1.66	a	**117**	5	a

After significant F-test (p<0.05) a Mean Separation (MS) was performed; means with the same letters are not significantly different.

our variety trials were much reduced in comparison to the 2010 harvest. None-the-less, UK/EU varieties, such as Gladiator, Warrior, Reaper and Monopol, continued to provide some of the highest grain and straw yields. Panorama's stand was not good come spring due to winter-kill and/or wet over-winter soil conditions. Varieties from eastern Canada, such as Princeton, Harvard and

Stanford, and Monopol and Reaper grew tall. The earliest to mature were also the varieties from eastern Canada, while Monopol was the last to mature.

With the exception of Princeton and, to some extent Reaper, all other varieties continued to provide good stripe rust resistance. As in the previous year, eastern

2011 Winter Wheat: Flag Leaf Disease Assessments/Ratings

	Stripe Rust - GS 59 to 65			Septoria - GS 59 to 65		
Variety	**Mean**	sd	**MS**	**Mean**	sd	**MS**
Princeton - HR	5.3	0.5	a	1.0	0.0	b
Harvard - HR	1.7	0.9	c	3.0	0.8	a
Stanford - HR	1.0	0.0	c	3.3	0.5	a
Norwest 553 - HR	1.7	1.5	c	1.0	0.3	b
Panorama - HR	2.0	1.1	c	1.0	0.0	b
Gladiator - HR	1.3	0.5	c	1.0	0.0	b
Warrior - SW	2.5	0.6	bc	1.0	0.0	b
Reaper - HR	4.5	0.6	a	1.0	0.0	b
Monopol - HR	3.3	0.9	b	1.0	0.0	b

After significant F-test ($p<0.05$) a Mean Separation (MS) was performed; means with the same letters are not significantly different.

Note: Disease rating 1 (highly resistant) to 9 (highly susceptible); n, >90% flag leaf necrotic due to earlier stripe rust infections

Canadian varieties Harvard and Stanford had some evidence of septoria, but not much.

In general, test weights were good for all varieties, and best for Stanford,

2011 Winter Wheat: Grain Quality Components

	Test Weight (kg/hL)			Protein (%)		
Variety	**Mean**	sd	**MS**	**Mean**	sd	**MS**
Princeton - HR	83	2	bc	10.0	n/a	n/a
Harvard - HR	82	2	bc	8.1	n/a	n/a
Stanford - HR	90	3	a	7.4	n/a	n/a
Norwest 553 - HR	87	2	ab	7.1	n/a	n/a
Panorama - HR	83	2	bc	6.6	n/a	n/a
Gladiator - HR	86	2	b	5.6	n/a	n/a
Warrior - SW	81	2	bc	5.6	n/a	n/a
Reaper - HR	86	2	b	5.7	n/a	n/a
Monopol - HR	87	3	ab	7.2	n/a	n/a

After significant F-test ($p<0.05$) a Mean Separation (MS) was performed; means with the same letters are not significantly different.

Note: Minimum Protein content for Canada No. 1 is 10%

Note: Minimum test weight for Canada No. 1 is 75 kg/hL

Norwest and Monopol. Because of the late fertilizer application grain protein levels were very low – hence only one sample was analyzed. Low protein in feed grains can be supplemented in feeding regimes, however, all of the 2011 winter wheats , with the possible exception of Stanford, fell below bread making standards.

Winter Barley Results: 2010/2011 overview

The winter barley matured by mid-July, some three to four weeks earlier than winter wheat. All five winter barley varieties (Flagon, Winsome, Retriever, Suzuka, and Vanquish) tested in 2010/11 provided relatively good resistance to stripe and brown rust and septoria; and yields of both straw and grain were also relatively good. Test weights were also good for all varieties. Protein levels were low, but suitable for malting and feed - only one sample was analyzed.

2011 Winter Barley: Harvest Yields & Height

	Grain (t/ha)			Straw (t/ha)			Harvest Height (cm)		
Variety	**Mean**	sd	**MS**	**Mean**	sd	**MS**	**Mean**	sd	**MS**
Flagon - 2 row/malting	**6.08**	0.44		**6.68**	1.10		**74**	2	ab
Retriever - 2 row/feed	**5.87**	0.91		**5.35**	0.60		**67**	3	bc
Suzuka - 2 row/feed	**4.98**	0.56		**5.33**	1.06		**70**	4	c
Vanquish - 2 row/malting	**5.34**	0.46		**6.30**	0.81		**67**	3	bc
Winsome - 2 row/malting	**5.30**	0.67		**6.20**	0.61		**76**	5	a

After significant F-test (p<0.05) a Mean Separation (MS) was performed; means with the same letters are not significantly different.

2011 Winter Barley: Flag Leaf Disease Assessments/Ratings

	Stripe Rust - GS 75 - 80			Septoria - GS 75 - 80			Brown Rust - GS 75 - 80		
Variety	**Mean**	sd	**MS**	**Mean**	sd	**MS**	**Mean**	sd	**MS**
Flagon - 2 row/malting	1.0	0.0		1.0	0.0		2.3	0.5	a
Retriever - 2 row/feed	1.0	0.0		1.0	0.0		2.3	0.5	a
Suzuka - 2 row/feed	1.0	0.0		1.0	0.0		1.5	0.6	b
Vanquish - 2 row/malting	1.0	0.0		1.0	0.0		1.0	0.0	b
Winsome - 2 row/malting	1.0	0.0		1.0	0.0		1.3	0.5	b

After significant F-test (p<0.05) a Mean Separation (MS) was performed; means with the same letters are not significantly different.

Note: Disease rating 1 (highly resistant) to 9 (highly susceptible); n, >90% flag leaf necrotic due to earlier stripe rust infections

2011 Winter Wheat: Grain Quality Components

	Test Weight (kg/hL)			Protein (%)		
Variety	**Mean**	sd	**MS**	**Mean**	sd	**MS**
Flagon - 2 row/malting	80	1	a	5.3	n/a	n/a
Retriever - 2 row/feed	77	1	bc	5.6	n/a	n/a
Suzuka - 2 row/feed	78	2	b	6.8	n/a	n/a
Vanquish - 2 row/malting	78	2	b	6.3	n/a	n/a
Winsome - 2 row/malting	76	1	bc	5.8	n/a	n/a

After significant F-test (p<0.05) a Mean Separation (MS) was performed; means with the same letters are not significantly different.

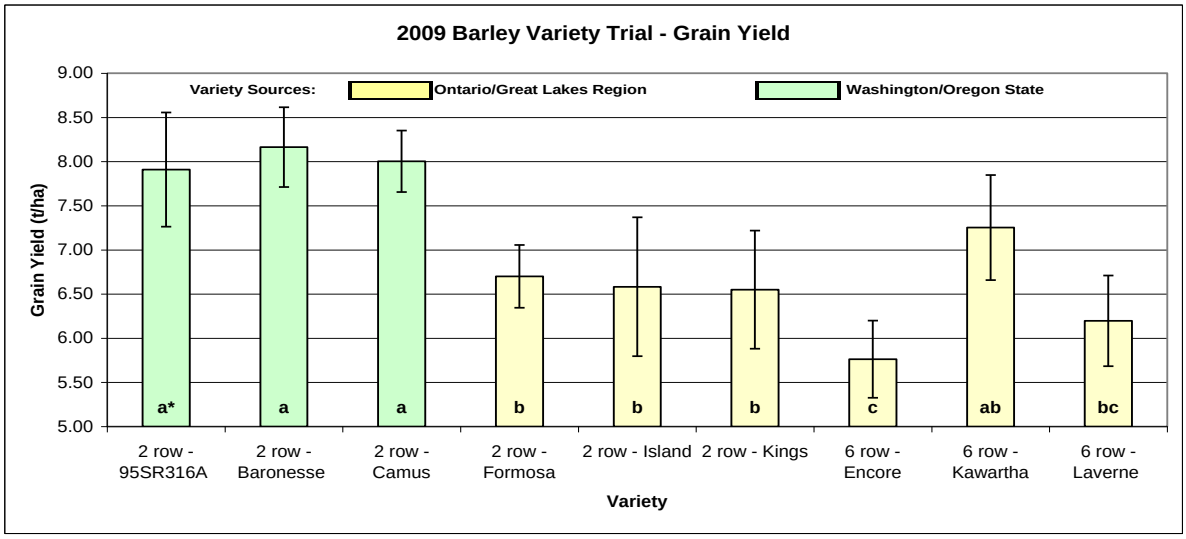
Note: Minimum test weight for Canada No. 1 is 63 kg/hL for 2-row and 62 for six-row

Upon planting, the winter barley established much faster (e.g. height and cover) then winter wheat. Some of the best weed control was with the taller growing varieties Flagon and Winsome.

Our variety trial was planted on September 11, 2010 and established and grew much faster then the winter wheat planted in adjacent plots on the same day. By early November the winter barley was 25 to 30 cm tall, compared to 15 to 20 cm for the winter wheat (data not presented). By mid December, much of the winter barley had begun to lodge; and, by early February many plants had become smothered and some consequently died. This led to a patchy stand for all varieties come spring. It is unclear at this time as to what caused this. Perhaps the crop was planted too early and/or the over-winter soil conditions were too wet.

Spring Barley Results: 2009 and 2010 overview and comparison

Compared with spring barley variety trials in 2009, our 2010 varieties were taller and straw yields were higher. Straw yields compared across all varieties for both years were similar, however the 2010 straw yield numbers were nearly double those measured for 2009. This may be attributed in large part to the contrasting weather conditions of the two years. In both years, the 6-row barley varieties generally grew taller relative to the 2-row types, with Sundre and Kawartha on top in 2010. At maturity, we observed *brackling*, or buckling in the lower part of the stem, with the tallest variety, Sundre. Brackling is an expression of the standing power of the straw, and is not necessarily an indication of a damaged crop unless the ears lie on the soil surface[8].



* After significant F-test (p<0.05) a Mean Separation (MS) was performed; means with the same letters are not significantly different

2009 Spring Barley: Harvest Yields & Height

	Grain (t/ha)			Straw (t/ha)			Harvest Height (cm)		
Variety	**Mean**	sd	**MS**	**Mean**	sd	**MS**	**Mean**	sd	**MS**
2 row - 95SR316A	7.91	0.65	a	4.43	0.12	ab	70	3	c
2 row - Baronesse	8.16	0.45	a	4.99	0.28	a	61	3	d
2 row - Camus	8.00	0.35	a	4.97	0.25	a	69	6	c
2 row - Formosa	6.70	0.36	b	4.17	0.54	bc	65	7	cd
2 row - Island	6.58	0.79	b	4.63	0.36	ab	75	4	ab
2 row - Kings	6.55	0.67	b	4.61	0.26	ab	75	4	ab
6 row - Encore	5.76	0.44	c	4.48	0.32	ab	81	5	a
6 row - Kawartha	7.25	0.59	ab	3.81	0.51	c	74	5	ab
6 row - Laverne	6.20	0.51	bc	4.12	0.33	bc	80	5	a

After significant F-test (p<0.05) a Mean Separation (MS) was performed; means with the same letters are not significantly different

[8] http://www.afbini.gov.uk/index/services/services-specialist-advice/reclists-homepage/reclists-cereal-homepage/reclists-cereals-characteristics.htm

2009 Spring Barley: Late Milk/Early Dough Disease Assessments/Ratings - GS 79 - 81

	Flag Leaf			Penultimate			Observed Disease	
Variety	**Mean**	sd	**MS**	**Mean**	sd	**MS**	**1° Disease**	**2° Disease**
2 row - 95SR316A	1.9	0.5	bc	2.5	0.5	c	Septoria	none
2 row - Baronesse	2.0	0.6	bc	3.8	0.8	ab	Septoria	Stripe Rust
2 row - Camus	2.8	0.3	b	3.7	0.6	ab	Septoria	none
2 row - Formosa	2.5	0.4	b	4.3	0.8	a	Septoria	Stripe Rust
2 row - Island	1.7	0.3	c	2.7	0.5	bc	Septoria	none
2 row - Kings	3.4	0.2	a	4.5	1.0	a	Septoria	none
6 row - Encore	2.1	0.3	bc	2.4	0.2	c	Septoria	none
6 row - Kawartha	1.8	0.3	c	3.3	0.7	ab	Septoria	none
6 row - Laverne	2.5	0.5	b	3.6	1.4	ab	Septoria	none

After significant F-test (p<0.05) a Mean Separation (MS) was performed; means with the same letters are not significantly different

Note: Disease rating 1 (highly resistant) to 9 (highly susceptible); At ZGS 65 the flag and penultimate leaves were clean; methods of disease assessments key/rating are the same - in terms of % area infected – as described/used for stripe rust; low level stripe rust infections upon Formosa and Baronesse very late in season; difficult to rate/distinguish senescence from septoria/stripe rust; no scald/leaf blotch or net blotch.

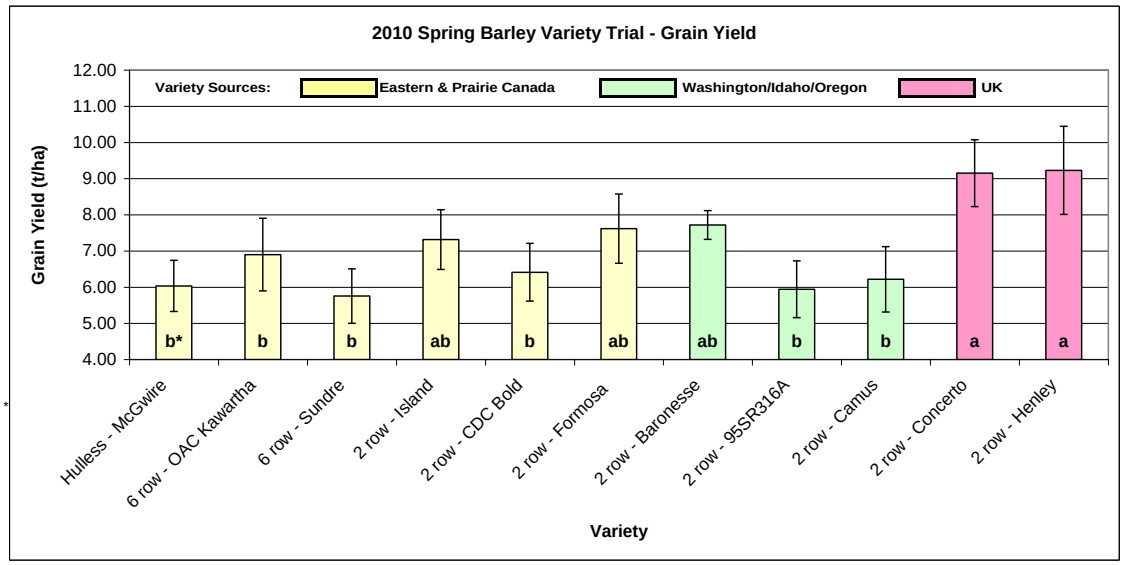
2009 Spring Barley: Grain Quality Components

	Test Weight (kg/hL)			Protein (%)		
Variety	**Mean**	sd	**MS**	**Mean**	sd	**MS**
2 row - 95SR316A	75	2	a	8.5	0.1	b
2 row - Baronesse	72	4	a	8.5	0.4	b
2 row - Camus	74	1	a	8.4	0.1	b
2 row - Formosa	73	1	a	7.6	0.6	c
2 row - Island	72	1	a	9.3	0.6	ab
2 row - Kings	75	2	a	8.5	0.3	b
6 row - Encore	61	1	c	8.7	0.1	b
6 row - Kawartha	67	2	b	8.7	0.4	b
6 row - Laverne	75	3	a	9.9	0.4	a

After significant F-test (p<0.05) a Mean Separation (MS) was performed; means with the same letters are not significantly different

Note: Minimum test weight for Canada No. 1 is 63 kg/hL for 2-row and 62 for six-row

Barley varieties from the Pacific-Western U.S. yielded best in the 2009 spring barley comparisons; and many varieties also had higher protein levels relative to 2010 levels. However, 2010 test weights were higher. Plump kernels were probably associated with the wetter 2010 growing season. In our 2010 trials, the varieties added from the U.K. out yielded all others. The hulless barley, CDC McGwire had the highest test weight in 2010. Two varieties, Formosa and the numbered 95SR316A, made the top five lists for test weights in 2009 and 2010.



After significant F-test (p<0.05) a Mean Separation (MS) was performed; means with the same letters are not significantly different.

