YUKON AGRICULTURE

RESEARCH AND DEMONSTRATION
2012 PROGRESS REPORT

Yukon
Energy, Mines and Resources

Front page photo: Grain trial Yukon government Research Farm, Whitehorse

EXECUTIVE SUMMARY

There are four agricultural regions in Yukon, with the highest concentration of farms in the Whitehorse area. The Yukon government, in cooperation with the industry, initiated agricultural research in the 1980s. A small research farm is currently operated near Whitehorse with a secondary site at McCabe Creek in central Yukon. At this time there is no research being conducted by the Yukon government in the Haines Junction and Watson Lake regions.

The difference between the daily highs and lows was less than normal during the early and mid-summer months of 2012. Because it was cooler during the day and warmer at night, the daily average temperature was not significantly affected. Whitehorse and Haines Junction experienced below average agroclimatic conditions. Dawson City and Watson Lake had near normal conditions with the Effective Growing Degree Days (EGDD) close to the ten year average. Haines Junction had 100 mm more precipitation than normal, yet the Whitehorse and Dawson areas received slightly less than expected. Precipitation data for Watson Lake was incomplete.

2012 was the third year of a soil amendment trial at the Research Farm. Four major soil amendments are being tested: synthetic fertilizer, organic fertilizer, compost, and compost with lime. It was projected that over time, the alternative soil amendments would produce a comparable yield to synthetically fertilized plots. Plots amended with organic fertilizer matched synthetically fertilized plots in 2012, but the compost and compost with lime plots' yield decreased below first year levels.

Oat, wheat and pea variety trials were initiated at the Research Farm and McCabe Creek in 2010. Maturing wheat and peas at the Research Farm continues to be a challenge though oats consistently mature. The AC Murphy variety is beginning to show good potential as a forage oat at both sites, but lags behind in grain production compared to the AC Mustang variety. There are no clear trends in forage pea production, but the Polstead variety has consistently produced the highest yield of pea seed. Wheat yields have been very variable at the Research Farm and McCabe Creek without any variety standing out. The 5604 HR CL was the first of five varieties to mature at the Research Farm in 2012, a significant advantage in marginal conditions. It will continue to be evaluated in 2013 to see if this trend continues.

Two potato studies were initiated in 2012: a variety trial and a spacing trial. Six varieties were examined at the Yukon Grain Farm in partnership with Steve and Bonnie MacKenzie-Grieve. Ranger Russet, Russet Norkotah, Norland, Chieftain, Shepody and Yukon Gold cultivars were planted. The russets, Norland and Shepody varieties produced the highest yields while the Yukon Gold yields were noticeably less. Chieftain had the lowest overall yield, but highest yield of small potatoes. The russet varieties, though high yielding, are baking potatoes and did not achieve the optimum large size for baking.

Spacing trials were conducted at the Yukon Grain Farm and the Research Farm. A significant increase in potato size and yield per plant was directly correlated with increasing the in-row spacing at the Yukon Grain Farm. There was very little difference in t/ha yield and 62 cm (24") spacing uses half the seed as 31 cm (12") spacing. At the Research Farm larger potato sizes were also seen with an increase in in-row spacing, but total yields dropped dramatically.

PREFACE

This document is a record of agricultural demonstrations and studies conducted in Yukon. It is a yearly publication of new and accumulated information set out to assist growers and researchers with future endeavors related to northern agriculture.

The target audience for this publication is commercial agriculture producers, growers and those interested in northern agronomic research.

ACKNOWLEDGEMENTS

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CONTACT

Please contact the Agriculture Branch for more information on these and other research studies.

Phone: 867.667.5838
Toll Free: 1.800.661.0408 ext. 5838
Fax: 867.393.6222
Email: agriculture@gov.yk.ca

PREPARED BY

Matthew Ball
Agrologist

Krystal Reaume
A/Agriculture Research Technician

Table of Contents

1.0 INTRODUCTION.....1
  1.1 CLIMATE MONITORING..... 3
2.0 NORTHERN SOIL AMENDMENTS.....6
  2.1 WHAT IS BIOCHAR? 11
3.0 OAT VARIETY TRIAL 12
4.0 FIELD PEA VARIETY TRIAL.....17
5.0 WHEAT VARIETY TRIAL.....22
6.0 POTATO VARIETY TRIAL 26
7.0 POTATO SPACING TRIAL 31

List of Figures

Figure 1: Precipitation in 2012 by month and region 5
Figure 2: Layout for soil amendment trial; southwest corner of irrigated field at Research Farm 6
Figure 3: Effects of biochar and humic acid on kale growth - 2012 8
Figure 4: Percent yield compared to NPK over three years 9
Figure 5: The relationship between EGDD and oat seed maturity at the Research Farm and McCabe Creek 16
Figure 6: Three year irrigated yellow pea seed yield at McCabe Creek 21
Figure 7: McCabe Creek wheat yields over four years (t/ha) 23
Figure 8: Average wheat yields at the Research Farm by variety (t/ha) 24
Figure 9: How sizing is affected by tuber shape 28
Figure 10: Potato distribution at the Yukon Grain Farm based on individual potato weights (g) 32

List of Tables

Table 1: Definitions and operational constraints of agroclimatic capability classes for cultivated agriculture in Yukon 3
Table 2: Agroclimatic data from Yukon's four agricultural regions 4
Table 3: EGDD, land capability class, and precipitation data from the past 10 years at the Research Farm 5
Table 4: Amendment schedule 7
Table 5: Selected oat varieties 12
Table 6: Average dry biomass of oat varieties over three years (t/ha) 14
Table 7: Average grain yields of oat varieties over three years (t/ha) 15
Table 8: Typical composition of feed peas 17
Table 9: Selected yellow field pea varieties 18
Table 10: Dry biomass yields of yellow field peas over three years (t/ha) 19
Table 11: Average yellow pea seed production over three years (t/ha) 20
Table 12: Selected hard red spring wheat 22
Table 13: Average yield of wheat over four years (t/ha) 25
Table 14: Potato variety descriptions 26
Table 15: Potato sizing chart 27
Table 16: Total calculated potato yield at the Yukon Grain Farm (t/ha) 27
Table 17: University of Saskatchewan potato variety research results 28
Table 18: Total potato yield – Research Farm 32
Table 19: Potato yield at the Yukon Grain Farm by size and average individual potato weight 32

1.0 INTRODUCTION

The Yukon government Agriculture Branch began conducting research in co-operation with industry in the 1980s. In 1988, the Yukon government established a small research farm at the Gunnar Nilsson and Mickey Lammers Research Forest, allowing for additional research in a controlled environment. Projects in partnership with industry are on-going in southern and central Yukon. The co-operation takes advantage of on-farm expertise and site variation while providing insight into the diversity and potential that exists in different Yukon regions.