2010 Spring Barley: Harvest Yields & Height

	Grain (t/ha)			Straw (t/ha)			Harvest Height (cm)		
Variety	**Mean**	sd	**MS**	**Mean**	sd	**MS**	**Mean**	sd	**MS**
Hulless - McGwire	**6.04**	0.71	b	**8.77**	1.43		**100**	11	bc
6 row - OAC Kawartha	**6.90**	1.00	b	**8.90**	2.11		**125**	3	ab
6 row - Sundre	**5.76**	0.75	b	**8.35**	1.54		**131 Brackled**	10	a
2 row - Island	**7.32**	0.83	ab	**8.17**	1.11		**101**	6	bc
2 row - CDC Bold	**6.41**	0.80	b	**7.17**	1.19		**100**	4	bc
2 row - Formosa	**7.62**	0.96	ab	**8.33**	1.11		**86**	5	c
2 row - Baronesse	**7.72**	0.40	ab	**7.11**	0.98		**89**	5	c
2 row - 95SR316A	**5.94**	0.79	b	**8.72**	1.20		**113**	7	b
2 row - Camus	**6.22**	0.90	b	**7.00**	1.96		**104**	3	b
2 row - Concerto	**9.15**	0.92	a	**8.10**	2.65		**91**	6	c
2 row - Henley	**9.23**	1.22	a	**7.27**	1.08		**86**	2	c

After significant F-test (p<0.05) a Mean Separation (MS) was performed; means with the same letters are not significantly different.

2010 Spring Barley: Grain Quality Components

	Test Weight (kg/hL)			Crude Protein (%)		
Variety	**Mean**	sd	**MS**	**Mean**	sd	**MS**
Hulless - McGwire	93	5	a	7.5	0.4	b
6 row - OAC Kawartha	76	4	bc	8.4	0.3	ab
6 row - Sundre	68	2	c	8.5	0.5	a
2 row - Island	81	2	b	8.8	0.4	a
2 row - CDC Bold	77	3	bc	8.4	0.4	ab
2 row - Formosa	79	3	b	8.1	0.3	ab
2 row - Baronesse	80	4	b	8.1	0.3	ab
2 row - Idaho/95SR316A	79	5	b	8.0	0.5	ab
2 row - Camus	76	4	bc	8.0	0.3	ab
2 row - Concerto	77	3	bc	7.3	0.4	b
2 row - Henley	78	3	b	7.5	0.7	b

After significant F-test (p<0.05) a Mean Separation (MS) was performed; means with the same letters are not significantly different.

Note: Minimum test weight for Canada No. 1 is 63 kg/hL for 2-row and 62 for six-row

Disease resistance was a particularly important trait for the 2010 growing season, and we observed stripe and brown rust on spring barley crops in our trial. As with our disease observations in 2009, we found Formosa to be moderately susceptible to stripe rust in 2010. Septoria was observed on Camus in 2009, and in 2010 we noted this variety was moderately susceptible to stripe rust yet resistant to brown rust. Island and 95SR316A were resistant to stripe rust in the 2009 and 2010 trials. Tested in the 2010 growing conditions only, Sundre, and the two varieties from the U.K., Concerto and Henley were also very

resistant to stripe rust. Inversely, Sundre, 95SR316A, and Island were moderately susceptible to brown rust in 2010.

2010 Spring Barley: Flag Leaf Disease Assessments/Ratings

	Stripe Rust - GS 75			Brown Rust - GS 75		
Variety	**Mean**	sd	**MS**	**Mean**	sd	**MS**
Hulless - McGwire	2.8	0.5	b	1.0	0.0	d
6 row - OAC Kawartha	3.3	0.5	ab	1.0	0.0	d
6 row - Sundre	1.0	0.0	c	4.8	0.5	a
2 row - Island	1.0	0.0	c	3.3	1.0	bc
2 row - CDC Bold	3.5	0.6	ab	1.0	0.0	d
2 row - Formosa	4.8	1.0	a	1.0	0.0	d
2 row - Baronesse	4.0	0.8	a	1.0	0.0	d
2 row - Idaho/95SR316A	1.0	0.0	c	3.5	0.6	b
2 row - Camus	5.0	0.8	a	2.3	1.0	c
2 row - Concerto	1.0	0.0	c	1.0	0.0	d
2 row - Henley	1.0	0.0	c	1.0	0.0	d

After significant F-test ($p<0.05$) a Mean Separation (MS) was performed; means with the same letters are not significantly different.
Note: Disease rating 1 (highly resistant) to 9 (highly susceptible); no/incidental scald/leaf blotch or net blotch.

We found relatively low crude protein levels measured across varieties in 2010. This suggested low fertilizer N inputs and consequently low available N for our demonstration field. For both years, 2-row Island was one of the top two in crude protein percentage. In 2009, the highest percentage of crude protein was found with the 6-row variety, Laverne, and in 2010, the 6-row Sundre showed the second highest protein percentage behind Island.

We found for overall yield characteristics and disease resistant qualities, Concerto, Henley, Island, 95SR316A, Baronesse, McGwire, Kawartha, and Bold performed well. For spring barley, Canadian national registration includes our tested and recommended varieties of Island, McGwire, Kawartha, and Bold.

Spring Oats Results: 2009 and 2010 overview and comparison

Similar to the spring barley in 2010, the hulless oats in our demonstration trial grew taller and had higher straw yields compared with 2009 results. For both years, we trialed AC Baton and Navaro varieties with our spring oats demonstration. These varieties matured at roughly the same rate as our spring barley in 2010. AC Baton grew taller comparatively and had higher protein levels for both years. We did not observe lodging or disease in either variety for 2009 or 2010. Both AC Baton and Navaro are nationally registered and we recommend both for South Coastal B.C. growing conditions.

2009 Spring Oat: Harvest Yields

	Grain (t/ha)			Straw (t/ha)			Harvest Height (cm)		
Variety	**Mean**	sd	**MS**	**Mean**	sd	**MS**	**Mean**	sd	**MS**
AC Baton	5.05	0.43		5.97	0.58		90	6	a
Navaro	4.77	0.34		5.52	0.53		75	5	b

After significant F-test (p<0.05) a Mean Separation (MS) was performed; means with the same letters are not significantly different

2009 Spring Oat: Grain Quality Components

	Test Weight (kg/hL)			Protein (%)		
Variety	**Mean**	sd	**MS**	**Mean**	sd	**MS**
AC Baton	63	2	b	14.7	0.6	a
Navaro	73	3	a	11.8	0.3	b

After significant F-test (p<0.05) a Mean Separation (MS) was performed;
means with the same letters are not significantly different
Note: Minimum test weight for Canada No. 1 is 56 kg/hL

2010 Spring Oat: Harvest Yields

	Grain (t/ha)			Straw (t/ha)			Harvest Height (cm)		
Variety	**Mean**	sd	**MS**	**Mean**	sd	**MS**	**Mean**	sd	**MS**
AC Baton	6.59	0.33		10.3	1.5		119	6	a
Navaro	6.65	0.78		9.2	1.5		103	5	b

After significant F-test (p<0.05) a Mean Separation (MS) was performed; means with the same letters are not significantly different

2010 Spring Oat: Grain Quality Components

	Test Weight (kg/hL)			Protein (%)		
Variety	**Mean**	sd	**MS**	**Mean**	sd	**MS**
AC Baton	64	2		12.3	0.8	a
Navaro	67	3		10.9	0.5	b

After significant F-test (p<0.05) a Mean Separation (MS) was performed;
means with the same letters are not significantly different
Note: Minimum test weight for Canada No. 1 is 56 kg/hL

Recommended Cereal Varieties for Planting on South Coastal BC

Of the 52 varieties of winter and spring cereals we tested using low input management practices, the following table list represents our selections with a balance of good yields and disease resistance[9]. Note the highlighted varieties and indications of national or regional registration for availability, as well as the following brief comments on our selections[10].

The prairie spring wheat varieties planted in 2010 grew tall and lodged to some extent near maturity (Glenlea, Lillian, and Strongfield). Glenlea is relatively

[9] Our low-input practices were: low soil N inputs, no fungicides, insecticides, or growth regulators. The selection criteria for disease resistance focused on stripe-rust.

[10] For a complete list of varieties which are registered in Canada, and procedures for registration of varieties in Canada, please refer to following CFIA web page:

http://www.inspection.gc.ca/english/plaveg/variet/proced/procede.shtml

Suggested List of Recommended Cereal Varieties for Registration and/or Planting for South Coastal BC

Spring Wheat	Winter Wheat	Spring Barley	Winter Barley	Spring Oats
♣ ♦ ¤ Glenlea - Hard red (HR)	§ ♦ ¤ Monopol - HR	♣ ¤ Island - 2 row/feed	♠ ¤ Flagon - 2 row/malting	♣ ¤ AC Baton - Hulless
(R) ♦ ¤ Lillian - HR	Reaper - HR	♣ CDC Bold - 2 row/feed	♠ ¤ Retriever - 2 row/feed	♣ ¤ Navaro - Hulless
(R) ♦ ¤ Strongfield - Durum	(R) § ¤ Harvard - HR	♣ ¤ McGuire - hulless/feed	♠ ¤ Suzuka - 2 row/feed	
(R) ¤ Sable - HR	(R) ¤ Stanford - HR	♣ ¤ OAC Kawartha - 6 row	♠ ¤ Vanquish - 2 row/malting	
♥ Expresso - HR	§ ♥ ¤ Norwest 553 - HR	♥ ¤ Baronesses - 2 row/feed	♠ ¤ Winsome - 2 row/malting	
♥ Cabernet - HR	♠ Gladiator - HR	♥ ¤ 95SR316A - 2 row/feed		
♠ ¤ Paragon - HR	♠ Warrior - Soft White	♠ ¤ Concerto - 2 row/malting		
		♠ ¤ Henley - 2 row/feed		

♣ Varieties which are registered in Canada and seed available to producers on South Coastal BC
(R) Varieties which have "regional" registration in Canada, but not on South Coastal BC; subject to CFIA approval
♥ Varieties registered in Washington/Oregon State, but not in Canada; subject to CFIA approval
♠ Varieties registered in UK/EU, but not in Canada; subject to CFIA approval
♦ Varieties which grew tall and susceptable to lodging
¤ Varieties which establish quickly and/or grew tall to exhibit relatively good weed control without the use of herbicides.
§ Varieties of winter wheat with a relatively good spring stand after intensive over-winter waterfowl grazing
For a complete list of varieties which are registered in Canada; and, procedures for registration of varieties in Canada, please refer to following CFIA web page:
http://www.inspection.gc.ca/english/plaveg/variet/proced/procede.shtml

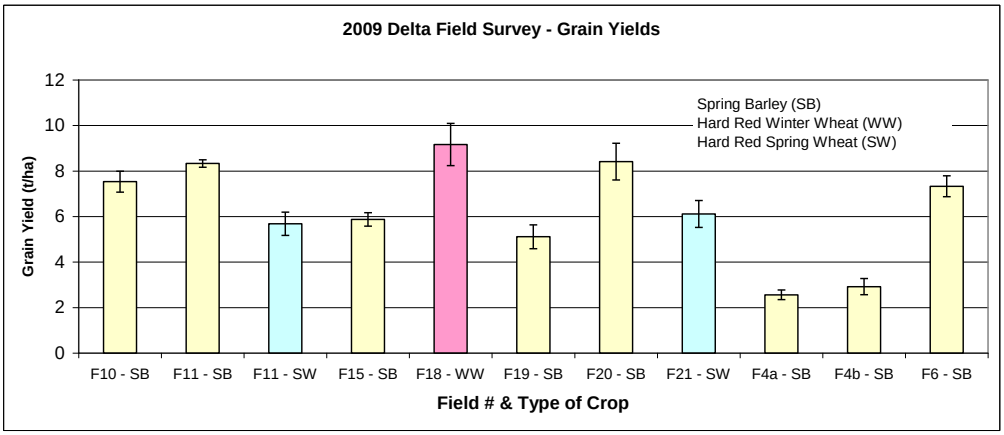
slower to mature. Expresso, a semi-dwarf variety, was slow to establish and consequently, weeds were an issue in our demonstration plots. In our winter wheat trials, Monopol grew taller and matured later than others. Harvard and Stanford matured the quickest and were somewhat susceptible to septoria, but showed good stripe rust resistance. Both of our spring oat selections matured late, and this later maturity included the readiness of the oat straw.

For organic producers, weed control is an important attribute when it comes to growing cereals. Cereal varieties which are fast to establish or provide cover and then grow tall demonstrated the best weed control. These cereal varieties are marked in the above table with a "¤".

Outreach: Cooperating Producers Cereal Grains Assessment

In addition to the cereal grains variety trials grown as research/demonstration-scale plots at the Montgomery's Canoe Pass Farm, we monitored and sampled spring wheat, spring barley, and winter wheat grown at the field scale on our soil survey field sites. The results below show yield and grain protein characteristics for those fields of cereal grains grown by farmer-cooperators within our project for the 2009-cropping season. Not all soil survey field sites grew

cereal grains this year, only those numbered on the graph below.



Due to our small sample size, planting dates and other factors - such as pests and disease, etc. - results from our variety trial may vary from those observed in farmers' fields.

2009 Field Survey: Grain Quality Components

	Protein (%)		TGW's (g)	
Field #	**Mean**	sd	**Mean**	sd
F10 - SB - Formosa	10.6	0.8	51.0	1.0
F11 - SB - Formosa	11.2	0.5	45.7	1.5
F11 - SW - Norwell	14.5	0.2	37.9	1.2
F15 - SB - Formosa	8.3	0.5	49.8	0.6
F18 - WW - Monopol	9.1	0.8	45.1	2.3
F19 - SB - Formosa	9.9	0.6	44.7	1.0
F20 - SB - Formosa	11.6	0.5	47.1	1.1
F21 - SW - Katepwa	13.5	1.0	48.1	1.0
F4a - SB - Lacombe	8.6	0.7	47.5	0.7
F4b - SB - Lacombe	7.6	0.2	44.4	1.5
F6 - SB - Formosa	11.8	0.2	51.5	1.6

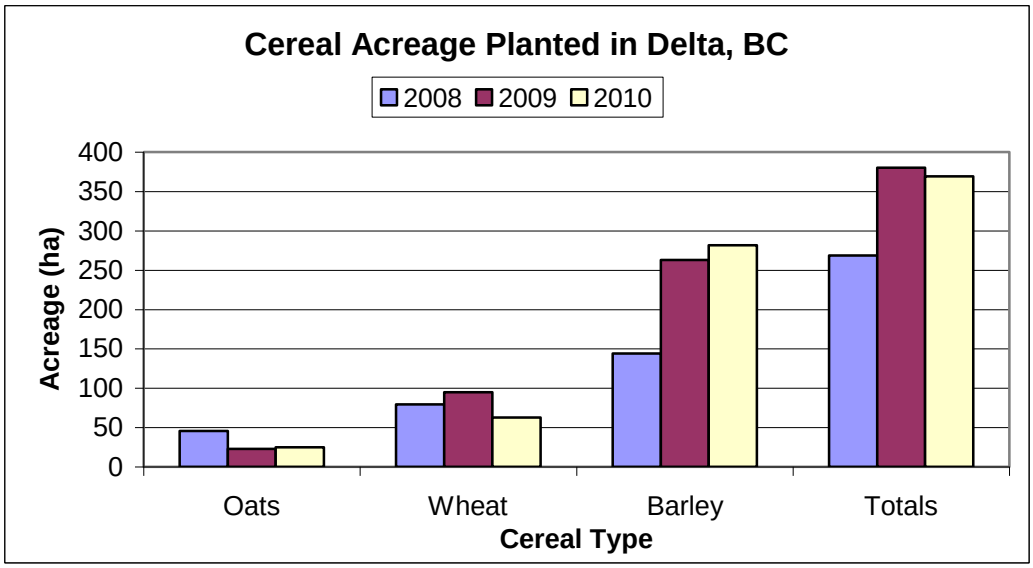
Note: Spring Barley (SB); Hard Red Winter Wheat (WW); Hard Red Spring Wheat (SW)

Several of our grower-cooperators reported better grain yields for their cereal crops in 2009, compared with better straw yields in 2010. The range of reported yields for barley crops harvested by our grower cooperators in 2009 was 3.7 to 8.6 t/ha. For 2010, the reported yields for barley ranged from 2.5 to 6.1 t/ha. Wheat harvest yields were also down from 2009 to 2010 as reported by our cooperators. In 2009, our growers reported a harvest yield range for wheat crops of 6.9 to 8.6 t/ha, and in 2010, these numbers were 4.4 to 6.1 t/ha. While it is difficult to isolate and compare across fields, management systems, inputs, and weather conditions for all of our cooperating farmers and their fields, we can report that our growers have indicated interest in experimenting with reductions with their

Combine Field Samples - 2009 Spring Wheat & Oats

Producer - Variety	Crude Protein (%)	Bread Making Potential
Kamlah - Superb	8.7	Low
Montgomery - Katepwa	**11.0**	**High**
Montgomery - Superb	9.6	Low
Montgomery - Glenlea	**10.3**	**Medium**
Harris - Norwell	**11.9**	**High**
Kamlah- Max	8.4	Low
Ruess - Sable	**10.0**	**Medium**
Montgomery - Naked oats	12.2	N/A - Feed

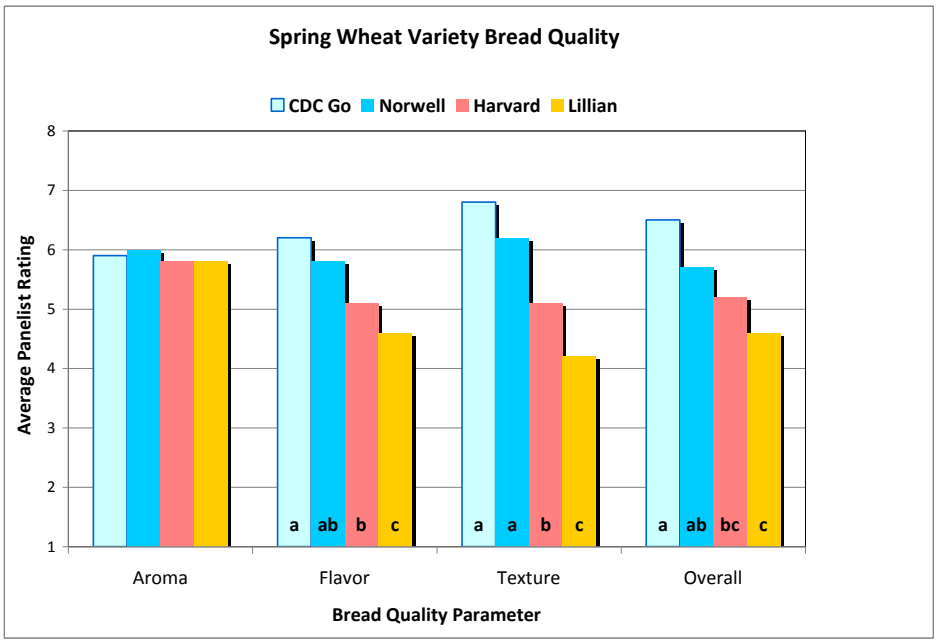
fertilizer inputs for cereal grains, and with including a range of cereals in their cash crop rotations. In Delta, planted cereal acreage has increased since our project began in 2008, much of which was barley.



Outreach: Vancouver Cereal Grains CSA

As part of our outreach and educational initiatives with this project, since 2009, we have collaborated with a UBC-Vancouver Grains Community Supported Agriculture (CSA) program for their wheat variety baking competition. We supplied this 2-year class project with selected varieties of South Coastal B.C. grain, and participants analyzed the nutrient levels, conducted taste-tests, and compared our selections with those grown in the Fraser Valley by the Vancouver CSA cooperative.

Our entrant, Norwell, grown in the Fraser River Delta, was selected as the #1 wheat for bread baking and taste in 2009. The 2010 baking competition results depicted in the graphs and images that follow, demonstrated that Norwell, along with CDC Go, performed well across the categories of flavor, texture, and for overall bread making quality.



Clover Under-seeding Trials… we're letting nature do the work!

A well nodulated and established clover crop on an adequately drained soil can provide many benefits: improved tilth and soil fertility, habitat for worms, wildlife, over-winter cover, and a subsequent green manure supply of nitrogen for cash crops. We observed early planting dates with spring cereals in our region deliver the best results. When the cereal crops are beginning to tiller, broadcast inoculated red or white clover seed (10 kg/ha). With these planting practices, we've observed good stands of clover following the cereal harvest. These stands of underseeded clover were ready to provide a soil fall cover crop and green manure the following spring.

Extend your low input practices and save input costs

A well-established clover crop used as a green manure can provide much of next year's crop nitrogen! For soils already rich in available P and K - and many of our cultivated soils in Delta are in that category – many crops typically planted within our region would require little additional inputs of either composted-aged poultry manure or granular fertilizer NPK.

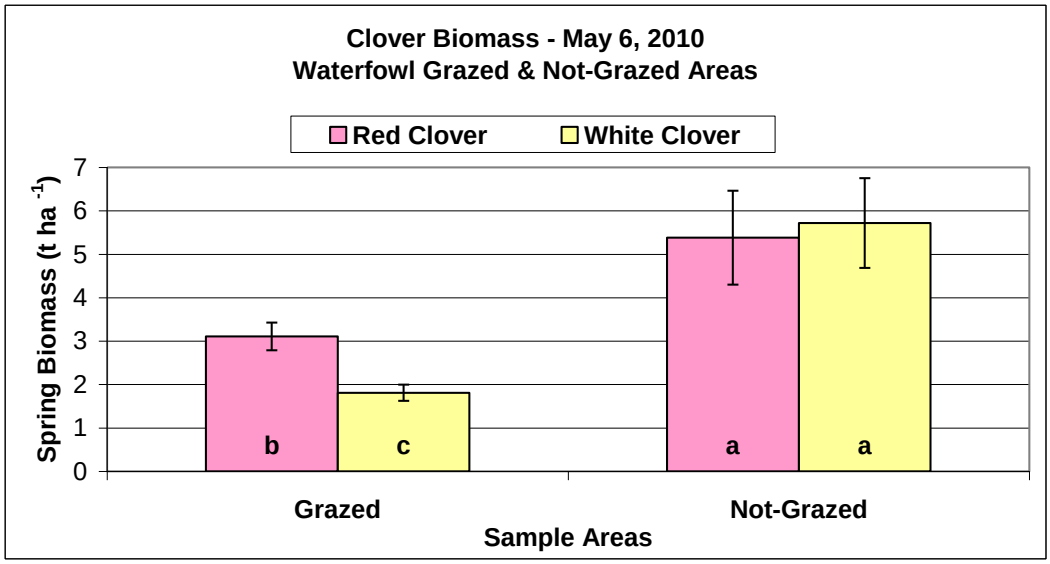
Red clover is a particularly tall growing legume, and we found swathing may be necessary when this clover grows into the harvest canopy. Alternatively, white clover is a low growing variety and, if planted on the same plant date as the main crop of barley, this lower growth habit would reduce the need to swath. Some growers opt to wait and seed clover after the cereal crop is well established.

After the barley crop was swathed, combined, and straw baled, a good stand of clover became well established in the fall of 2009. We observed that spillage of harvest grains during combining can create negative impacts on clover stand establishment, and that clover established more readily when the straw was baled.

In our demonstration trials, the established clover provided excellent soil cover and overwinter habitat for wildlife. Once hunting season was over, the clover provided feed for over-wintering or spring staging snow geese.

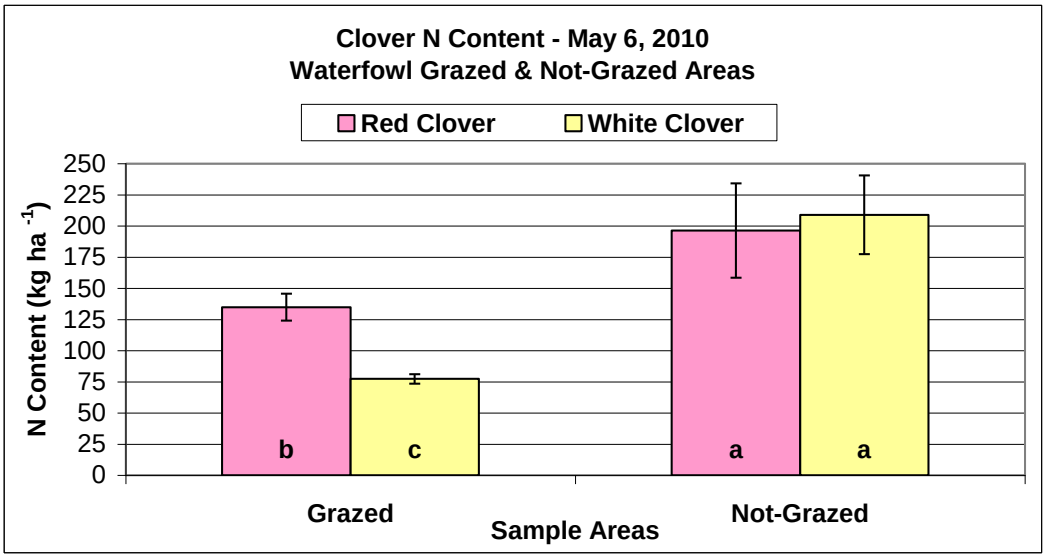
After the waterfowl migrated north in the spring, the clover began to grow back. Just before ploughdown in early May 2010, a good stand of clover presented itself for use as a green manure crop in potato production.

The ungrazed fenced exclosure area had a green manure biomass between 5 and 6 t/ha for both the white and red clover. The grazed plot areas had a biomass of 2 and 3 t/ha for the white and red clover respectively.



After significant F-test ($p<0.05$) a Mean Separation (MS) was performed; means with the same letters are not significantly different.

The N contents followed the same trends as demonstrated with the biomass yields. The ungrazed fenced exclosure area had a green manure N content of roughly 200 kilograms per hectare for both the white and red clover, while the grazed plot areas had a N contents of 75 and 130 kilograms per hectare for the white and red clover respectively.



After significant F-test (p<0.05) a Mean Separation (MS) was performed; means with the same letters are not significantly different.

For soil mineralization of a green manure crop such as clover, the crop's percent nitrogen (%N) and carbon to nitrogen ratio (C: N) are important. The N concentrations for the clover crops are high and C: N ratios are low. This indicates that clover as a green manure crop decomposes rapidly and can provide the soil with available soil N for crop uptake soon after incorporation into the soil.

2010 Spring Green Manure Crops %N & C/N Ratio

	%N			C/N Ratio		
	Mean	sd	MS*	Mean	sd	MS
Spring 2010- May 6						
Red Clover - Grazed	**4.35**	0.26	a	**9.8**	0.5	b
White Clover - Grazed	**4.29**	0.28	a	**9.5**	0.7	b
Red Clover- Not Grazed	**3.66**	0.13	b	**11.5**	0.4	a
White Clover - Not Grazed	**3.67**	0.15	b	**11.1**	0.3	a

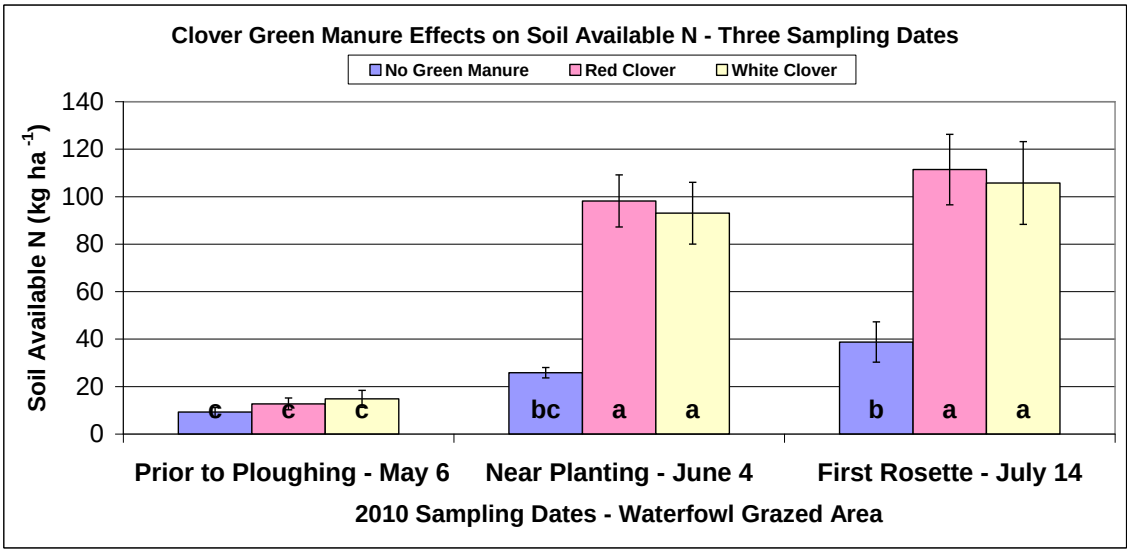
*After significant F-test (p<0.05) a Mean Separation (MS) was performed; means with the same letters are not significantly different

The over-winter grazed stands of red and white clover produced relatively lower green manure biomass, higher % N and lower C: N ratios.

Our spring 2010 clover green manure plots (clover underseeded in 2009) were located on Westham Island on the "Westham" soil series. This soil had an organic matter (OM) content of 3.0%, relatively low for the region. The soil

available N levels for the grazed plots were low when observed one week prior to ploughing and incorporating the green manure stands. On June 4th, 2010, three weeks after the plots with red and white clovers were ploughed and disked, the soil levels of available N were close to 100 kilograms per hectare. This was just prior to the 2010 planting date for the potato crop established in the area of our clover test plots. The level of soil available N observed would be sufficient for crop types ranging from peas and beans, to potatoes and cereals.

Soil available N levels on July 14, roughly 8 weeks after incorporation of the clovers, were close to those documented four weeks earlier. This was prior to any significant crop uptake of soil available N. These results suggest that the green manure clover crops mineralized approximately 70 kilograms per hectare of available N within three weeks after plough-down. The results suggest that most of the N content of the white clover had mineralized and roughly 50% of the N content in the red clover had become plant available.



After significant F-test ($p<0.05$) a Mean Separation (MS) was performed; means with the same letters are not significantly different.

In 2008 and 2009, we established two additional clovers under seeding trials with another cooperating grower on the Delta soil series. This soil series has comparatively higher soil organic matter contents with 7.2% OM. Despite this higher percentage of OM, the clovers on the Delta soils did not establish well or exhibit a uniform stand. Field level management may have been a more significant factor than the OM content with the establishment of the clover plots on Delta soils.

Barley grains spilled during combining on the Delta soils in both 2008 and 2009. This resulted in a large, fall stand of volunteer barley after harvest. Additionally, none of the barley straw was baled in these fields. Without removal of the barley straw, we observed a large area where the clover was either smothered in barley straw or choked with competition from volunteer barley. In the spring of 2009,

very little of the under-seeded clover managed to overcome the competition and establish in our plots, and we observed virtually no clover established in the subsequent year of 2010. Only a small area (10m x 10m) at one end of the 2009 plots grew into a uniform stand and allowed for a useful set of soil and crop measurements.

The series of photographs shown here were taken on June 6, 2009. Depicted are the barley mulch and the red and white clover crops grown as green manure. The plough-down date for these crops was June 8, 2009. The spring biomass of the barley mulch was approximately half that of the clover crops, and its N content was a third that of the clovers. Fall biomass and N contents of the barley were also significant, and would have contributed to the cumulative biomass and available N content of the soil. The clover crops had a much higher percentage N and narrower C: N ratios compared with the fall barley cover.