The research and demonstration reports enhance the knowledge base of agriculture north of 60^{o} and support the development of a sustainable Yukon agriculture industry.

The research and demonstrations reported in this document include:

- Northern soil amendment trial;
- Oat, wheat, pea, and potato variety trials; and
- Potato spacing trials.

Agriculture Regions:
Yukon agriculture has been divided into four defined agricultural regions:

- Whitehorse
- Central Yukon
- Southwest Yukon, Haines Junction
- Southeast Yukon, Watson Lake

These agriculture areas are a result of either climate, and/or current and past agriculture activities.

The area surrounding Whitehorse accounts for the majority of Yukon agricultural activity. Although there are a few outlier farms in this region, the bulk of the developed agricultural land is in the Takhini River valley and Yukon River valley between Marsh Lake and Lake Laberge.

The central Yukon region is the largest of the agriculture regions and is recognized for having Yukon's warmest growing season. The region is also historically one of the first areas in Yukon developed into agriculture, because of demand for fresh food from the influx of miners at the turn of the 20^{th} century. The central Yukon agriculture region lies in the Yukon, Pelly, Stewart and McQuesten river valleys stretching from Carmacks to Dawson City and includes the communities of Pelly Crossing and Mayo.

The Haines Junction region has a cool growing season and high incidence of frosts. It has been identified as an agriculture region because historically it was home to an Agriculture Canada research station from 1944 to 1968. It is also considered to have a strong developing agriculture community with the addition of an agricultural subdivision near Marshall Creek.

The Watson Lake region has warm continental temperatures and receives more precipitation than the other regions. The area has been identified as having an enhanced agriculture potential and currently has a stable agriculture industry.

The Yukon government conducts research in the Whitehorse and Central Yukon agriculture areas. The Research Farm is located just north of Whitehorse near the confluence of the Takhini and Yukon Rivers. In the central Yukon there is a satellite research station on the banks of the Yukon River at McCabe Creek, just off the North Klondike highway between Carmacks and Pelly Crossing.

There is currently no field research being conducted by the Agriculture Branch in the Haines Junction and Watson Lake agriculture regions.

Site Descriptions:
The bulk of the research and demonstration projects are conducted in the Whitehorse area at the Yukon government Research Farm. In 2012, the Research Farm supported forage demonstrations, potato cultivar and spacing trials, irrigated and dryland oat and pea variety trials, wheat variety trials, and vegetable crops grown under various soil amendments. This site is located in the Gunnar Nilsson and Mickey Lammers Research Forest located at the junction of the Yukon and Takhini River valleys. The research site is two hectares surrounded by lodgepole pine (*Pinus contorta*) and embedded in soils that are typical of those encountered at many farms in the southwest region of Yukon. The forest provides shelter from winds, but consequently creates a frost pocket. The soil, landscape and climatic properties of the site are typical of the farms in this region of Yukon. The area was cleared of willow (*Salix sp.*), aspen (*Populus tremuloides*), white spruce (*Picea glauca*), lodgepole pine, soapberry (*Sheperdia canadensis*), and bearberry (*Arctostaphylos uva-ursi*) in 1987, and has been worked intensively for a variety of research projects since. The soil texture is silty loam to fine loamy sand and moderately well to well drained. The pH is 7.0 with organic matter levels around 2%.

Research and demonstration trials are conducted at a satellite site in the central Yukon at McCabe Creek. This site is within the central Yukon agriculture region and provides research results that are applicable to farms in this area. Research was conducted at McCabe Creek in the 1990s, and in 2009 the Agriculture Branch re-established the site at Kathy and Jerry Kruse's farm. The site was split up to evaluate irrigated and dryland trials including forage demonstrations, oat, wheat, and pea trials. The site is located on the east side of the Yukon River along the north side of a large hay field which provides excellent solar radiation and frost drainage. The soils in the area are fine sandy loams to silt loams and are moderately well drained. The pH is around 7.5 and organic matter levels are roughly 2%.

1.1 CLIMATE MONITORING

The major limiting factor to farming north of 60° is climate. Yukon has a short growing season with a threat of frost at any time, and in most years less than desirable precipitation. The 2012 growing season was slightly cool compared to the previous 10 year average in the Whitehorse and southeast regions. Dawson farmers experienced an average season and Haines Junction was cold and wet.

Climate data is collected from meteorological stations operated by Environment Canada (EC) and Yukon government (YG) as well as several portable weather stations maintained by the Yukon Agriculture Branch. Data from the four regions is compiled to better understand the diverse weather patterns and the season-to-season variability in growing conditions. The breadth of information that can be derived from climate monitoring provides growing season analysis for both producers and research purposes.

The climate data from the past growing season was collected and used to calculate agroclimatic capability. Agroclimatic capability is a measure of the limitation imposed by climate on agricultural production and the amount of heat available to crops during the growing season. The agroclimatic capability is modified to account for local climate patterns, such as killing frost, daily average temperature, and day length. Table 1 defines the agroclimatic classes from Class 1 (no restrictions) to Class 6 (severe limitations). The agroclimatic capability is based on Growing Degree Days (GDD), which are calculated using the average daily temperature minus a basic mean temperature of 5°C (the minimum requirement for cool season crop growth). For example, if the daily mean temperature is 10°C, the GDD total is 5. Similarly if the daily mean temperature is 16°C, the GDD equals 11. In the instance that an average temperature is 5°C or lower, however, the GDD would equal 0.

Table 1: Definitions and operational constraints of agroclimatic capability classes for cultivated agriculture in Yukon

Class 1	1,400-1,600 GDD	These lands have no significant limitations that restrict the production of the full range of common Canadian agricultural crops.
Class 2	1,200-1,400 GDD	These lands have slight limitations that restrict the range of some crops, but still allow the production of grain and warm season vegetables.
Class 3	1,050-1,200 GDD	These lands have moderate limitations that restrict the range of crops to small grain cereals and vegetables.
Class 4	900-1,050 GDD	These lands have severe limitations that restrict the range of crops to forage production, marginal grain production and cold-hardy vegetables.
Class 5	700-900 GDD	These lands have very severe limitations that restrict the range of crops to forages, improved pastures and cold-hardy vegetables.
Class 6	<700 GDD	These lands have such severe limitations for cultivated agriculture that cropping is not feasible.

GDD calculations begin the fifth consecutive day of the year with a daily mean temperature of 5°C or higher, and terminate the day of the first killing frost occurring after July 15. This killing frost temperature does not need to occur as a daily mean temperature, but rather at any moment of the day. Although specific killing frost temperatures differ between crops, for the purpose of determining the end of the growing season from year to year in Yukon, a temperature of -2.2°C is used (the standard killing frost for cool season crops).

The longer day length experienced in Yukon has a positive effect on the crop growth which is not accounted for in a simple GDD calculation. To account for the boost plants receive from the long hours of daylight north of 60°, the GDD is adjusted upward. The calculation is reported as Effective Growing Degree Days (EGGD) as outlined in the calculation of the day length factor in the Land Suitability Rating System for Agriculture Crops (AAFC Technical Bulletin 1996-6E). For example, 1000 GDD recorded at Whitehorse Airport is multiplied by a factor of 1.16 and becomes 1,160 EGDD. The daylight factor changes with latitude:

Watson Lake	1.14
Whitehorse and Haines Junction	1.16
Dawson City	1.18

The daily average temperatures in the Whitehorse area and central Yukon basin in 2012 were relatively normal. The beginning of summer felt cooler because the daily highs around Whitehorse in May and June were 1.5 and 1 degrees, respectively, cooler. The daily lows were warmer than normal, thus there was little effect on the average daily temperature. The Dawson area enjoyed a very warm June, with average daily temperatures more than 1.5 degrees above normal. May and July showed a similar story to Whitehorse's weather with daily maximum temperatures lower and daily minimum temperatures higher than historical averages. Watson Lake experienced a late spring and average growing conditions. The southwest Yukon had fewer frosts than normal in 2012, but very cool daily highs. The summer in Haines Junction was comparable to 2008 – the worst growing season in the region since 1987.

Table 2: Agroclimatic data from Yukon's four agricultural regions

	Whitehorse Airport		**Haines Junction**		**Dawson Airport**		**Watson Lake Airport**	
	2012	**10 Yr Average**	**2012**	**10 Yr Average**	**2012**	**10 Yr Average**	**2012**	**10 Yr Average**
EGDD	922	1097	628	902	1165	1139	1163	1177
Frosts During Growing Season	3	12	15	24	10	14	3	10
Start of Growing Season	21-May	5-May	24-May	7-May	14-May	5-May	23-May	7-May
End of Growing Season	11-Sep	9-Sep	30-Aug	29-Aug	8-Sep	4-Sep	25-Sep	21-Sep
Land Capability Class	Class 4	Class 3	Class 6	Class 4	Class 3	Class 3	Class 3	Class 3
Precipitation: May - September (mm)	146.6	161.25	239	137.7	161.5	169.9	Missing Data	240.8

* Note: The Whitehorse Airport has excellent frost drainage and thus a longer growing season in the fall than most areas around Whitehorse.

The central Yukon basin recorded average precipitation, but with more rain in the spring than fall (see Figure 1). The Whitehorse area experienced a different pattern with most precipitation falling in the June and July, but the total was still 15 mm below the ten year average (see Table 2).

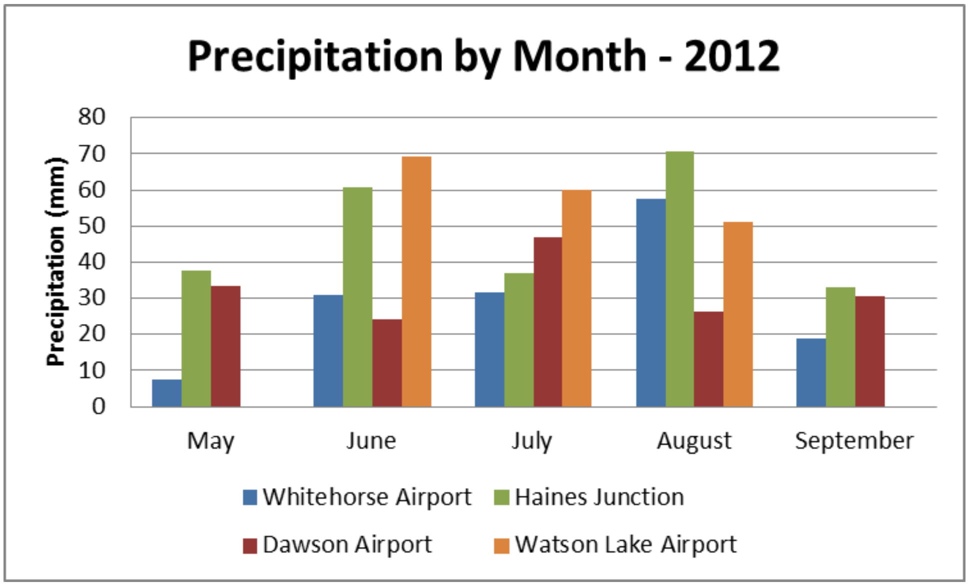

Figure 1: Precipitation in 2012 by month and region

Haines Junction and the southwest Yukon were significantly wetter than normal with a total of 239 mm of precipitation. The region hasn't seen that much rain and snow over the summer since 2000. The 2012 precipitation data from Watson Lake Airport was incomplete.

Table 3: EGDD, land capability class, and precipitation data from the past 10 years at the Research Farm

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
EGDD	778	1263	764	912	964	681	682	1008	772	833
Land capability class	Class 5	Class 2	Class 5	Class 4	Class 4	Class 5	Class 5	Class 4	Class 5	Class 5
Total Precipitation: May - September (mm)	123.2	123	170.6	133.63	184.03	201.12	125.55	166.31	175.62	189.07

The growing conditions at the Research Farm were near average. There was considerably more precipitation than normal, but not early in the season when dryland crops need it most for germination. Overall, productivity was better than in 2011, but yields were not as high as those seen in 2010.

The central Yukon climate continues to produce the best growing conditions in Yukon. The longer daylight and warmer temperatures allow for the consistent maturation of small grain cereals and a wide range of vegetables. In four seasons out of the past ten, the climate was considered Class 2: only slight limitations that restrict range of crops. The southeast Yukon climate is also well suited for agriculture with higher precipitation and a later killing frost in September. The Whitehorse area and southwest Yukon continue to display marginally viable agroclimatic capabilities that have been overcome by the resourcefulness of agriculture producers in the territory.

2.0 NORTHERN SOIL AMENDMENTS

Location: Government of Yukon Research Farm
Initiated: 2010
Funding: Government of Yukon and Canada-Yukon Growing Forward Program
Partner: City of Whitehorse

Objective:
In partnership with the City of Whitehorse, the Agriculture Branch initiated a long term trial at the Yukon government Research Farm in 2010 to test the effectiveness of soil amendments in northern soils.