Fall 2008 Cover & Spring 2009 Green Manure Crops Biomass & N Content

	Biomass (t/ha)			N Content (kg/ha)		
	Mean	sd	MS*	Mean	sd	MS
Fall 2008 - Nov. 7						
Barley Cover Crop	**2.90**	0.38	b	**76**	12	b
Spring 2009 - June 6						
Barley Mulch	**3.48**	0.42	b	**66**	7	b
Red Clover	**6.84**	0.52	a	**179**	14	a
White Clover	**6.62**	1.05	a	**182**	33	a

*After significant F-test ($p<0.05$) a Mean Separation (MS) was performed; means with the same letters are not significantly different

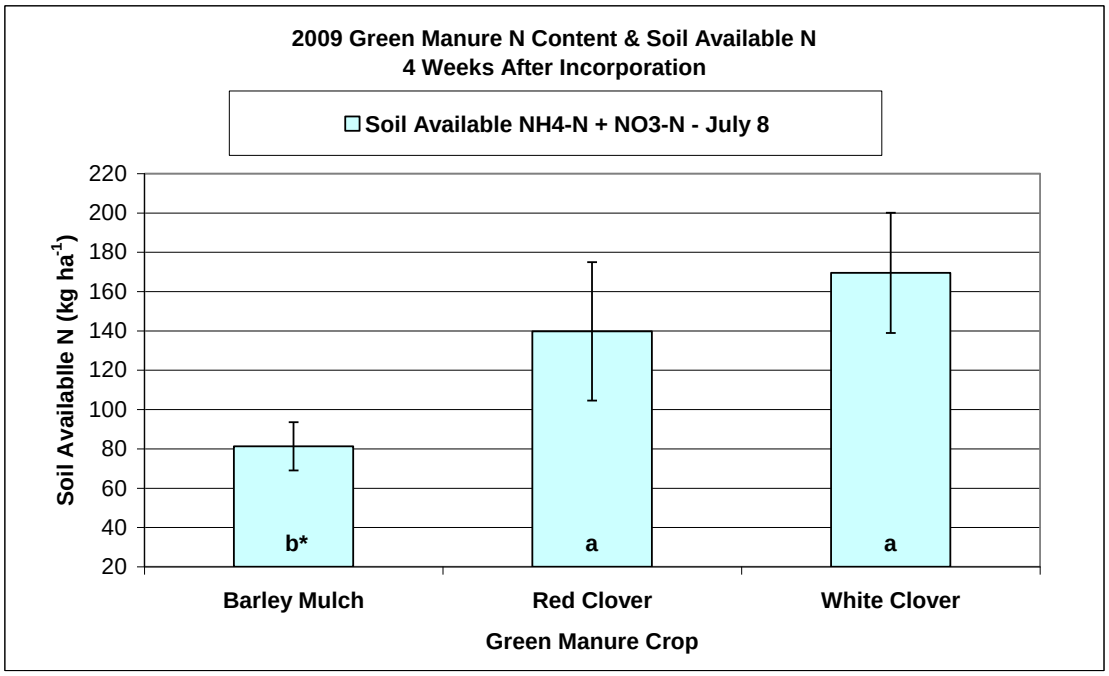
Fall 2008 Cover & Spring 2009 Green Manure Crops %N & C/N Ratio

	%N			C/N Ratio		
	Mean	sd	MS*	Mean	sd	MS
Fall 2008 - Nov. 7						
Barley Cover Crop	**2.60**	0.18	a	**15.1**	1.2	b
Spring 2009 - June 6						
Barley Mulch	**1.48**	0.20	b	**24.2**	2.8	a
Red Clover	**2.62**	0.04	a	**15.1**	0.4	b
White Clover	**2.75**	0.22	a	**14.0**	1.8	b

*After significant F-test ($p<0.05$) a Mean Separation (MS) was performed; means with the same letters are not significantly different

The soil available N levels on July 8, 2009, were approximately 80, 140 and 170 kilograms per hectare for barley mulch, red and white clover respectively. The levels of available N measured for the soils where green manure clover crops were incorporated would be sufficient for a wide range of crop types, including corn[11].

[11] See BCMAL vegetable growing recommendations: http://www.al.gov.bc.ca/fieldvegetable/production_guide/2008_2009/production_guide.htm



* After significant F-test ($p<0.05$) a Mean Separation (MS) was performed; means with the same letters are not significantly different

In our climatic region, the benefits of later season incorporation of the green manure clover crops, such as greater biomass or total N content, are outweighed by the likelihood of limited growing season precipitation. For better establishment of the intended cash crop, growers in our region would likely opt to incorporate the clovers in early May when seasonal rainfall aids decomposition of the clover biomass, and subsequent germination of the intended crop. Also interesting to note, with respect to the variation in clover stand establishment and uniformity, the ungrazed clover on Westham soils measured on May 6, 2010 was close to 200 kilograms per hectare. These levels were comparable to the N content measured on June 6, 2009 on the Delta soils. These observations suggest significant benefits with a clover stand that is uniform and well established during the previous fall.

Outreach: Delta Farmland & Wildlife Trust: Greenfields Stewardship Program

In 2010, as a consequence of our field trial work using under-seeded clover, the Delta Farmland & Wildlife Trust (DF&WT) implemented a cereal under-seeding with clover program with cooperating producers in Delta. This project is part of DF&WT's Greenfields cover crop program. DF&WT field staff is currently monitoring some 40 hectares of established clover fields in collaboration with Delta producers. All five of these producers are also cooperating participants with our Eco-Friendly Crop Rotations Project.

In cooperation with the DF&WT and its Greenfields Stewardship Program, we have helped established large field demonstration and small test plots of both

white and red clover. This cooperation contributes in significant ways to our project's education and outreach efforts, as well as to the collaborative synergies and links between sustainable farmland management and wildlife values within our region. The DF&WT will be monitoring the field sites for waterfowl use over the fall and winter of 2010 to 2011.

Eco-Friendly Crop Rotation Project: Report Summary and Conclusion

Soil Survey

Growers with fields high in organic matter, and those growers who routinely apply manures or manure-based composts, tend to have higher levels of spring available nutrients. The fields with reported inputs of poultry-based manures in the spring had significantly higher levels of fall residual nitrates. In most cases, the fields in our survey have high or excessive levels of P. Growers in our study that purchase granular N-P-K could carefully review their soil test results, and potentially eliminate the P from the blended fertilizer application. In roughly half of the fields from our soil test survey, growers could also eliminate potassium (K) from the fertilizer blend. This would contribute to lower production costs on the farm. For those growers dependant on manures and cover crops for fertility, the results from our clover under-seeding trials indicate this practice, coupled with the cereal grain rotation, may be a promising means of reducing annual manure applications. Moreover, we also conducted our clover trials on fields where granular fertilizer inputs are the routine, and observed viable opportunities to reduce these inputs as well.

Spring and Winter Cereal Grains Variety Trials

Depicted in “Executive Summary” above, is a summary table with our list of recommended varieties from the demonstration trials of 2009-2010. Canadian national or regional registration may affect the availability of recommended cereal grains, though we hope to contribute, through this set of recommendations, to the enhanced availability of these regionally adapted, disease resistant selections.

Low Input Recommendations for Eco-friendly Crop Rotations

Regionally adapted spring wheat, barley, and oats may provide South Coastal B.C. growers with a set of viable low-input options for their vegetable and potato rotations. Nutrient imbalances, disease pressures, input costs, and limited marketing outlets suggested a closer investigation of the potential for low-input cereal grains for this region. From our findings, we recommend continued soil testing for spring available nitrates, and targeted application of nutrients.

Interest from our network of collaborators from Fraser Valley Grains Growing Cooperative and the UBC Faculty of Land and Food Systems student researchers suggests there is market potential for regionally produced grains with bread making qualities. In general terms, this indicates a possible niche for grains with higher levels of protein. Our variety trials were situated on field sites

with low levels of available N. We recommend attention to residual nitrates and overall soil N levels for growers with an interest in tapping the newly developed and niche artisanal bread-making markets.

For some growers, winter cereals in this region can serve as cover crop or as a low-input, marketable grain. Challenging climate and waterfowl pressures dictate an early September planting date for establishment of over-winter cereals if waterfowl grazing is likely. In the absence of grazing pressure, late September/early October planting dates may be optimal. As mentioned, under-seeding with low growing white clovers or, after-good establishment of the grain crop, with red clovers, appears to deliver a set of soil and wildlife conservation benefits. Collaborative efforts with the DF&WT are underway to continue the assessment of these costs and benefits with growers in the Fraser River Delta.

Final Word of Thanks…

Again, as UBC Faculty of Land and Food Systems based researchers, we thank you all for your generous assistance with both time and access to your farm fields. We would also like to acknowledge our financial support and assistance made possible by the B.C. Agriculture Council (BCAC), Investment Agriculture Foundation (IAF), and Ducks Unlimited, Canada. We invite you to contact us with any questions or corrections you might have regarding this report, the detailed results to date, and the continuing research project.

Funding provided by:

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Appendix A - Outreach: Group Soil Test Results Reported to Growers

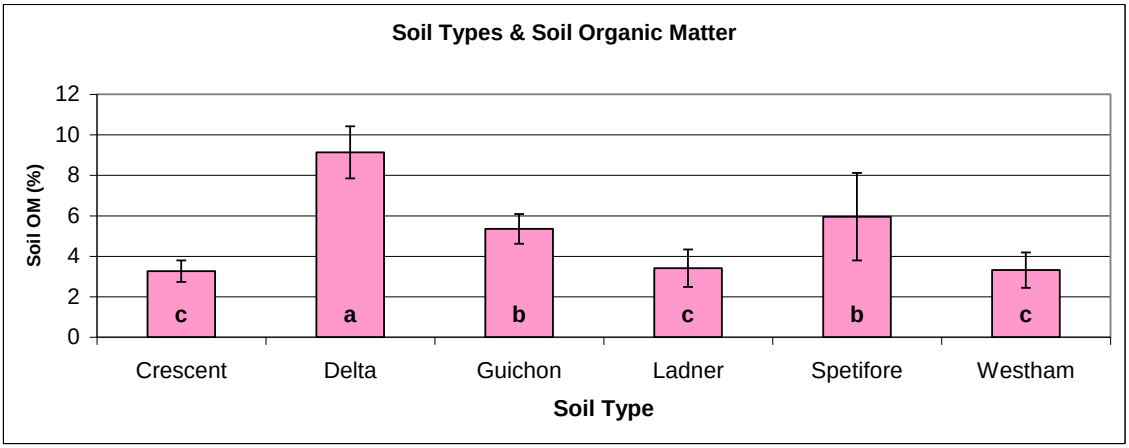
Soil Organic Matter (OM) and Total Nitrogen (%N)

With the results of spring and fall soil survey, we are seeing a relationship between the soil series that the fields are located within and soil organic matter. Soils found within the Delta and Spetifore soil series are showing higher levels of soil OM compared with the Ladner, Crescent, and Westham soils.

From the results that follow, a key finding from these first year soil surveys is that close management of available nitrogen may be the best area to focus for additional inputs. In most cases with our field site soil survey, **the results below strongly indicate that available phosphorus and potassium appear to be at levels at which crop yield responses to additional inputs will not be profitable**.

An additional comment and clarification on the soil series type and soil OM table found below: If your soils were mapped as a complex of Blundell and Crescent or Blundell and Delta, we labeled the soil series according to the soil characteristics that best represents the particular soil. Similarly, the mapped Ladner/Spetifore soils were listed as Ladner soils.

Soil Series Types and Soil Organic Matter (Graph 1)



* After significant F-test (p<0.05) a Mean Separation (MS) was performed; means with the same letters are not significantly different

Field Number, Soil Series, %OM, and %N (Table 1)

Nitrogen (N) - Phosphorus (P) - Potassium (K)

Soil Organic Matter (OM) & Total Nitrogen (N)

Field #	Soil Series	%OM Mean	Std Dev	%N Mean	Std Dev
1	Delta	3.02	0.10	0.16	0.01
2	Blun/Cres	3.60	0.53	0.17	0.02
3	Ladner	4.04	0.07	0.19	0.01
4	Westham	2.43	0.13	0.14	0.01
5	Ladner/Sp	2.28	0.70	0.11	0.03
6	Delta	8.50	0.48	0.33	0.03
7	Blun/Delta	8.69	1.87	0.30	0.06
8	Delta/Blun	9.40	1.18	0.36	0.04
9	Guichon	4.97	0.56	0.22	0.02
10	Guichon	5.14	0.35	0.23	0.01
11	Guichon	5.94	0.91	0.28	0.03
12	Spetifore	4.04	0.41	0.21	0.01
13	Crescent	3.14	0.21	0.15	0.02
14	Westham	3.21	0.31	0.15	0.01
15	Crescent	2.72	0.49	0.13	0.02
16	Westham	3.01	0.10	0.14	0.01
17	Westham	3.06	0.25	0.16	0.02
18	Blun/Cres	3.85	0.36	0.17	0.02
19	Ladner	3.91	0.31	0.17	0.01
20	Westham	4.89	0.31	0.22	0.01
21	Spetifore	7.87	0.96	0.31	0.04
22	Delta	8.88	0.18	0.18	0.01

Many growers submit soil samples on a regular basis for fertility analysis with the intention of targeting the nutrient application required for optimal crop yield response. With the spiking prices of fertilizer and trucking costs, nearly all growers are carefully reviewing whatever means are available to reduce input expenses. This is directly linked with our overall project goal: we hope that the field-scale exploration of regionally adapted cereal grains can provide a viable, low-input alternative to crops requiring costly fertilizers and manures. Providing each of our farmer-cooperators with complementary results of their spring and fall soil sample testing with interpretation is one of the ways we have of keeping you updated and sharing lessons learned from the overall project.

Soil Test Interpretation with Colour-Coding: We developed a simple colour code to interpret the results for N-P-K. Soil test result levels that fall within a green shading indicate low levels of this nutrient are present and additional applications would be expected to produce a **yield increase**. Areas that are shaded yellow are meant to suggest caution: **low probability of crop yield response** to additional inputs of fertilizer or manures, and possibility of negative environmental impacts. The red shading indicates **excessive levels** of this nutrient are already present in the soil. Additional inputs at these levels may have negative economic and ecological impacts.

Economic and Ecological Risk Classes for Soil Test Interpretation (Table 2)

Nutrient	**Spring Available N**	**Fall Available N**	**P**	**K**
Method-Unit of Measure	NO3-N (kg/ha)	NO3-N (kg/ha)	Bray P1 (mg/kg)	*NH4-Acetate (mg/kg)*
Low/Yield increase expected	**<25**	**<50**	<50	<150
Medium/Caution	**25-50**	**50-100**	50-100	150-250
High/ Excessive nutrients already present	**>50**	**>100**	>100	>250
Rough costs per ton (2009 $)		**$600-800/ton** urea	$700-900/ton Mono Ammonium Phosphate (MAP)	$500-800/ton Muriate of Potash (MOP)/Potassium Chloride (KCl)

Soil Survey Nitrogen (N) Phosphorus (P) and Potassium (K) Group Test Results 2009

Samples collected during April and October 2009 for spring and fall samples (Table 3).

Soil N-P-K

	Spring Available N		**Fall Residual N**		**Bray Available P**		**Available K**	
Field #	**kg/ha**	Std Dev	**kg/ha**	Std Dev	**mg/kg**	Std Dev	**mg/kg**	Std Dev
1	**13**	3	**12**	3	**196**	26	**165**	4
2	**15**	3	**8**	1	**194**	31	**221**	8
3	**14**	3	**15**	2	**221**	28	**344**	19
4	**11**	2	**7**	1	**236**	19	**254**	28
5	**15**	5	**10**	1	**224**	30	**316**	48
6	**25**	3	**12**	2	**287**	58	**420**	74
7	**13**	3	dns		**252**	30	**198**	46
8	**40**	10	**216**	23	**213**	21	**218**	20
9	**25**	10	**238**	36	**135**	17	**246**	45
10	**25**	3	**44**	12	**150**	5	**221**	10
11	**31**	6	**48**	16	**162**	10	**393**	35
12	**20**	3	**157**	12	**195**	15	**336**	15
13	**8**	2	dns		**177**	9	**120**	4
14	**9**	0	**122**	13	**163**	9	**165**	9
15	**19**	3	**12**	4	**226**	6	**203**	28
16	**16**	2	**1**	0	**123**	7	**270**	11
17	**16**	6	**228**	40	**181**	30	**243**	26
18	**16**	2	**17**	1	**338**	22	**204**	19
19	**23**	3	**24**	6	**100**	22	**276**	5
20	**34**	6	**16**	6	**63**	7	**191**	20
21	**20**	2	**44**	6	**314**	41	**270**	30
22	dns		**99**	9	**428**	55	**428**	45

BCMAL/BCMAFF (1996) Fertilizer Recommendations for Phosphorus (P) and Potassium (K) (Tables 4 and 5)

Phosphate Fertilizer Recommendations From Soil Test Results

Group I - beans, corn, cucumbers, dill, eggplant, lettuce, melons, peas, pumpkins, spinach, squash, zucchini.

Group II - asparagus, beet, broccoli, Brussels sprouts, cabbage, cauliflower, carrot, celery, garlic, leek, onions, parsnip, pepper, potato, radish, rhubarb, rutabaga, tomato.

"BRAY P1" METHOD			
Rating	Soil Test P(ppm)	Requirement (kg/ha P_2O_5)	
		Group I	*Group II*
V. Low	5	190	225
Low	10	160	190
Mod.	20	90	135
High	50	30	40
V. High	70+	0*	0*

** Soils with >70 ppm (Bray P1 method) have sufficient P for crop needs. Application of P in either manure or fertilizer form may lead to loss of P to the environment, causing water pollution.*

Source: *Soil and Plant Tissue Testing Methods and Interpretations of Their Results, BCMAL, 1996.*

Potassium Fertilizer Recommendations From Soil Test Results

Group I – beans, corn, cucumbers, dill, eggplant, lettuce, peas, spinach.

Group II – asparagus, beet, broccoli, Brussels sprouts, cabbage, cauliflower, carrot, celery, garlic, leek, melons, onions, parsnip, pepper, potato, pumpkin, radish, rutabaga, squash, tomato, zucchini.