Introduction:
A soil amendment is a material added to the soil to improve its properties. Common soil amendments include fertilizers, manures or compost. Deciding which amendments to use is always a challenge as farmers must consider the distance products need to be transported, the availability of local products, and the increasing cost of fertilizer and shipping. The four major amendments being studied are synthetic fertilizer (NPK), organic fertilizer (ORG), city compost (COM), and city compost with lime (C&L). In 2011, biochar was added in combination with each of the other four treatments and plots with humic acid were also added in 2012. A different vegetable was grown each year starting with beets in 2010, carrots in 2011, and kale in 2012.

Materials and Methods:
The long term trial is set up at the Research Farm in the southwest corner of the irrigated field. This section was left fallow for a number of years prior to the trial to help establish soil homogeneity. The plots were permanently delineated and mapped in 2010 to ensure amendments would be kept consistent over time (see Figure 2).

Southwest Corner of Irrigated Field

2 m	Synthetic Fertilizer	Synthetic Fertilizer & Humic Acid	Synthetic Fertilizer
2 m	Organic fertilizer & Humic Acid	Organic fertilizer & Biochar	Organic fertilizer
2 m	Compost & Lime	Compost, Lime & Humic Acid	Compost & Lime
2 m	Compost & Lime	Compost, Lime & Biochar	Compost & Lime
2 m	Compost & Lime	Compost & Lime	Compost & Lime
2 m	Compost	Compost & Humic Acid	Compost
2 m	Compost	Compost & Biochar	Compost
	10 m	10 m	10 m

Figure 2: Layout for soil amendment trial; southwest corner of irrigated field at Research Farm

The compost, biochar and humic acid were added on May 30th and 31st, prior to seeding the kale. The amounts are listed below in Table 4. Kale was seeded June 1st with a four-row Jang precision seeder. The rows were spaced 26 cm (10”) apart and plants spaced 26 cm (10”) apart. The seeder required wheel ratio changes to ensure proper plant spacing nonetheless, seeding wasn't completely consistent. Organic and synthetic fertilizer was added to the appropriate plots on June 7.

Table 4: Amendment schedule

Amendment	2010	2011	2012
Synthetic Fertilizer (NPK)	100 Kg/ha Nitrogen 20 Kg/ha Phosphate 50 Kg/ha Potassium	100 Kg/ha Nitrogen 20 Kg/ha Phosphate 50 Kg/ha Potassium	100 Kg/ha Nitrogen 20 Kg/ha Phosphate 50 Kg/ha Potassium
Organic Fertilizer (ORG)	100 Kg/ha Nitrogen 20 Kg/ha Phosphate 50 Kg/ha Potassium	100 Kg/ha Nitrogen 20 Kg/ha Phosphate 50 Kg/ha Potassium	100 Kg/ha Nitrogen 20 Kg/ha Phosphate 50 Kg/ha Potassium
Compost (COM)	45 t/ha	40 t/ha	35 t/ha
Compost and Lime (C&L)	45 t/ha + 6.7 t/ha lime	40 t/ha	35 t/ha
Biochar Addition	-	10 t/ha Biochar to NPK, ORG, COM, and C&L	10 t/ha Biochar to NPK, ORG, COM, and C&L
Humic Acid Addition	-	-	0.44 t/ha Humic Acid to ORG, COM, and C&L

A low pressure centre pivot system was used to irrigate the plots with 120 mm of water applied over the summer and an additional 136 mm of precipitation at the Research Farm. Weeding on site was by hand rogueing.

The first kale harvest occurred August 13. Random numbers were used to select a 'start point' within the plots. A 2 m section of the row was then measured from the starting point and the number of plants counted. The four plants closest to the 30, 60, 120 and 150 cm intervals were harvested by snipping the plant at soil level. The individual plants were weighed to the nearest gram. The process was then repeated four more times for a total of 20 plants per plot.

Results and Discussion:

The COM and C&L plots yielded significantly less kale than both the ORG and NPK plots. Lime was only added to the C&L plots in 2010 to increase available calcium for plant growth. It made a very clear difference in yield compared to COM plots by the third year. The average plant weight from plots treated with compost and lime was 120 g heavier than plants from straight compost plots. The ORG kale samples were found to be slightly heavier than NPK samples - both yielded very well - differences are within the range of sampling error. Regardless, the organic fertilizer produced comparably sized kale to the synthetic NPK in this third year of the trial, the first alternative fertilizer to do so. Each year the bloodmeal, bone meal and potassium sulphate mixture contained the same amount of nitrogen, phosphate and potassium sulphate as the synthetic fertilizer, but it took a longer period of time for the nutrients to become available for plant growth. Now, in this third year, the organic amendments are supplying required plant nutrients for optimum plant growth.

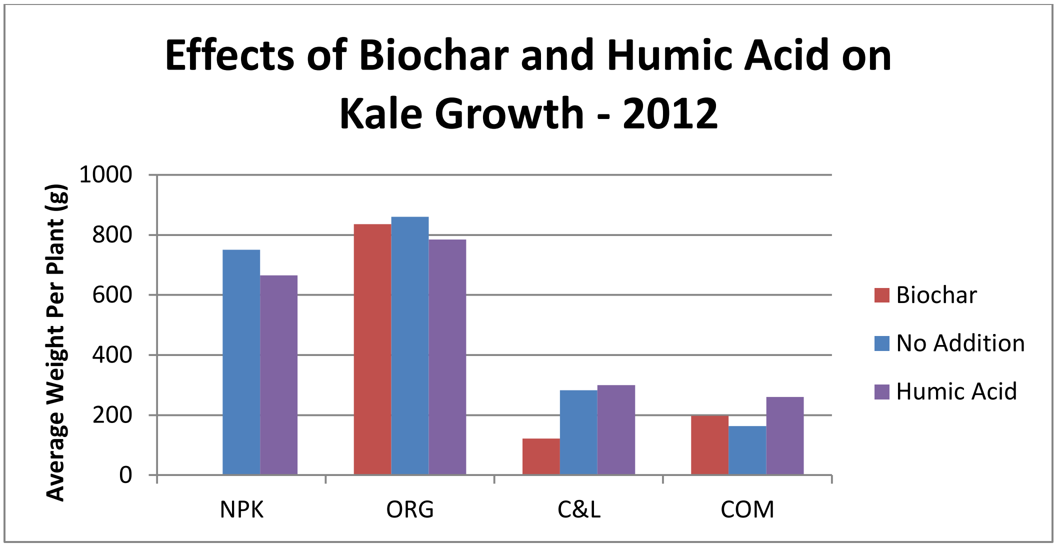

Figure 3: Effects of biochar and humic acid on kale growth - 2012

2012 was the second growing season that biochar was added to plots already treated with each of the major soil amendments. The only statistically significant difference seen between biochar and a standard treatment was in the compost and lime plots (C&L). Kale plants were significantly smaller (less than half the size) in plots amended with compost, lime and biochar than kale in only compost and lime plots. It is theorized that the biochar addition absorbs nutrients within the soil to slowly build soil and release nutrients over the longer term (see Section 2.1: What is Biochar?). This could explain the depressed yields in Year 2. Though our samples showed kale from biochar and compost plots were larger than kale from straight compost plots, the difference is within the range of sampling error. Plants harvested from both plots showed significant variability in size and thus, we cannot conclude there is a substantial difference. After the next season's trial, trends should become more apparent and analysis of biochar's effects will be more appropriate.

Humic acid was added to the amendment trial in 2012 and appears to have increased yields in the compost treatments and decreased yields in the organic fertilizer and synthetic fertilizer treatments. Humic acid is a naturally occurring component of soil that is formed by the microbial decomposition of organic matter. Once in this form, humic acid is very resistant to further chemical breakdown. Humic acid contains a large amount of carbon which serves as food for soil organisms. The soil organisms in turn use the humic acid to help build productive soils. In addition to a naturally synthesized form, humic acid can also be extracted from mineral deposits similar to coal. Commercially mined humic acid is sold as a soil amendment product and has been linked with assisting the breakdown of compacted soils, helping the absorption and transfer of macro- and micronutrients, and encouraging the development of soil microbes.

At the Yukon government Research Farm, humic acid only improved yields in one of four plots – the straight compost plot. A review of the research literature regarding humic acid's effect on plant growth and yield shows mixed results. Some studies found very significant differences in nutrient composition of plant roots and shoots and others did not see any notable difference at all. Soil type, organic levels within the soil, and the origin of the humic acid tested are considered possible explanations for the variation. There were also no decisive results on the optimal application rate. Local gardeners in the Whitehorse area have reported vegetable yield improvements with the addition of humic acid. Humic acid will continue to be studied in 2013's soil amendment trial and it will be interesting to see if humic acid increases yields over time.

Conclusion:

For the first two years of the trial, all three alternative amendments yielded less than synthetic fertilizer. In the third year, 2012, the ORG treatment produced kale plants slightly larger than the NPK treatment (see Figure 4). Considering the very high yields in the NPK and ORG treatments, the kale yields from compost plots were substandard. The COM and C&L plots defied their previous trend, and yield from both treatments dropped considerably. The decline is likely due to the heavy nutrient requirements of kale. The rate of compost addition was slightly lower in 2012 and the nutrient composition of the compost is somewhat variable. More compost would have been required to meet the higher nutrient demand of kale to maintain yields.

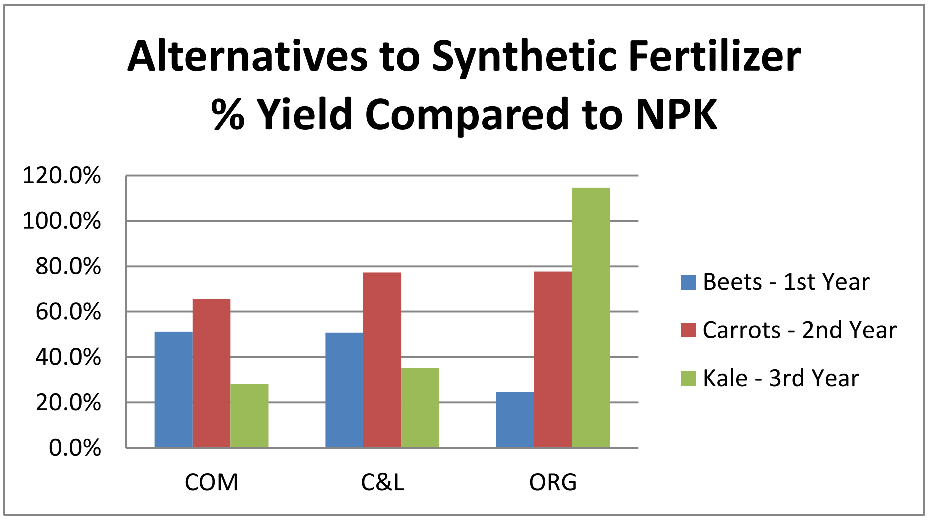

Figure 4: Percent yield compared to NPK over three years

Figure 4 compares the yield of each crop against the yield from plots treated with synthetic NPK fertilizer. For example, in the first year the COM treatment produced half the yield (50%) of the NPK treatment.

In the third year of the trial some trends between the four original treatments can be observed. It was expected that the yield in the compost, compost with lime, and organic plots would be well below synthetic fertilizer in the first year and increase steadily until reaching comparable yields by Year 3. In the third year, only the organic amendment has matched the synthetic yields. The organic fertilizer is supplying required plant nutrients for optimum plant growth. This is consistent with organic transition in southern Canada, where it may be three years for the organic system to match a synthetic fertilizer yield. Organic fertilizer is expected to continue producing comparable yields to NPK.

In future years, the yield of the compost treatments is expected to increase and eventually be equal to the synthetic and organic treatments. The soil amendment trial at the Research Farm will continue in 2013, further exploring the use of biochar and humic acid as well as the main amendments: compost, compost with lime, synthetic and organic fertilizer. Kale that was not used during sampling was donated to the Whitehorse Food Bank.

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2.1 WHAT IS BIOCHAR?

Biochar is essentially charcoal – the black, partially combusted remnants commonly found in a woodstove or after a campfire. Biochar is created when the heating of organic matter occurs with minimal oxygen – without the oxygen, carbon molecules cannot gas off as carbon dioxide and remains in solid form. The technical name for this process is pyrolysis.

Carbon plays a critical role in healthy soil function and is an absolutely vital component of organic matter decomposition. The same reaction in humans to create energy – cellular respiration – occurs in soil microbes as they break down organic matter. This reaction requires carbon, oxygen, and nitrogen (and many other elements). The primary source of nutrients in the soil is plant matter on or just below the surface. Soil microbes break down the chemical bonds of the organic matter into charged ions usable by living plants.

The new interest in biochar is based on a number of potential benefits, most importantly carbon sequestration and nutrient absorption. By adding biochar to the soil, carbon is diverted from the atmosphere. Carbon dioxide is a greenhouse gas and, at the very least, having less in the atmosphere is beneficial. It is currently being studied as a means of global carbon sequestration, but research into the practical application of such a strategy is still preliminary. As a soil amendment, biochar increases both nutrient and water retention. It is relatively inexpensive as it can be produced locally from a variety of sources. There are also recent publications on the ability of biochar to absorb fertilizer residues and prevent runoff of agricultural chemicals into neighboring water bodies.