"NH4-ACETATE" METHOD			
Rating	Soil Test K (ppm)	Requirement (kg/ha K_2O)	
		Group I	Group II
V. Low	25	225	280
Low	35	200	260
Mod.	80	90	170
High	150	45	70
V. High	175+	0*	0*

** Application is not normally required but in some situations, such as early in the season, a starter treatment (30kg/ha) may be beneficial.*

Source: *Soil and Plant Tissue Testing Methods and Interpretations of Their Results, BCMAFF, 1996.*

Soil Acidity (pH) Calcium (Ca) and Magnesium (Mg)

Most of the soils in the study area tend towards a pH range that is acidic, so our relative pH scale reflects this. We are fortunate to have centuries of accumulated farming experience with the soils represented by the 11 cooperators of our project. Crop selection favouring slightly acidic conditions and methods of reducing and managing salts and salinity are already standard practice within our grower group. We recognize that 10 out of 11 of our grower-cooperators are potato producers or may share land with potato producers and, therefore, maintain *moderately* acidic soil to control scab.

Growers in Delta generally recognize that maintaining a minimum pH value of 5.5 is in good order. Metal toxicities and P deficiency tend to increase below that pH and are less problematic when pH > 5.5. A common approach would be to monitor pH and add any lime amendments in the fall or spring following potatoes, benefiting the other crops - such as cereals, beans, peas and/or corn - in the rotation. Our soil analysis laboratory typically includes the buffer pH-lime requirement measurement for any soil samples returning a value with pH less than 6. This is a measure of the reserve acidity and lime requirement and is included in the table below for your reference (See table 6). Note that lime application rates less than 2 t/ha are likely not practical for most field equipment.

Managing for optimal pH is similar in importance to managing for optimal levels of soil OM; both of these factors help make most efficient use of the available nutrients to the soil-crop interface. With your help, we are looking for ways to pinpoint these optimal levels at the field site scale for our regional study area.

The test ranges for interpretation of Ca and Mg in the table (6) below were adapted from the Oregon University extension soil test interpretation guide[12] and rely on the ammonium acetate extraction method. The interpretation range for Mg closely resembles that presented in the B.C. Ministry of Agriculture and Lands (BCMAL) publications of the 1980s. They are simplified and presented for your reference.

With the pH scale, a green colour was used to indicate soils that were within the neutral range and would require no additional liming agents for most crops. Yellow was used to indicate a soil test pH result in a range that is slightly acidic and may warrant caution or adjustment with more sensitive crops, but would be desirable for potatoes. Similarly, the green colour was used with the Ca and Mg test results to indicate a safe zone for nutrient balance within most soils; the yellow was added to suggest a range of Ca or Mg levels that might require closer monitoring or caution.

[12] Marx, E., Hart, J., & Stevens, R. *Soil Test Interpretation Guide.* Oregon and Washington State Extension Service. Corvallis: Oregon State University Extension Service.

Soil Survey Group pH, Ca and Mg results with Lime Requirement (Table 6)

	Soil Acidity (pH)		Soil Bases Ca and Mg				Lime Requirement
	pH		Available Ca		Available Mg		To pH 6.0
Field #	2:1 H_2O	Std Dev	mg/kg	Std Dev	mg/kg	Std Dev	t/ha
1	5.7	0.1	2488	193	191	11	2.6
2	5.8	0.1	2438	125	185	24	2.2
3	6.4	0.2	2338	75	455	68	0.0
4	5.9	0.2	2200	71	205	17	1.2
5	6.8	0.1	2388	287	349	37	0.0
6	5.5	0.0	3088	236	199	19	2.8
7	5.2	0.0	2238	284	200	35	4.1
8	5.6	0.1	2913	214	335	18	2.6
9	5.8	0.2	1913	229	353	54	2.2
10	6.3	0.1	2525	87	844	61	0.0
11	6.0	0.1	2050	147	359	14	0.0
12	5.9	0.0	1900	58	414	9	1.0
13	5.7	0.2	1900	248	224	18	2.1
14	5.5	0.2	2138	206	216	21	2.6
15	6.0	0.2	2475	375	160	24	0.0
16	5.7	0.1	2450	108	140	7	2.2
17	5.9	0.2	2113	48	323	24	1.1
18	5.9	0.3	2188	138	158	20	1.1
19	5.4	0.2	1575	233	400	42	3.1
20	6.0	0.1	2638	263	353	13	0.0
21	5.4	0.1	1800	122	448	12	3.4
22	5.7	0.2	1900	40	228	12	1.6

Potassium to Magnesium and Calcium to Magnesium Ratio (K: Mg and Ca: Mg)

The interactions between all of the cations (Potassium (K), Calcium (Ca), Magnesium (Mg), and Sodium (Na)) with soil acidity (pH), Ca: Mg and K: Mg ratios and levels of available Na and salinity (EC) can complicate soil test interpretations beyond those indicated by the colour-coding scheme. BCMAL soil test interpretations include K: Mg ratios as well, and increase Mg fertilization if they exceed 2:1.

The Oregon University extension guide cautions (p.3): “If extremely high levels of any of the cations exist, plant deficiencies of other cations may occur due to competition for plant uptake”. BCMAL recommendations for Mg fertilization of low Mg soils increase when Ca: Mg ratios exceed 10 or K: Mg ratios exceed 2. From this perspective, the relatively high Ca: Mg ratios may justify monitoring of crop Mg levels to ensure adequacy. From our results, K: Mg ratios do not indicate that past K fertilization is interfering with Mg availability. For your reference, the calculated ratios are provided in a table below. The cautionary levels, more prominent with the Ca: Mg ratios of our group soil survey results are highlighted in yellow.

Soil Survey Group K: Mg and Ca: Mg Ratios (Table 7)

Soil Base Ratios		
Field #	K/Mg Ratio	Ca/Mg Ratio
1	0.9	13.0
2	1.2	13.2
3	0.8	5.1
4	1.2	10.7
5	0.9	6.8
6	2.1	15.5
7	1.0	11.2
8	0.6	8.7
9	0.7	5.4
10	0.3	3.0
11	1.1	5.7
12	0.8	4.6
13	0.5	8.5
14	0.8	9.9
15	1.3	15.5
16	1.9	17.5
17	0.8	6.6
18	1.3	13.9
19	0.7	3.9
20	0.5	7.5
21	0.6	4.0
22	1.9	8.3

Sodium (Na) and Salinity (EC)

There were only a few outliers in the group soil test results for sodium and salinity. Careful monitoring of the physical properties of soil along with observing the levels of Ca, Mg, and K relative to Na should result from a review of some of the highlighted test levels. Water management and attention to the soil OM are key follow-up management strategies.

Past research in Delta has found elevated levels of Na to be associated with poor drainage and compacted soils. This may indicate reduced soil aeration and soil biological activity. One key symptom of this condition could be reduced mineralization of soil organic N and lower N availability to crops.

Issues with salinity in otherwise wet, coastal environments may arise particularly in areas with soils that are[13]:

- Affected by an intrusion of salt water
- Located near high concentration of fertilizer material with a high salt index

[13] Bomke, Soil Fertility 315-Laboratory Methods for Soil Science

Group Results for Sodium (Na) and Salinity (EC) (Table 8)

Soil Sodium & Salinity

Field #	Available Na mg/kg	Std	Est. Sat. EC dS/m	Std
1	27	3	0.40	0.10
2	26	13	0.38	0.05
3	153	55	0.45	0.01
4	17	1	0.28	0.03
5	33	7	0.37	0.05
6	20	9	0.44	0.13
7	25	3	0.31	0.04
8	55	5	0.45	0.04
9	51	20	0.39	0.07
10	369	64	1.99	0.59
11	47	10	0.46	0.07
12	76	13	0.47	0.01
13	14	1	0.26	0.02
14	21	4	0.47	0.12
15	14	2	0.39	0.03
16	22	3	0.45	0.04
17	49	15	0.44	0.04
18	31	10	0.44	0.04
19	58	9	0.40	0.01
20	113	18	0.94	0.23
21	289	12	1.98	0.26
22	13.6	2.5	0.80	0.14

Funding provided by:

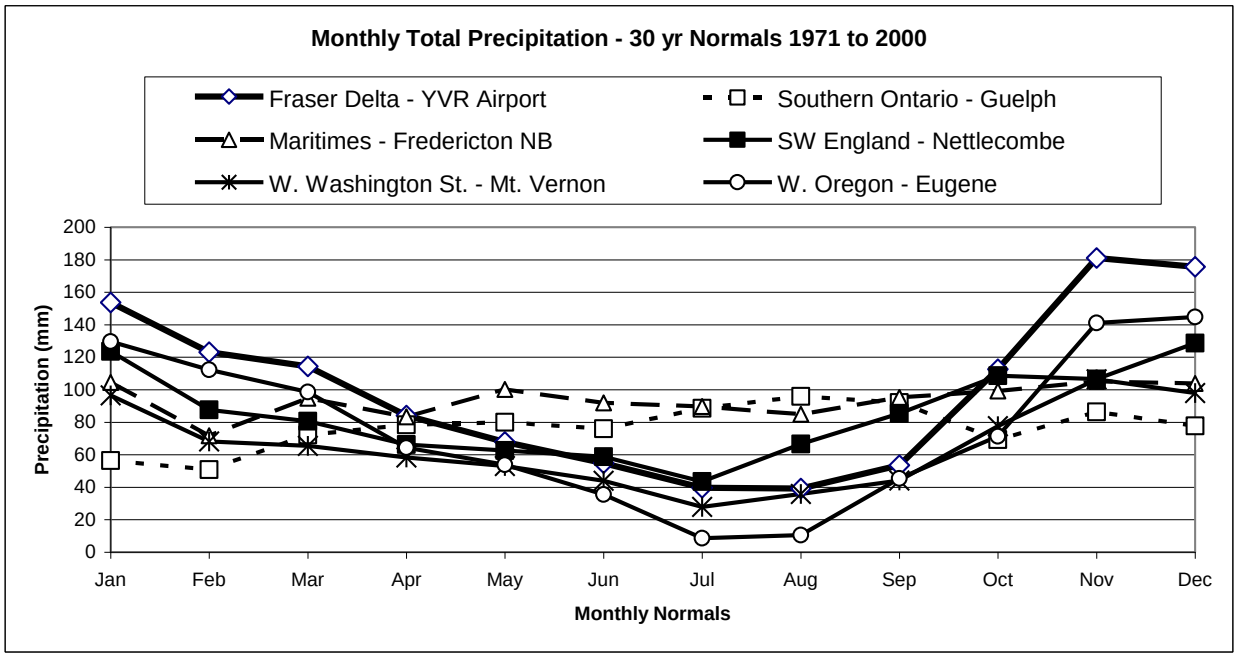
Appendix B – Outreach: Cereal Variety Trial Selection Criteria & Methods

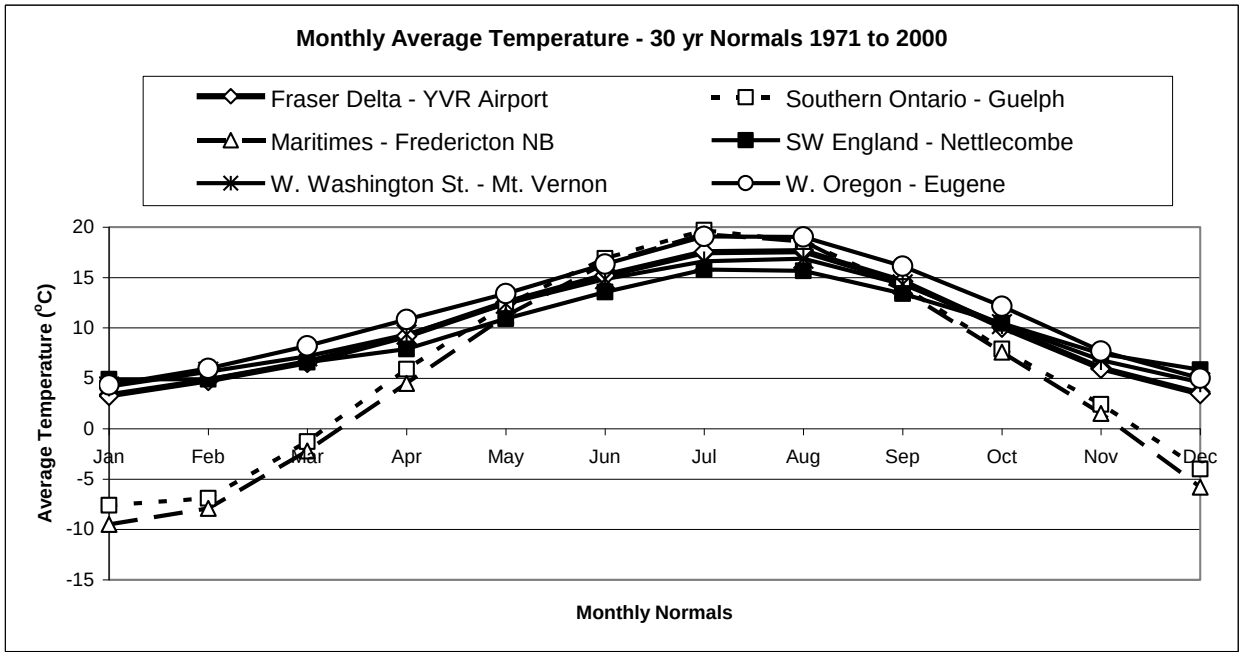
Background: We have conducted three years of cereal variety trials situated on the Fraser River Delta or south coastal British Columbia. We have sourced seed/varieties - as candidates from the EU/UK, Eastern Canada/USA (Southern Ontario, Quebec & Maritimes; Michigan and Indiana) and Pacific Northwest (i.e. Washington, Idaho & Oregon) – which have relatively similar growing conditions. We looked for cereals - spring/winter wheat's (hard reds), barley (2 or 6 row and feed) and oats (naked) - that would fit into vegetable crop rotations (although the spring seeded varieties should be of interest to our Interior and Vancouver Island growers as well); and, ones that would be appropriate for organic and low input conventional producers (no fungicides; low N inputs). Therefore, we are putting a strong emphasis on disease resistance, standability and, while yield is important, it is just one of the characteristics we're looking for.

Our producers will likely focus on feed grain, but if the other characteristics are similar, having the opportunity to fill a local craft brew/malting or artisan food grain market could be of interest, especially to organic growers. Since the cost of feed grains is highest to more isolated farmers, e.g. Vancouver Island, we need to focus on grains that would be easily processed for feed on-farm. Naked or hulless oats seem to be an idea we should try as well.

The compiled “candidate” list – given below - is based upon available variety trial assessments posted on the web for selected regions. Input advice and first-hand knowledge with respect to the list of varieties from selected region – additions and/or deletions – for us to try under our mild and wet growing conditions (see climate data for our region below) has been sought. Cereal disease pressures for South Coastal BC include some mildew upon over-winter cereals, high incidence of yellow/strip and brown rust and septoria. Soils are heavy textured silt loam or silt clay loam deltaic rego-humic gleysols.

With the exception of Canadian barley varieties and “Glenlea” spring wheat, none of the other selected varieties for monitoring and evaluation are registered for commercial use in south Coastal BC; and, an objective to doing such research variety trials will be to work with growers/CFIA to gain registration of those varieties which demonstrate themselves of beneficial growth and development, so that our producers may source such seed in the future. CFIA (Ottawa) is aware of this objective. As a note, we would prefer certified seed; where CFIA importation requirements dictate (i.e. USA and/or UK) phytosanitary certificates are required;





furthermore, we can not import genetically modified or engineered varieties of seed into Canada.

CFIA Contacts: Cindy Pearson: cindy.pearson@inspection.gc.ca ; Jason Murphy Jason.Murphy@inspection.gc.ca
Procedures for Registration
http://www.inspection.gc.ca/english/plaveg/variet/proced/procede.shtml
Registered Varieties in Canada
http://www.inspection.gc.ca/english/plaveg/variet/varnote.shtml

Spring Cereal Candidates from Eastern & Prairie Canada

Spring Wheat

Ontario Trials: http://www.secan.com/index.php?sv=&category=Provincial%20Data&title=Provincial
& Ontario Cereal Crops Committee: http://www.gocereals.ca/variety_trial.php
Contact person: Peter Johnson – Cereal Specialist OMAFRA peter.johnson@ontario.ca

Norwell R (regional registration); hard red; high and consistent yields without fungicides; well suited to all growing areas in Ontario; medium height/good lodging resistance; disease resistance: moderate to Fusarium head blight, excellent leaf disease tolerance; good milling and bread making quality. C & M Seeds: http://www.redwheat.com/ Ellen Sparry esparry@redwheat.com

Hoffman R (regional registration); hard red feed wheat; consistent yields without fungicides; good leaf rust, powdery mildew and septoria resistance; good standability; tall; Hyland Seeds: http://www.hylandseeds.com/ Mark Etienne MEtienne@HylandSeeds.com

Sable R (regional registration); hard red; consistent yields without fungicides; most popular milling wheat in Ontario; height: short; lodging: excellent resistance; disease resistance: intermediate to brown rust, excellent powdery mildew tolerance; unique feature: high test weight, small kernels; unique looking red heads/field; C & M Seeds: http://www.redwheat.com/ Ellen Sparry esparry@redwheat.com

Prairie Trials: http://www.abbcvarinfo.com/ Seed Source: http://seed.ab.ca/

Lillian (regional registration); hard red; high and consistent yields without fungicides; good bread making characteristics; good lodging and stripe rust resistance

Glenlea (national registration); hard red; good bread making characteristics; good lodging and stripe rust resistance; good septoria and fair brown rust resistance

Snowbird (regional registration); hard white; fair stripe rust and good lodging resistance

Snowstar (regional registration); hard white; fair stripe rust and good lodging resistance

Strongfield (regional registration); durum; yields well; good stripe rust and fair lodging resistance

Spring Barley - 2 row

Ontario Trials: http://www.secan.com/index.php?sv=&category=Provincial%20Data&title=Provincial
& Ontario Cereal Crops Committee: http://www.gocereals.ca/variety_trial.php
Contact person: Peter Johnson – Cereal Specialist OMAFRA peter.johnson@ontario.ca

Formosa (malting) good mildew and net blotch disease resistance; fair scald resistance; C & M Seeds: http://www.redwheat.com/ Ellen Sparry esparry@redwheat.com
AC Kings (malting) consistent yields without fungicides; Bramhill Seeds; Carl Coleman carl@bramhillseeds.com

Prairie Trials: http://www.abbcvarinfo.com/ and
http://wheat.pw.usda.gov/ggpages/BarleyNewsletter/42/rossnagel2.html
Seed Source: http://seed.ab.ca/

CDC McGuire (hulless) good yields; good lodging resistance; moderate scald and net blotch resistance; low beta-gluten levels and high digestibility energy fro swine and poultry; relatively good straw strength and threshability

CDC Bold semi- dwarf; good yields; good lodging resistance; fair scald and fair/poor net blotch resistance

Maritime – New Brunswick Trials: http://www.gnb.ca/0316/03160001-e.asp

Island feed; good yields; good mildew, scald and net blotch resistance; McCardle Seeds (PEI) http://www.mccardleseeds.com/products.shtml

Spring Barley - 6 row

Ontario Trials: **http://www.secan.com/index.php?sv=&category=Provincial%20Data&title=Provincial**
& Ontario Cereal Crops Committee: http://www.gocereals.ca/variety_trial.php
Contact person: Peter Johnson – Cereal Specialist OMAFRA peter.johnson@ontario.ca

OAC Kawartha consistent yields without fungicides; SeCan: http://www.secan.com/index.php Carl Coleman carl@bramhillseeds.com

OAC Laverne consistent yields without fungicides; SeCan/Bramhill Seeds Carl Coleman carl@bramhillseeds.com

Prairie Trials: http://www.abbcvarinfo.com/ Seed Source: http://seed.ab.ca/

Sundre good yields; good lodging resistance; very good scald and fair/poor net blotch resistance

Maritime – New Brunswick Trials: http://www.gnb.ca/0316/03160001-e.asp

Encore does well in the Maritimes; good mildew and scald disease resistance; not so resistant against net blotch; Eastern Grains: http://www.easterngrains.ca/seed.htm Eric Theriault:; easterngrains@aernet.ca with SeCan: http://www.secan.com/index.php

Spring Oats - Hulless

Quebec: based upon Ontario & New Brunswick Trials

Navaro limited Ontario yield data; did well in Maritimes; very good disease resistance; Semican Inc.: http://www.semican.ca/english/semican/index.htm Jacques Beauchesne jacquesbeauchesne@semican.ca Julie Durand jdurand@semican.c Vern Burrows – AAFC Vern.Burrows@AGR.GC.CA

AC Baton did well in Maritimes; good yields; high resistance to head blight and moderate net blotch resistance; high % hulless; not tall; moderate lodging; Eastern Grains: http://www.easterngrains.ca/seed.htm; Eric Theriault: easterngrains@aernet.ca

Spring Cereals Candidates from Pacific Northwest

Washington State:
Resource contacts: Steve Jones – WSU joness@wsu.edu
Victor Shaul – Washington Dept..of Agriculture; USDA PC's; vshaul@agr.wa.gov
Margaret Gollnick – PC's; mvigil@wsu.edu WSU Pathologist
Mike Flowers – OSU Mike.Flowers@oregonstate.edu

Spring Wheat

WSU Trials: http://variety.wsu.edu/2008/index.htm
Seed Source: Connell Grain Growers: http://www.connellgg.com/index.cfm Contact: Scott Marks; scott.marks@chsinc.com

Cabernet hard red, high stripe/yellow rust resistance; no Mt. Vernon yield data available; awned, intermediate maturity similar to Express; good yields and protein; medium height/stiff straw/excellent standability; good adult plant resistance to stripe rust under irrigated and higher rainfall dryland production; Syngenta.

Expresso hard red, high stripe/yellow rust resistance; good yields; semi-dwarf with white chaff, high protein, and good test weight; high yield capacity in irrigated and high rainfall environments; moderately tolerant to stripe rust; good resistance to powdery mildew, leaf rust, stem rust, and septoria; Monsanto.

Scarlet hard red, low stripe/yellow rust resistance; 1989 WSU release targeted to semi-arid applications; mid-tall, mid season maturity with excellent yield; good protein.

Spring Barley

WSU Trials: http://variety.wsu.edu/2008/index.htm
Seed Source: Connell Grain Growers: http://www.connellgg.com/index.cfm Contact: Scott Marks; scott.marks@chsinc.com

Baronesse 2 row; little stripe/yellow rust resistance at Mt. Vernon; yielded well; feed barley; excellent yields; good test weights in both irrigated and dryland production; most planted barley in Washington State.

Source: Washington State Crop Improvement Association – Foundation Seed Service serving Tri-State: WA, OR and ID; Contact person: Darlene Hilkin – WSCIA – Foundation Seed Service wscia_fss@wsu.edu; css.wsu.edu/proceedings/2005/WSCIA_FSS.pdf

Camus 2 row; USDA-ARS/University of Idaho joint release; recommended by Michael Flowers/OSU

From Idaho State:
Contact person: Phil Bregitzer – USDA – Aberdeen Research Station, Idaho
Phil.Bregitzer@ars.usda.gov ; Gary West – Idaho Dept. of Agriculture – Twin Falls ID; USDA PC's;

95SR316A 2 row; USDA- ARS - Phil Bregitzer – was released as a germplasm line with resistance to stripe rust, which traces to a high temperature adult plant resistance gene (thought to be durable); potential malting variety as low on soluble/total protein.

Spring Cereals Candidates from UK

Similar Climate: Nettlecombe – Southwest Coast UK:
http://www.metoffice.gov.uk/climate/uk/averages/19712000/sites/nettlecombe.html

Spring Barley

HGCA Recommendation List:
http://www.hgca.com/content.output/382/382/Varieties/HGCA%20Recommended%20Lists/Spring%20barley.mspx
Contact person: Jim McVittie – HGCA Jim.McVittie@hgca.com

Henley 2 row; good disease resistance to yellow/stripe rust and lodging; good yields without fungicide http://www.nickersonseeds.co.uk/; Contact person: Frank Curtis frank.curtis@nickerson.co.uk; Rose Brewster rose.brewster@limagrain.co.uk

Concerto 2 row malting; good resistance to yellow/stripe rust and lodging; good yields without fungicide.

Spring Wheat

HGCA Recommendation List:
http://www.hgca.com/content.output/353/353/Varieties/HGCA%20Recommended%20Lists/Spring%20and%20late%20autumn%20wheat.mspx

Paragon hard red/feed; good milling/bread making; high resistance to yellow/stripe and brown rust and lodging; good/fair yields without fungicide popular with organic grower's http://www.ragt.co.uk/__80257118005301f7.nsf/display/index.htm Contact person: Chris Black CBlack@ragt.FR

Winter Cereal Candidates from Eastern Canada/Great Lakes Region

Ontario Trials: **http://www.secan.com/index.php?sv=&category=Provincial%20Data&title=Provincial**
& Ontario Cereal Crops Committee: http://www.gocereals.ca/variety_trial.php
Contact person: Peter Johnson – Cereal Specialist OMAFRA peter.johnson@ontario.ca

Winter Wheat

25R47 R (regional registration); soft red; and consistent yields without fungicides; Pioneer Hi-Bred: http://www.pioneer.com/ Dave Harwood ph: 519 401 2066 cell david.harwood@pioneer.com; Ellis Clayton ellis.clayton@pioneer.com ph: 306 956 3530; cell 306 221 4229

25R39 R (regional registration); soft red; consistent yields without fungicides; good/excellent stripe rust resistance; Pioneer Hi-Bred: http://www.pioneer.com/

Wentworth R (regional registration); hard red; consistent yields without fungicides; Hyland Seeds: http://www.hylandseeds.com/; Mark Etienne MEtienne@HylandSeeds.com

Princeton (regional registration); hard red; consistent yields without fungicides; disease resistance: MR to fusarium, good leaf disease tolerance; C & M Seeds: http://www.redwheat.com/ Ellen Sparry esparry@redwheat.com

Stanford (regional registration); hard red; consistent yields without fungicides; rated MR to Fusarium, short variety that can be managed intensively without lodging issues; C & M Seeds: http://www.redwheat.com/ Ellen Sparry esparry@redwheat.com

Harvard (regional registration); hard red; consistent yields without fungicides; powdery mildew tolerance; excellent straw strength; C & M Seeds: http://www.redwheat.com/ Ellen Sparry esparry@redwheat.com

Palmer R (regional registration); soft red; consistent yields without fungicides; good all round disease tolerance; C & M Seeds: http://www.redwheat.com/ Ellen Sparry esparry@redwheat.com

Winter Barley

MacKellar R (regional registration); Hyland Seeds: http://www.hylandseeds.com/; Mark Etienne MEtienne@HylandSeeds.com

Winter Cereals Candidates from Pacific Northwest

Washington State:
Source: Connell Grain Growers: http://www.connellgg.com/index.cfm
Contact: Scott Marks; scott.marks@chsinc.com

Winter Wheat

WSU Trial Results: http://variety.wsu.edu/2008/index.htm & http://variety.wsu.edu/2007/index.htm

Eddy hard red; fair/moderate stripe/yellow rust resistance; formerly known as WB788E Westbred variety; variety does well in dry land to fully irrigated situations; very early maturing variety; fair disease and rust resistance; good milling and baking quality.

Paladin hard red; medium height, semi-dwarf, excellent straw strength and medium maturity; good general disease resistance including leaf rust and stem rust ; moderately susceptible to stripe rust; good yield potential in areas of intermediate rainfall potential; proteins is above average; good milling and baking qualities.

Declo hard red; moderate/good strip/yellow rust resistance; a semi-dwarf type meant for irrigated production in the Pacific Northwest; high tillering common head type;

susceptible to powdery mildew; good adult plant resistance to stripe rust; good milling and baking properties; acceptable for use in many export markets.

Winter Barley

Source: Washington State Crop Improvement Association – Foundation Seed Service serving Tri-State: WA, OR and ID; Contact person: Darlene Hilkin – WSCIA – Foundation Seed Service wscia_fss@wsu.edu; css.wsu.edu/proceedings/2005/WSCIA_FSS.pdf

Strider 6 row; feed; good/excellent stripe/yellow rust resistance; A feed variety released by Oregon AES, USDA-ARS in 1998. Strider has excellent yield potential; resistance to barley stripe rust.

Winter Wheat

Source: Washington State Crop Improvement Association – Foundation Seed Service serving Tri-State: WA, OR and ID; Contact person: Darlene Hilkin – WSCIA – Foundation Seed Service wscia_fss@wsu.edu;

Norwest 553 hard red; semi-dwarf; excellent stripe/yellow rust resistance; Norwest 553 was bred by Limagrain in France; commercial release in the US by Oregon State University (Jim Peterson). Based on French parentage - ORN00B553; best adapted to moderate to high rainfall areas; acceptable milling and baking quality; superior dough mixing strength**.**

Winter Cereals Candidates from UK/EU

Similar Climate: Nettlecombe – Southwest Coast UK:
http://www.metoffice.gov.uk/climate/uk/averages/19712000/sites/nettlecombe.html

Winter Wheat

From HGCA Recommendation List:
http://www.hgca.com/content.output/235/235/Varieties/Varieties/HGCA%20Recommended%20Lists.mspx
Contact person: Jim McVittie – HGCA Jim.McVittie@hgca.com

Panorama (hard red/bread) popular bread milling wheat in UK high/good disease resistance to yellow/stripe rust and lodging; good yields without fungicide http://www.nickersonseeds.co.uk/ Contact person: Frank Curtis frank.curtis@nickerson.co.uk; Rose Brewster rose.brewster@limagrain.co.uk

Gladiator (hard red/feed) high disease resistance to yellow/stripe and brown rust and lodging; good/fair yields without fungicide; http://www.ragt.co.uk/__80257118005301f7.nsf/display/index.htm Contact person: Chris Black CBlack@ragt.FR

Warrior (soft white) high disease resistance to yellow/stripe and brown rust and lodging; good/fair yields without fungicide http://www.ragt.co.uk/__80257118005301f7.nsf/display/index.htm

Monopol German variety used locally and mostly as a cover crop since 1986; set Canadian wheat yield record in Delta, 1987; good stripe rust resistance; moderate resistance to brown rust, septoria and fusarium head blight; tall growing; good resistance to lodging; late maturing.

Reaper UK variety used locally and mostly as a cover crop since mid-1990's; as a cereal crop not much is known; reported to have good yields.

Winter Barley

From HGCA Recommendation List:
http://www.hgca.com/content.output/235/235/Varieties/Varieties/HGCA%20Recommended%20Lists.mspx
http://www.hgca.com/document.aspx?fn=load&media_id=5779&publicationId=362

Vanquish 2 row malting; good yield; high/good stripe rust, brown rust, scald and net blotch resistance; good lodging resistance; http://www.nickersonseeds.co.uk/ Contact person: Frank Curtis: frank.curtis@nickerson.co.uk

Retriever 2 row feed; good yields; high/good stripe rust and scald resistance; fair lodging resistance; http://www.nickersonseeds.co.uk/ Contact person: Frank Curtis: frank.curtis@nickerson.co.uk

Suzuka 2 row feed; good yield; high/good stripe rust, brown rust, scald and net blotch resistance; good lodging resistance; Syngenta Seeds www.newfarmcrops.co.uk Contact person: jim.duncumb@syngenta.com

Winsome 2 row malting; good yield; high/good stripe rust and scald resistance; fair lodging resistance; Syngenta Seeds www.newfarmcrops.co.uk Contact person: jim.duncumb@syngenta.com

Flagon 2 row malting; good yield; high/good stripe rust, brown rust and scald resistance; fair lodging resistance; Syngenta Seeds www.newfarmcrops.co.uk Contact person: jim.duncumb@syngenta.com

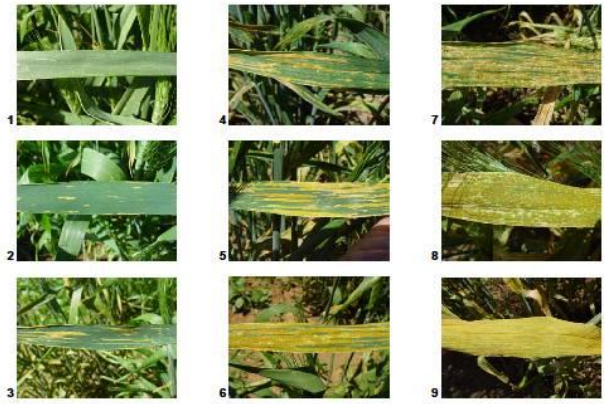
Materials & Methods

Cereal Crop Small Plot Variety Trials: New potentially suitable and available varieties of spring and fall planted cereals/grains were sourced from Eastern Canada/USA (Ontario, Quebec and Maritimes; Michigan and Indiana), Pacific Northwest (i.e. Oregon, Idaho and Washington State) and Europe/UK. Small grain screening trials were established to monitor and compare available varieties of cereal grains as potential low-input break crops (i.e. demonstrate disease resistance in absence of pesticides; and yield well under low fertilizer N inputs). Crops were evaluated for yield components (e.g. grain and straw yields; number of heads m^2; 1000 grain weights (TGW's); number grains/head); and, selected growth, development and quality criteria such as % cover/emergence (point method), plant density, height (plate method), pest, disease and lodging resistance, test weights and protein content for feed milling/bread making characteristics. Over-wintering cereals were planted - using a 3m wide "Vicon" air-seeder with 10cm row spacing - in early September; while spring cereals were be planted - as early as possible (i.e. April); and, targeting 300 viable plants/m^2 plant densities. Therefore, we targeted a seed density of 450 seed/m^2 for winter wheat and for spring wheat, 400 seeds/m^2. Our target seed density for spring barley was 350 seeds/m^2 and for hulless oats, we targeted at 500 seeds/m^2. The over-winter and spring planted cereal grain variety trials were established using a completely randomized block design. Each plot measured 3m x 10m in length using 4 replicates/blocks for each variety tested. For over-winter plots - where over-winter waterfowl use is high - fence-enclosures were established on the plots. At the time of plot establishment composite soil samples (0-30 cm) were taken from each block to characterize the sites soil fertility (e.g. Soil pH, EC, Total N, OM, and Available N, P, K, Ca, Mg and Na).