There is very limited research on the widespread effectiveness of biochar as a soil amendment to increase crop yields. Most research has been conducted on Amazonian Dark Earth soils and tropical soils. The Yukon College has initiated a multi-partner three year study on the soil amendment potential of biochar in northern soils for both agricultural and mining remediation purposes. To further enhance our understanding of biochar additions, it has been added to the soil amendment trials at the Yukon government Research Farm.

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3.0 OAT VARIETY TRIAL

Locations: Government of Yukon Research Farm and McCabe Creek Farm
Initiated: 2010
Funding: Government of Yukon and Canada-Yukon Growing Forward Program

Objective:
To assess performance of oat varieties in Yukon.

Introduction:
Oats are a major crop in Yukon for green manure, forage and grain. Most Yukon producers use AC Mustang as the oat variety of choice. Selection of appropriate varieties can make a significant difference in the yields for both forage and grain at the end of a growing season. Although AC Mustang oats have served producers well, the purpose of this trial is to understand if there are any other varieties that may increase yields over the current standard.

Varieties sourced for this trial are recommendations from different seed companies in western Canada. The recommendations are based on the varieties expected to perform best in a short, water-deficient growing season as seen in Yukon. This trial was designed to be a low-input crop trial and investigate the crop as a forage and grain.

Materials and Methods:
This trial was conducted at the Research Farm and McCabe Creek. These sites provide insight into the different growing conditions of the Whitehorse region and central Yukon. At each site the trial was split up to include an evaluation of dryland and irrigated management. The trial was originally designed as a demonstration at the Research Farm in previous years, but in 2012 the layout was changed to allow for replication and more extensive testing. The irrigated plots were delineated into 1 x 5 m sections for a total of 16 plots with four plots for each variety. Dryland plots were laid out into 1 x 15 m sections and varieties replicated three times. At McCabe Creek the oats were seeded into 1 x 5 m strips, and each variety was seeded into a dryland and irrigated plot.

Table 5: Selected oat varieties

Variety	Supplier	Location
AC Mustang	Edward Hadland	Baldonnel, BC
AC Lu	SeCan, Harold Warkentin	Tofield, AB
Triactor	Canterra Seeds, PW Farms	Cecil Lake, BC
AC Murphy	SeCan, Harold Warkentin	Tofield, AB
Local Oats*	Steve MacKenzie-Grieve	Whitehorse, YT

*of AC Mustang pedigree

Oats were seeded at approximately 100 kg/ha, using the Jang precision seeder. Seeding occurred on May 19 at the Research Farm and May 14 at McCabe Creek. Plots were fertilized shortly after in early June. At the Research Farm, irrigated oats received:

326 kg/ha	Urea
44 kg/ha	Super P
100 kg/ha	Potassium sulphate

Dryland plots required less nitrogen and were fertilized with:

217 kg/ha	Urea
44 kg/ha	Super P
100 kg/ha	Potassium sulphate

A low pressure centre pivot system was used to irrigate the plots at the Research Farm. Forty mm was applied over the summer and 189 mm of precipitation fell between May 19 and September 30 for a total of 239 mm. Conventional weed control methods were used at the Research Farm with MCPA Amine 500 applied at 550 mL/ha in early July.

At McCabe Creek all weeds were removed by hand as the site is relatively small. The site received 183 mm of precipitation between May 19 and September 30 and 65 mm of irrigation for a total of 248 mm.

Oats have two primary uses: as a forage crop or as a grain. Protein content is highest before plants mature and forage samples were collected on August 16 at McCabe Creek and August 17 at the Research Farm. Three ½ m² samples were collected from the irrigated Research Farm plots and all McCabe Creek plots. Four samples were taken from the dryland plots at the Research Farm because of the large plot sizes and fewer replicates.

All stems within the ½ m² area were sampled; plants were cut 5 cm above the ground to simulate mechanical harvesting. Weights were recorded from each of the samples and subsamples set aside to be dried. Subsamples from each plot were combined to get a representative sample from each plot. The subsamples were then dried for three months at 2-6°C. Each plot's subsample was reweighed to determine % moisture. Randomly selected dried subsamples were also sent to Central Laboratories in Winnipeg for nutrient content and residual moisture testing.

Biomass for each sample was calculated using the applicable subsample's percent moisture and residual moisture results from Central Laboratories.

Percent Moisture = Dried Subsample Weight / Fresh Subsample Weight x 100%

Biomass = Fresh Sample Weight x (100% - (% Moisture + % Residual Moisture))

For the grain harvest, irrigated plots at McCabe Creek were sampled on September 20 and dryland samples collected on October 8. Oat crops at the Research Farm reached maturity late in the season and both irrigated and dryland plots were sampled the week of Oct 22-26. Because of the small plots sizes at McCabe Creek and the irrigated section of the Research Farm, only one or two ½ m² samples were taken per plot.

Results – Forage:
The climate in 2012 at both the Research Farm and McCabe Creek site was favourable to forage oat production. At the Research Farm, varieties AC Lu and AC Murphy were the top performers, producing roughly 1.5 t/ha more total dry biomass than AC Mustang and local oats. This pattern was not seen in the dryland plots, however, and the local seed produced statistically higher yields than the other three varieties (see Table 6). AC Murphy appeared to yield more dry biomass than AC Mustang and AC Lu, but due to variability in the data it is not statistically certain.

Table 6: Average dry biomass of oat varieties over three years (t/ha)

Average Dry Biomass (t/ha)			Year		
Location	**Management**	**Variety**	2010	2011	2012
McCabe Creek	**Dryland**	Local Oats	-	-	8.2
		AC Lu	4.8	5.5	6.5
		AC Murphy	6.3	7.6	7.9
		AC Mustang	7.7	5.1	5.4
		Triactor	4.5	6.0	-
	Irrigated	Local Oats	-	-	8.2
		AC Lu	6.5	8.0	10.2
		AC Murphy	8.3	12.1	13.2
		AC Mustang	8.0	11.0	8.4
		Triactor	6.6	7.3	-
Research Farm	**Dryland**	Local Oats	-	-	6.4
		AC Lu	2.7	-	4.3
		AC Murphy	3.2	12.9	5.4
		AC Mustang	2.5	10.7	4.0
		Triactor	2.9	9.8	-
	Irrigated	Local Oats	-	-	13.9
		AC Lu	11.4	9.2	15.4
		AC Murphy	13.2	9.2	15.5
		AC Mustang	11.8	9.0	14.1
		Triactor	13.8	8.2	-

*(-) indicates variety was not tested

At McCabe Creek, irrigated forage yields were lower than at the Research Farm. The varieties performed in a similar pattern to those at the Research Farm. Both AC Murphy and AC Lu yielded more than AC Mustang and local oat plots. Due to the small sample size, the results are based on trends not statistics. Dryland yields were about 4 t/ha less than irrigated yields. The local oat yields were higher than the other varieties and consistent with results seen in the dryland plots at the Research Farm.