Crop Yield Component Sampling & Analysis: The crop in the field demonstration plots were sampled by harvesting the above ground biomass – leaving 10 cm stubble - within a 0.5 x 0.5m quadrate, placed within the approximate centre of the plot. The numbers of heads/stems were counted. Crop material was dried at 60°C using a pot-hole drier; cereal crop were threshed to recover the grain; 100 grain weights and test weights determined; and, grain was ground and analyzed for total nitrogen according to Parkinson and Allen (1975) and converted to crude protein levels (%N x 5.7). Grain yield, test weight, thousand grain weight (TGW's) and protein concentrations are expressed at 13.5% moisture.

Cereal Disease Surveys: Cereal stem/crown, leaf and head disease of economic importance such as Eyespot or Strawbreaker (*Pseudocercosporella herpotrichoides*), Take-all (*Gaeumannomyces graminis*), Fusarium (*Fusarium spp*.), Barley Stripe (*Helminthosporium gramineum*), Scald or Leaf Blotch (*Rhynchosporium secalis*), Stem/Leaf/Stripe/Yellow/Brown Rust (*Puccinia spp*.), Powdery Mildew (*Erysiphe graminis*), Septoria Leaf Spot or Glume Blotch (*Septoria tritici*), Net Blotch (*Pyrenophora teres*), Smut (*Ustilago spp*.), Bunt (*Tilletia spp*.) and other diseases as they present themselves were monitored and noted over the course of crop development. During flowering to milking stage (Zadoks growth stage (ZGS) 65 to 75 as described by Tottman, 1986) disease assessments were conducted. Five plants were randomly selected from each plot with their stems, leaf (flag and penultimate) and head inspected for diseases and leaf resistance rated according to the assessment key (see below).

Score	Description
1	highly resistant: no visible symptoms
2	highly resistant: occasional symptoms of infection including necrotic flecks and small stripes without sporulation
3	resistant: symptoms evident and may include stripes with necrosis and chlorosis, limited sporulation, and affected leaf area up to 15%
4	moderately resistant: sporulating areas arranged in stripes, some chlorosis and necrosis, and affected leaf area up to 30%
5	intermediate: sporulating areas arranged in stripes with some chlorosis, and affected leaf area up to 50%
6	moderately susceptible: sporulating stripes and affected leaf area up to 70%
7	moderately susceptible to susceptible: sporulating stripes merging into broader leaf areas supporting symptoms; chlorosis and necrosis evident; leaf area affected up to 90%
8	susceptible: sporulation across the whole leaf surface with no stripes but with evidence of chlorotic areas
9	highly susceptible: abundant sporulation across the whole leaf area with no evidence of stripes
10	dead leaf



Statistical Analysis: All data was subjected to an Analysis of Variance (ANOVA) using SAS Institute Inc. "JMPin" statistical program, version 4.0.4 (JMP, 2001). Following a significant F-value for treatment, treatment mean separations (MS) were performed using "Tukey's-Krammer", "Student's t-Test" and/or "Dunnett's. Level of significance was $p<0.05$.

Climate & Weather Condition: Climate and weather data are collected from Environment Canada's Vancouver International Airport climate station situated approximately 10 to 15 km from the Delta sites described in this report.

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Hard Red Winter Wheat

Hard Red Spring Wheat

Soft Red Winter Wheat

Durum Wheat

Hard White Wheat

Soft White Wheat

Wheat Classes

Wheat is a versatile crop. There are 6 classes of wheat grown in the United States but there are more than 30,000 different varieties, each with its own characteristics.

Spring wheats are planted in late spring, usually before or in the month of April. Spring wheats do not go thru a dormant stage, but just develop and mature until they are harvested.

Winter wheats are planted in the fall, starting in September and continuing thru October. Winter wheat sprouts and grows in the fall. Once it freezes in the fall, winter wheat becomes dormant until the soil warms up in the spring. Then the wheat grows and matures until harvest in the summer. In fact, without the cold temperatures, winter wheat would just continue to produce leaves and would never produce the head of wheat kernels (the flower of the wheat plant).

Hard wheats are higher in protein and gluten and are usually used for yeast breads. Soft wheats are primarily used for tender pastries, cakes, cookies, flatbreads, crackers and muffins. Soft and hard wheats are often blended to make all-purpose flour, used in a wide variety of baked products. Durum wheat is the hardest wheat and is primarily used for making pasta.

Hard Red Winter Wheat - This wheat is high in protein and strong in gluten. It is used for yeast breads and hard rolls. Hard Red Winter Wheat is grown in many states, including Arizona, Washington, California, Montana, Wyoming, Idaho, Utah, Minnesota, Missouri, and the Plains states of North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, and Texas. Kansas ranks first among the 50 states in wheat production, primarily producing hard red winter wheat.

Hard Red Spring Wheat - This wheat is high in protein and used in yeast breads and hard rolls. It is grown in areas where the growing season is shorter, such as Minnesota, North Dakota, South Dakota, Montana, and Idaho.

Soft Red Winter Wheat - This wheat is used for flat breads, cakes, pastries, and crackers. It is the dominant wheat grown east of the Mississippi River. Soft Red Winter Wheat states include Texas, Missouri, Arkansas, Louisiana, Mississippi, Alabama, Georgia, South Carolina, North Carolina, Tennessee, Kentucky, Illinois, Indiana, Ohio, Michigan, Pennsylvania, Virginia, New Jersey, and Wisconsin.

Durum Wheat - Durum wheat is the hardest wheat. It is used primarily for making pasta, including macaroni and spaghetti. Durum wheats are primarily grown in North Dakota,

Minimum test weights for grains under the *Canada Grain Act*

Barley, Canada Western (CW)

	g/0.5 L	kg/hL	A lb/bu	lb/W bu
Special Select CW Two-row	303	63.0	50.5	47.0
Special Select CW Six-row	298	62.0	49.7	46.2
Select CW Two-row	293	61.0	48.8	45.5
Select CW Six-row	288	60.0	48.0	44.7
Standard Select CW Two-row/Six-row	No minimum			

Barley, Canada Western General Purpose (CW)

	g/0.5 L	kg/hL	A lb/bu	lb/W bu
No. 1 CW	303	63.0	50.5	47.0
No. 2 CW	274	57.0	45.7	42.5
Grade, if No. 2 specs not met	Barley, Sample CW Account Light Weight			

Oats, Canada Western (CW)

	g/0.5 L	kg/hL	A lb/bu	lb/W bu
No. 1 CW	260	56.0	44.9	40.4
No. 2 CW	245	53.0	42.5	38.0
No. 3 CW	235	51.0	40.9	36.5
No. 4 CW	220	48.0	38.5	34.1
Grade, if No.4 specs not met	Oats, Sample CW Account Light Weight			

Wheat, Canada Western Red Spring (CWRS)

	g/0.5 L	kg/hL	A lb/bu	lb/W bu
No. 1 CWRS	365	75.0	60.1	56.6
No. 2 CWRS	350	72.0	57.7	54.3
No. 3 CWRS	335	69.0	55.3	52.0
No. 4 CWRS	330	68.0	54.4	51.2
CW Feed	315	65.0	52.1	48.9
Grade, if specs for CW Feed not met	Wheat Sample CW Account Light Weight			

Wheat, Canada Western Red Winter (CWRW)

	g/0.5 L	kg/hL	A lb/bu	lb/W bu
No. 1 CWRW	380	78.0	62.5	59.0
No. 2 CWRW	360	74.0	59.3	55.9
CW Feed	315	65.0	52.1	48.9
Grade, if specs for CW Feed not met	Wheat Sample CW Account Light Weight			

http://grainscanada.gc.ca/guides-guides/weight-poids/tw-ps/mtwg-psmg-eng.htm

Quality of No 1 CWRS from the 2003 western Canadian harvest. [1] [2]

Property	**No 1 CWRS-14.5**	**No 1 CWRS-13.5**	**No 1 CWRS-12.5**
Wheat			
Test weight, kg/hL	82.2	82.4	82.7
Protein content, %	14.8	13.8	12.8
Falling Number, s	420	395	405
Flour yield, %	75.4	75.7	75.5
Flour			
Protein content, %	14.3	13.3	12.2
Ash content	0.48	0.46	0.48
Farinograph			
Absorption, %	66.3	65.7	65.3
Development time, min	6 ½	5 ¾	4 ½
Stability, min	10	11	9 ½
Extensigraph			
Length, cm	22	21	22
Maximum height, BU	715	690	670
Area, cm2	205	190	195
Short process bread			
Absorption, %	68	69	68
Mixing time, min	7.0	9.8	10.3
Loaf volume, cc	1105	1130	1075

[1] Source: Quality of 2003 western Canadian wheat (CGC 2003b).

[2] Data reported on a 13.5% moisture basis for wheat and a 14.0% moisture basis for flour.

http://grainscanada.gc.ca/cgc-ccg/grl-lrg/bread-panifiable-eng.htm

Abbreviations

g/0.5 L - grams per 0.5 litre

- determined using the operational Test Weight methodology outlined in the Canadian Grain Commission Official Grain Grading Guide. The method incorporates a Cox Funnel, 0.5 L container, hardwood striker and digital electronic scale.

kg/hL - kilograms per hectolitre

- derived from g/0.5 L incorporating CGC-developed regression equations to predict the approximate kg/hL as would have been determined by standard Schopper Chondrometer methodology.

A lb/ bu - Avery pound per bushel

- derived by dividing the determined approximate kg/hL by 1.247. The value 1.247 represents the arithmetic relationship between the lb/British dry bushel and kg/hL:
  - 1 British bushel = 0.3637 hectolitre
  - 1 kg = 1000 grams
  - 1 lb = 453.59 grams
  - kg/hL = 0.45359/0.3637 = 1.247 lb/bu (arithmetic conversion)

Note: The CGC determined approximate kg/hL by definition takes into account the compaction of grain. Conversion to approximate lb/bu from this number will result in the lb/bu figure also allowing for grain compaction and is referred to as Avery.

lb/W bu - pound per Winchester bushel

- derived by multiplying the g/0.5 L measurement by 0.1552. The value 0.1552 represents the arithmetic relationship between g/0.5 L and lb/Winchester bushel:
  - 1 lb = 453.59 grams
  - 0.5 L = 500 cm^3
  - Winchester bushel = 35 200 cm^3 = 70.4/0.5 litre container.
  - The arithmetic multiplier then is 70.4/453.59 = 0.1552

Note:

1. The U.S. Winchester bushel (1.244 ft^3) is smaller than the British or Imperial bushel (1.2843 ft^3).
2. The lb/Winchester bushel is an arithmetic conversion that does not allow for grain compaction.
3. The Winchester bushel measures shown in the CGC test weight conversion charts are derived only from g/0.5 L.

Note: The g/0.5 L test weight numbers appear in the Grain Grading Guide, while the numbers for the kg/hL, A lb/bu and lb/W bu measurements are taken from the CGC's test weight conversion charts. The kg/hL numbers in the Grain Grading Guide and the test weight conversion charts vary slightly due to rounding.

Avery and Winchester conversions are intended for information purposes only and are not to be used for grading purposes.

Funding provided by:

Appendix C – Factsheet: Recommended Cereal Varieties for South Coastal BC

Suggested List of Recommended Cereal Varieties for Registration and/or Planting for South Coastal BC

Spring Wheat	Winter Wheat	Spring Barley	Winter Barley	Spring Oats
♣ ♦ ¤ Glenlea - Hard red (HR)	§ ♦ ¤ Monopol - HR	♣ ¤ Island - 2 row/feed	♠ ¤ Flagon - 2 row/malting	♣ ¤ AC Baton - Hulless
(R) ♦ ¤ Lillian - HR	Reaper - HR	♣ CDC Bold - 2 row/feed	♠ ¤ Retriever - 2 row/feed	♣ ¤ Navaro - Hulless
(R) ♦ ¤ Strongfield - Durum	(R) § ¤ Harvard - HR	♣ ¤ McGuire - hulless/feed	♠ ¤ Suzuka - 2 row/feed	
(R) ¤ Sable - HR	(R) ¤ Stanford - HR	♣ ¤ OAC Kawartha - 6 row	♠ ¤ Vanquish - 2 row/malting	
♥ Expresso - HR	§ ♥ ¤ Norwest 553 - HR	♥ ¤ Baronesses - 2 row/feed	♠ ¤ Winsome - 2 row/malting	
♥ Cabernet - HR	♠ Gladiator - HR	♥ ¤ 95SR316A - 2 row/feed		
♠ ¤ Paragon - HR	♠ Warrior - Soft White	♠ ¤ Concerto - 2 row/malting		
		♠ ¤ Henley - 2 row/feed		

♣ Varieties which are registered in Canada and seed available to producers on South Coastal BC
(R) Varieties which have "regional" registration in Canada, but not on South Coastal BC; subject to CFIA approval
♥ Varieties registered in Washington/Oregon State, but not in Canada; subject to CFIA approval
♠ Varieties registered in UK/EU, but not in Canada; subject to CFIA approval
♦ Varieties which grew tall and susceptable to lodging
¤ Varieties which establish quickly and/or grew tall to exhibit relatively good weed control without the use of herbicides.
§ Varieties of winter wheat with a relatively good spring stand after intensive over-winter waterfowl grazing
For a complete list of varieties which are registered in Canada; and, procedures for registration of varieties in Canada, please refer to following CFIA web page:
http://www.inspection.gc.ca/english/plaveg/variet/proced/procede.shtml

Recommended Spring & Winter Cereal from Eastern & Prairie Canada

Spring Wheat

Sable R (regional registration - Ontario); hard red; most popular milling wheat in Ontario; relatively short; good resistance to lodging, brown/stripe rust and reportable mildew; high test weight; unique looking red heads/field; C & M Seeds: http://www.redwheat.com/ Ellen Sparry esparry@redwheat.com

AC Lillian (regional registration - Prairie); hard red; good bread making characteristics; good lodging and stripe rust resistance; tall; SeCan; Seed Source: http://seed.ab.ca/

Glenlea (national registration); hard red; good bread making characteristics; tall; fair lodging and stripe rust resistance; good septoria and fair brown rust resistance; Seed Source: http://seed.ab.ca/

AC Strongfield (regional registration - Prairie); durum; good pasta making characteristics; yields well; good stripe rust and fair lodging resistance; tall; SeCan: Seed Source: http://seed.ab.ca/

Winter Wheat

Stanford (regional registration - Ontario); hard red; good bread making characteristics; good stripe rust resistance; susceptible to septoria; short variety that can be managed intensively without lodging issues; does not withstand intensive waterfowl grazing; C & M Seeds: http://www.redwheat.com/ Ellen Sparry esparry@redwheat.com

Harvard (regional registration - Ontario); hard red; good bread making characteristics; good stripe rust resistance; susceptible to septoria; good powdery mildew tolerance; excellent straw strength; does withstand waterfowl grazing when planted in early September. C & M Seeds: http://www.redwheat.com/ Ellen Sparry esparry@redwheat.com

Spring Barley

CDC McGuire hulless; 2 row; feed; Prairie variety; good yields; good lodging resistance; fair stripe rust, good brown rust and reported moderate scald and net blotch resistance; breed specifically for low beta-gluten levels and high digestibility energy for feeding swine and poultry; relatively good straw strength and threshability; Seed Source: http://seed.ab.ca/

CDC Bold 2 row; semi- dwarf; feed; Prairie variety; good yields; good lodging resistance; fair stripe rust, good brown rust and reported fair scald and fair/poor net blotch resistance; Seed Source: http://seed.ab.ca/

Island 2 row feed; Maritime; good yields; good stripe rust, fair brown rust and reported mildew, scald and net blotch resistance; McCardle Seeds Inc. http://www.mccardleseeds.com/products.shtml

OAC Kawartha Ontario; 6 row; feed; good yields; fair stripe and good brown rust resistance; SeCan: http://www.secan.com/index.php Carl Coleman carl@bramhillseeds.com

Spring Oats - Hulless

Navaro good yields; does well in Maritimes; very good disease and lodging resistance; Semican Inc.: http://www.semican.ca/english/semican/index.htm Jacques Beauchesne jacquesbeauchesne@semican.ca