Results – Seed:

Past oat variety data from McCabe Creek has been substantially variable due to the small sample size. In 2012, the range of grain yield was approximately 5-5.5 t/ha. There were not enough differences in the yields to make conclusions about varieties and no apparent trends emerging from previous years' data. The yield was higher than seen in 2011 and lower than 2010's yield by an average of 2 t/ha. The agroclimatic capability at McCabe Creek was considered Class 3, the same as 2011, compared to 2010 when the site achieved Class 1. It should be noted that Triactor was not sourced for 2012 and replaced with oat seed from a local producer.

Dryland plots produced approximately 2 t/ha less than the irrigated plots. Samples were variable making varietal comparisons inaccurate. No trends were found when examining yields over the past three years. Dryland yields reflected the same pattern as irrigated plots when compared to yields from 2010 and 2011 due to agroclimatic conditions.

Table 7: Average grain yields of oat varieties over three years (t/ha)

Average Oat Seed Yield (t/ha)			Average Yield (t/ha)		
Site	**Management**	**Variety**	**2010**	**2011**	**2012**
McCabe Creek	**Dryland**	Local Oats	-	-	2.4
		AC Lu	4.5	1.6	3.8
		AC Murphy	5.2	1.3	3.0
		AC Mustang	6.9	0.3	3.3
		Triactor	4.2	1.4	-
	Irrigated	Local Oats	-	-	5.4
		AC Lu	6.7	1.9	5.2
		AC Murphy	7.1	2.4	5.2
		AC Mustang	7.9	2.0	5.2
		Triactor	6.8	4.7	-
Research Farm	**Dryland**	Local Oats	-	n.m.	1.3
		AC Lu	2.1	n.m.	1.3
		AC Murphy	1.8	n.m.	1.3
		AC Mustang	1.9	n.m.	1.5
		Triactor	2.2	n.m.	-
	Irrigated	Local Oats	-	n.m.	4.2
		AC Lu	6.1	n.m.	3.8
		AC Murphy	7.2	n.m.	2.9
		AC Mustang	5.2	n.m.	4.8
		Triactor	5.8	n.m.	-

* n.m. indicates seed did not reach maturity
**(-) indicates variety was not tested

In 2011, the oats did not reach maturity at the Research Farm with the seeds being at best in the soft dough stage. This past summer, oats reached maturity – though marginally – at the very end of the growing season. Dryland yields were between 1-1.5 t/ha with considerable variability. Deer sign was consistently documented at the Research Farm from mid-September to the oat harvest in October. Most samples experienced some deer munching which is believed to have caused considerable variability. Unfortunately that creates some difficulty in determining which varieties performed best.

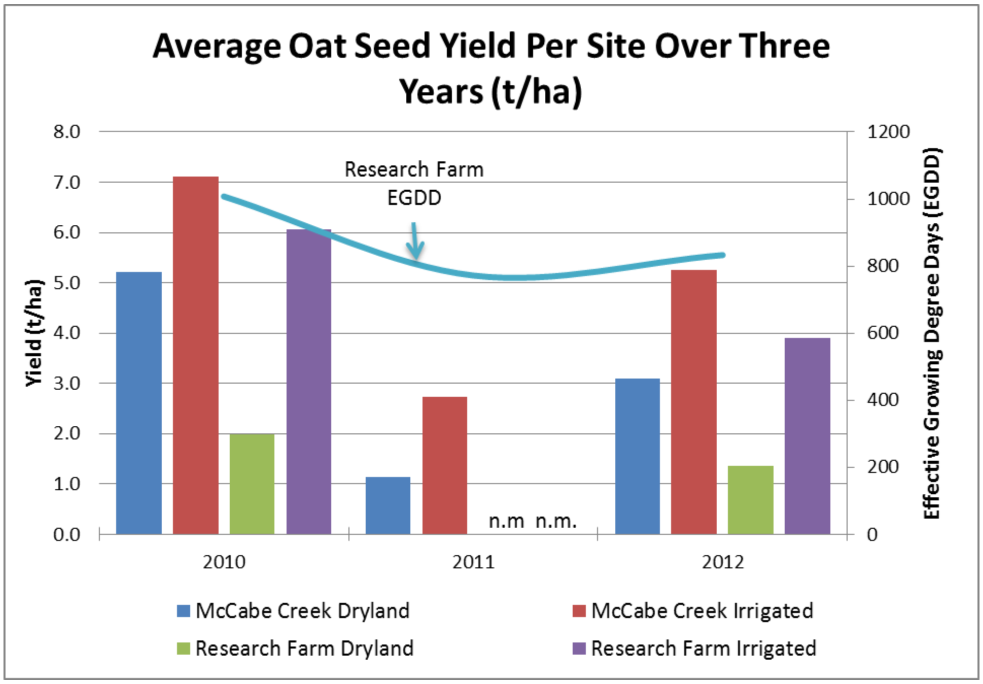
Irrigated oat yields at the Research Farm were between 3-5 t/ha. Again the interference by resident wildlife is presumed to have compromised the accuracy of samples. AC Mustang appears to have performed best, but results are in the range that it simply could be sampling error.

The Peace Region of British Columbia and central Yukon have similar climatic conditions, though the Peace receives significantly more precipitation. The BC Grain Producers Association completes oat varietal assessments every year in Dawson Creek, BC, and has four to twelve seasons of data on the varieties tested by the Yukon Agriculture Branch. The range of yield is substantial, 1-10.5 t/ha[1], depending on seasonal weather conditions. This range of yield is reflected in the data from McCabe Creek and the Research Farm though the minimum and maximum yield is lower: 2-8 t/ha at McCabe Creek and 0-7 t/ha at the Research Farm. AC Mustang was consistently the top seed producer in Dawson Creek conditions, but this trend has not materialized at either of the Yukon research sites.

[1] The BC Grain Producers Association reported all yields in bushels/acre – a pound per bushel conversion factor was provided for each variety and we converted pounds/acre values to tonnes/hectare using standard conversion factors.

Conclusion:
Oats continue to provide a valuable forage and green manure option, producing between 4 to 12 t/ha depending on management and climate. Irrigation provides additional yields for grains and biomass, gives certainty of early germination for the crop to take advantage of the full season, and provides a more consistent biomass yield year over year. Though not statistically significant, AC Murphy oats have yielded the highest dry biomass each year at each site regardless of management. The only exception being the local oat yields in dryland plots in 2012 – they were not included in the analysis as the variety has only have been tested one year.