AC Baton Maritimes; good yields; high resistance to head blight and moderate net blotch resistance; high % hulless; not tall; moderate lodging; Eastern Grains: http://www.easterngrains.ca/en/home.php; Eric Theriault: info@easterngrains.ca

Recommended Spring & Winter Cereals from Pacific Northwest

Spring Wheat

Cabernet hard red, good stripe/yellow rust and septoria resistance; awned; good yields and protein; medium height/excellent standability; Syngenta; Seed Source: Connell Grain Growers: http://www.connellgg.com/index.cfm Contact: Scott Marks; scott.marks@chsinc.com

Expresso hard red, semi-dwarf/short; good stripe rust and septoria resistance; and reported good resistance to powdery mildew; slow to establish; excellent standability; Monsanto; Seed Source: Connell Grain Growers: http://www.connellgg.com/index.cfm Contact: Scott Marks; scott.marks@chsinc.com

Winter Wheat

Norwest 553 hard red; semi-dwarf; excellent stripe/yellow rust and moderate septoria resistance; Norwest 553 was bred and marketed by Limagrain in France and later developed in cooperation with Oregon State University; demonstrated good regrowth potential after intense waterfowl grazing when planted in early September; WSCIA – Foundation Seed Service wscia_fss@wsu.edu;

Spring Barley

Baronesse 2 row; feed barley; moderate stripe rust resistance; good yields and test weights; most planted barley in Washington State; a German variety: http://www.saaten-union.com/index.cfm/article/2643.html; Seed Source: Connell Grain Growers: http://www.connellgg.com/index.cfm; Scott Marks scott.marks@chsinc.com

95SR316A 2 row; good stripe rust and moderate brown rust resistance; potential malting variety as low on soluble/total protein; Contact person: Phil Bregitzer – USDA – Aberdeen Research Station, Idaho Phil.Bregitzer@ars.usda.gov

Recommended Spring & Winter Cereals from UK

Spring Barley

Henley 2 row feed; good disease resistance to stripe/brown rust and lodging; excellent yields without fungicide http://www.nickersonseeds.co.uk/; Frank Curtis frank.curtis@nickerson.co.uk

Concerto 2 row malting; good resistance to stripe/brown rust and lodging; excellent yields without fungicide. http://www.nickersonseeds.co.uk/; Frank Curtis frank.curtis@nickerson.co.uk

Spring Wheat

Paragon hard red/feed; good milling/bread making; high stripe/brown rust, fir septoria and lodging resistance; good yields without fungicide; most popular in UK with organic grower's; http://www.ragt.co.uk/__80257118005301f7.nsf/display/index.htm Chris Black CBlack@ragt.FR

Winter Wheat

Gladiator (hard red/feed) high disease resistance to stripe/brown rust, septoria and lodging; excellent yields without fungicide; low tolerance to intensive waterfowl grazing; http://www.ragt.co.uk/__80257118005301f7.nsf/display/index.htm Chris Black CBlack@ragt.FR

Warrior (soft white) high disease resistance to stripe/brown rust, septoria and lodging; excellent yields without fungicide; low tolerance to intensive waterfowl grazing; http://www.ragt.co.uk/__80257118005301f7.nsf/display/index.htm; Chris Black CBlack@ragt.FR

Monopol German variety; used locally and mostly as a cover crop since 1986; good yields; set Canadian wheat yield record in Delta, 1987; good stripe rust resistance; fair/moderate resistance to brown rust, septoria and fusarium head blight; tall growing; good resistance to lodging; late maturing; good tolerance to intensive waterfowl grazing when planted in early September.

Reaper UK variety used locally and mostly as a cover crop since mid-1990's; excellent yields; good stripe and brown rust resistance; good/moderate resistance to septoria; low tolerance to intensive waterfowl grazing.

Winter Barley

Vanquish 2 row malting; good yield; high/good stripe rust, brown rust, scald and net blotch resistance; good lodging resistance; http://www.nickersonseeds.co.uk/ Contact person: Frank Curtis: frank.curtis@nickerson.co.uk

Retriever 2 row feed; good yields; high/good stripe rust and scald resistance; fair lodging resistance; http://www.nickersonseeds.co.uk/ Contact person: Frank Curtis: frank.curtis@nickerson.co.uk

Suzuka 2 row feed; good yield; high/good stripe rust, brown rust, scald and net blotch resistance; good lodging resistance; Syngenta Seeds www.newfarmcrops.co.uk Contact person: jim.duncumb@syngenta.com

Winsome 2 row malting; good yield; high/good stripe rust and scald resistance; fair lodging resistance; Syngenta Seeds www.newfarmcrops.co.uk Contact person: jim.duncumb@syngenta.com

Flagon 2 row malting; good yield; high/good stripe rust, brown rust and scald resistance; fair lodging resistance; Syngenta Seeds www.newfarmcrops.co.uk Contact person: jim.duncumb@syngenta.com

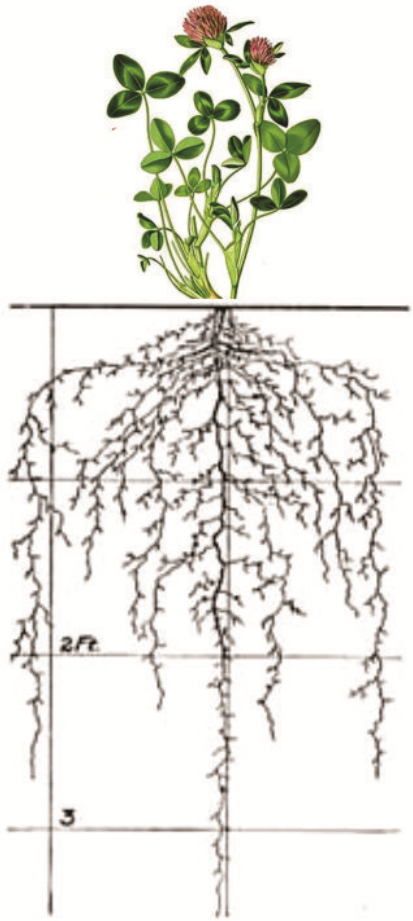
Funding provided by:

Appendix D – Factsheet: DF&WT Clover Under-seeding of Cereals Factsheet

Do you want to:
Reduce your N fertilizer bill?
Break up compacted soils?
Build soil organic matter?

Plant Clover as a Cover Crop!

Relay cropping clover with a spring grain can increase soil organic matter, protect soil from erosion, and provide plant available N to the next crop. Delta Farmland & Wildlife Trust is encouraging Delta farmers to relay crop clover with grain. We will be providing clover seed during 2011.



The Benefits of Using Clover

- Clover can supplies N to the next cash crop: **70-100 lbs/acre**
- Residue will mineralize quickly (usually within 3 weeks after plough down) because of a low C/N ratio: 9.5 - 11.5.
- Clover tap root can penetrate up to 3 feet, breaking up compaction.
- Maintain soil cover, even after the clover has bee grazed by waterfowl.
- Clover is eligible for a cost-share of $45/acre through the Winter Cover Crop Program.

BMPs to Plant, Establish Cover and Use of Clover as a Green Manure Crop

- Plant your spring cereals as early as possible (mid to late April) to avoid excessive weed growth and to allow for an early harvest.
- Broadcast "treated" clover seed when the planted grain has just begun to tiller.
- Use seed treated with inoculum/rhizobium at a rate of 4-6 lbs/acre (ask us about seeding methods).
- Seed white clover when using a short-stalked grain.
- After grain harvest, it is important to bail straw to allow the clover to grow as long as possible heading into the fall/winter.
- By no later than early June, till clover into the soil roughly 4 weeks prior to planting cash crop.

To Avoid Problems...

- Don't seed red clover at the same time as your grain crop; it may over grow the grain, requiring that you swathe the grain first before harvesting.
- IF planting clover at the same time as grain, try using white clover...it won't grow as tall as the red.
- Don't spill too much grain off of the combine during grain harvest; excess grain will choke out the clover in the fall and will nullify any beneficial effects of the clover.

If you have a grain field that you would like to have relay cropped with clover, please contact David at the Delta Farmland & Wildlife Trust office (604-940-3392).

Reporting Period: From Sept 23, 2008 to: Sept 30, 2011 Project #: A0573

	Activities		Status			
Due Date	**Proposed**	**Delivered**	**Not Started**	**In Progress**	**Complete**	**Comments**
Aug 08 – Jun 11	**Project 1 Residual Soil Nutrient Survey (Survey for N & P)**					
Mar 31, 2009	- Milestone 1	- source ≈10 cooperating producers - source fields for sampling residual N and P levels - prepare soil samples for lab analysis - prepare interim report			X	
Mar 31, 2010	- Milestone 2	- source 12 cooperating producers - source fields for sampling residual N and P levels - prepare soil samples for lab analysis - prepare interim report			X	
Mar 31, 2011	- Milestone 3	- tabulate data and analysis - prepare interim report			X	Flooding prevented a fall 2010 soil sampling; material and supply expenses somewhat less then expected.
Sept 30, 2011	- Milestone 4	- tabulate data and analysis - prepare Final report			X	
Aug 08 – Jun 11	**Project 2: Break Crops for Nutrient Management and Conservation (Small Plot Research)**					

Mar 31, 2009	- Milestone 1	source cooperating producers - source seed spring variety trials - establish small plot demonstrations - where applicable soil and/or crop sample - where applicable perform weed and disease assessments - prepare soil and/or crop samples for lab - lab analysis of samples - tabulate data and analysis - prepare interim report			X	
Mar 31, 2010	- Milestone 2	source cooperating producers - source seed spring variety trials - establish small plot demonstrations - where applicable soil and/or crop sample - where applicable perform weed and disease assessments - prepare soil and/or crop samples for lab - lab analysis of samples - tabulate data and analysis - prepare interim report			X	
Mar 31, 2011	- Milestone 3	- establish spring small plot demonstrations - where applicable soil and/or crop sample - prepare soil and/or crop samples for analysis - lab analysis of samples - prepare interim report			X	
Sept 30, 2011	- Milestone 4	- establish spring small demonstrations (Delta & Comox Valley); - where applicable soil and/or crop sample - prepare soil and/or crop samples for analysis - lab analysis of samples - prepare Final report			X	
Jan 09 – Jun 11	**Project 3: BMPs Awareness & Education**					

Jun 30, 2010	- Milestone 1	- attend/participate in project listed workshops/seminars/meetings/events/etc: - discussed and distribute "producer soil N & P reports" - See attached INFO sheets in previous reports; - soil survey N & P soil fertility reports distributed to 12 co-operators (Appendix A); - 2009 Variety Trial detailed results distributed to seed suppliers, breeders and co-operators – see attachment; - Attended 2009 and 2010 COABC meetings and made presentations to producers; - 2010 UBC "Reach Out" publication; - July 2009 Field Day for Producers - Signage produced and installed at on-farm sites. - UBC Ag Sc 315 "Bake-off" using cereals from CSA and Delta; Norwell was the best for making bread.			X	

Jun 30, 2011	- Milestone 2	- In December 2010, prepared and distributed second “producer” report to cooperating growers (see Appendix A). - prepared Factsheets on appropriate ways and means for poultry litter application; selected cereal varieties and seed sources; and BMP’s for clover under-seeding of cereal crops has been prepared In addition what we proposed and delivered above: -Participated in the Certified Organic Associations of British Columbia (COABC) 2011 meetings and workshops. - Conduced open house field days in July 2010; and input to DF&WT field day in March 2011. - Collaborated with Vancouver Grains Cooperative, UBC Faculty of Land and Food Systems student towards adapted grains for bread making. - The Canadian Farm Business Management Council Website published an article in November 29, 2010. - Delta Farmland & Wildlife Trust (DF&WT presented our work on clover/cereal research to the DFI in March 2010 and 2011; and, is now implementing a cereal under-seeding with clover program with cooperating producers in Delta. - The DF&WT, COABC, Country Life in BC, and Duck’s Unlimited have each published Newsletter article on our research - As an extension of this project we initiated/proposed to BCMAF’s BC Nutrient Management Working Group (BCNMWG) an“Integrated Nutrient Management” (INM) pilot project in 2011; which is now being implemented via ESCropconsult. .			X	

	Outputs/Deliverables	Status	

Due Date	**Proposed**	**Delivered**	**Not Started**	**In Progress**	**Complete**	**Comments**
	Project 1 Residual Soil Nutrient Survey (Survey for N & P)					
	- Milestone 1 – Data analysis	Analysis complete			**X**	
	- Milestone 2 – Data analysis	Soil Survey & Soil N&P reports to Farmers completed			**X**	
	Milestone 3 – Data analysis	Additional data analysis and report to Farmers			**X**	
	Milestone 4 – Final report	See above report				
	Project 2: Break Crops for Nutrient Management and Conservation (Small Plot Research)					
	- Milestone 1 – Data analysis	Small plot (2008) soil samples analyzed; crop samples in progress			**X**	
	- Milestone 2 – Data Analysis	Spring 2009 wheat, barley and oat variety trials completed; Winter 2009 wheat and barley trails in progress; clover rotation plots established on high and low organic matter soils			**X**	
	- Milestone 3 – Data Analysis	Spring 2010 wheat, barley and oat variety trials completed; Winter 2009 wheat and barley trails completed; Winter 2010 wheat and barley trails			**X**	
	- Milestone 4 – Final Report	See above report			**X**	
	Project 3: BMPs Awareness & Education					
	Milestone 1 – Attend in workshops/seminars/meetings/etc. - Each Feb/March distribute producer soil N&P reports	- soil survey N & P soil fertility reports distributed to 12 co-operators (see Appendix A); - 2009 & 2010 Variety Trial detailed results distributed to seed suppliers, breeders and co-operators; - attended 2010 and 2011 COABC meetings and made presentations to producers; - 2010 UBC Reachout publication; - July 2009 and 2010 Field Days			**X**	

	Milestone 2 – Distribute final reports - Prepare Factsheets	- see Executive Summary (Outreach and Education Section; pages 9 and 10)) and Outreach sections within the body of the report (see index on page 2). - Factsheets (see Appendix D and E); selected cereal varieties and seed sources; and BMP's for clover under-seeding of cereal crops have been prepared. - participated in Newsletter/Newspaper/Magazine articles and publication (see Executive Summary Outreach and Education section)			X	

	Indicators of Success		Status			
Due Date	**Proposed**	**Delivered**	**Not Started**	**In Progress**	**Complete**	**Comments**
Jun, 2011	Increased understanding and capacity to practice environmental sustainable production practices.	- see Executive Summary (pages 5 to 12)			X	

Jun, 2011	Development of 'eco-friendly' crop rotation protocols	- In discussions with the BCMAF's BC Nutrient Management Working Group (BCNMWG), we proposed an "Integrated Nutrient Management" (INM) pilot project; which is now being implemented by ESCropconsult (see pages 29 to32). - Delta Farmland & Wildlife Trust (DF&WT) is now is now implementing a cereal under-seeding/rotation with clover program with cooperating producers in Delta (see page 65). - Factsheet on appropriate cereal varieties has been developed (see page 53) and disseminated to producers; - Producers have now imported cereals varieties which we found to be most appropriate for crop rotations in our area (see page 54).			X	
Sept, 2011	Establishment of Best Management Practices (BMP) to improve profits and promote conservation & recycling of soil nutrients.	- see reports section on "ways and means to reduce soil nutrient loading and increase profits (pages 24 to 32); - see factsheets (Appendix C and D); selected cereal varieties and seed sources; and BMP's for clover under-seeding of cereal crops has been prepared; - see Report "Outreach" sections within the body of the report (see index on page 2).			X	

Comments: Severe flooding in the late summer/early fall of 2010 prevented us from implementing a planned soil residual N survey. Therefore, time/resources were allocated to:

- further analysis of the collected data and the distribution of its relevant findings to producer as discussed in this report. In addition to the distribution of this report to our 14 cooperators, we also sent it to our seed suppliers and professional contacts that have provided input to the implementation of this project.
- development of an "outreach" imitative called the "Integrated Nutrient Management Pilot Project" was proposed as a direct extension of this project's soil survey findings. We developed this project in conjunction with the David Poon and Orlando Schmidt of BCMAL of the Nutrient Management Working Group (BCNMWG); and, it is now being implemented by ESCropconsult (see page 21 of this report for more details on the project). Conceptually, this "Integrated Nutrient Management" pilot project would work as an extension of the "Integrated Pest Management" services which are currently employed with many growers. That is, fertilizer application would be based upon 3rd party soil testing; an observed need to reduce NPK soil applications; and with such cost savings passed onto producers and/or to the benefit to the environment from the potential overuse of such fertilizers.
- implementation of another over-winter wheat and barley variety trial as a consequence of last year's trial being so severely grazed by waterfowl or the need to have a second trial year to make recommendations.