The central Yukon provides good growing conditions for oat grain production with a warm climate providing sufficient heat for mature grains. Within the Whitehorse region, the climate limits oat grain production at least 1 out of 4 years.



* n.m. indicates seed did not reach maturity

Figure 5: The relationship between EGDD and oat seed maturity at the Research Farm and McCabe Creek

Over the past three years, yields at both McCabe Creek and the Research Farm have been directly correlated to the number of Effective Growing Degree Days (EGDD) in a season (see Figure 5). For a definition of EGDD please refer to Section 1.1 Climate Monitoring, page 3. Both McCabe Creek and the Research Farm experienced a warmer, longer growing season in 2010 followed by a cool summer in 2011. In 2012, conditions were closer to average. At the Research Farm there was only a 50 EGDD difference between 2011 and 2012 (772 vs. 833), but only the latter year produced mature seed. As trials continue, the EGDD threshold for mature oat seed production could be further investigated when marginal growing conditions occur.

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4.0 FIELD PEA VARIETY TRIAL

Location: Government of Yukon Research Farm and McCabe Creek Test Plots
Initiated: 2009
Funding: Government of Yukon and Canada-Yukon Growing Forward Program

Objective:
To assess crop viability and varietal performance in southern and central Yukon.

Introduction:
Research into cool season alternatives for high protein feeds for livestock and poultry has resulted in renewed interest in the viability of field peas for Yukon. Peas have been studied in past trials in Yukon with limited success. The availability of new short season varieties, renewed interest for alternative feeds, and crop rotation options has warranted new research into field peas.

Current research into field peas has focused on the new, shorter season varieties being grown in the Peace region of northern B.C. The climate is similar to central Yukon and varieties grown in this area offer hope of consistent performance in central Yukon and, in warm years, the Whitehorse area. Yields in the Peace region are in line with other pea producing areas in Canada. Although this evaluation will be looking for mature pea yields, the trial will also evaluate biomass yields of field peas to be used as forage/silage for livestock. Although it is more common to mix field peas with a cereal grain to use as forage/silage for livestock, this trial will focus on total biomass of the pea alone.

Peas can be used for both direct human consumption and animal feed. Peas are valued for both their protein and energy content and are regarded as a multi-purpose feed ingredient. The basic nutrient composition of feed peas is shown in Table 8.

Table 8: Typical composition of feed peas

Component	Average
Moisture	10.0%
Crude Protein (N x 6.25)	23.0%
Rumen bypass protein	22.0%
Oil	1.4%
Starch	46.0%
Ash	3.3%
Crude fibre	5.5%

For more information on the use of peas as a livestock or poultry feed, refer to the Canadian Feed Peas industry guide available online at www.pulsecanada.com. [2]

Materials and Methods:
In 2012, two new varieties were added to the four original varieties being evaluated. All varieties are yellow seed field peas and were evaluated at two locations under both dryland and irrigated management.

[2] Follow the links to Feed Industry, Animal Feed and click on Feed Pea Industry Guide

Table 9: Selected yellow field pea varieties

Variety	Supplier	Location
Agassiz	Canterra Seeds	Dawson Creek, BC
APCM 397107	DL Seeds	Morden, MB
Meadow	Clifford Cyre	Barrhead, AB
Polstead	FP Genetic, Radke Pedigree Seed	Barrhead, AB
CDC Golden	DL Seeds	Morden, MB
Peace River	DL Seeds	Morden, MB

* Thanks to Clair Langlois, Research Manager of the BC Grain Producers Association, for assistance with selection.

Test plots were set up at both research sites. Irrigated plots were delineated into 1 x 5 m sections with four replicates per variety at the Research Farm and dryland plots were laid out into 1 x 15 m with no replication. At McCabe Creek, 1 x 5 m plots were set up with no replication. Seeding was conducted using the Jang seeder. The field peas were planted at a rate of 210 kg/ha and seed was inoculated with *Rhizobium leguminosarium* bacteria at a rate of 4.6 kg/ha to enhance nitrogen fixing ability.

A low pressure centre pivot system was used to irrigate the plots. Eighty mm was applied over the summer and a total of 189 mm of precipitation fell at the Research Farm between May 19 and September 30. MCPA Amine 500 was applied at a rate of 550mL/ha at the Research Farm in early July for weed control.

At McCabe Creek, 65 mm of water was applied to the irrigated plots over the summer and 183 mm of precipitation fell between May 19 and September 30. All weeds were controlled by hand picking.

Protein content peaks in field peas before they mature, therefore, forage samples were collected on August 15 from the Research Farm and August 16 at McCabe Creek.

Three ½ m^2 samples per variety were collected from the 1 x 5 m plots at McCabe Creek and the Research Farm. Because of the larger plot size and lack of replicates, four samples were collected from the 1 x 15 m dryland plots at the Research Farm.

All stems within the ½ m^2 area were sampled. Plants were cut 5 cm above the ground to simulate mechanical harvesting. Weights were recorded to the nearest gram and subsamples set aside to be dried. The three subsamples from each plot were combined to get a representative sample for the replicate. The subsamples were then dried for three months at 2-6°C. Each plot's subsample was reweighed to determine % moisture. Randomly selected dried subsamples were also sent to Central Laboratories in Winnipeg to test for nutrient content and residual moisture.

Biomass for each sample was calculated using the applicable subsample's percent moisture and residual moisture results from Central Laboratories.

Percent Moisture = Dried Subsample Weight / Fresh Subsample Weight x 100%

Biomass = Fresh Sample Weight x (100% - (% Moisture + % Residual Moisture))

No variety of field pea reached consistent maturity at the Research Farm in either the irrigated or dryland plots. Only the irrigated field peas at McCabe Creek were mature and sampled.

Attempting to mature annual crops under dryland conditions in Yukon is a challenge, as spring moisture is required to germinate the crop to begin growth as quickly as possible. Three ½ m² samples were collected by handpicking pods from plants with stems within the sample area. Peas were stored at 2°C until they were cleaned and weighed in late November.

Results – Forage:

Forage yields at the Research Farm in 2012 were notably less than yields seen in 2010 and 2011. APCM397107 produced statistically higher yields in the dryland plots with dry biomass being 3.9 t/ha, an average of 1.5 t/ha more than the other varieties (see Table 10). CDC Golden was the top producer in the irrigated plots at an average yield of 4.4 t/ha of dry biomass. Meadow and APCM397107 varieties yielded 3.7 t/ha, 1-1.5 t/ha more than the remaining three varieties.

Table 10: Dry biomass yields of yellow field peas over three years (t/ha)

Average of Dry biomass (tonnes/hectare)			Year		
Location	**Management**	**Variety**	**2010**	**2011**	**2012**
McCabe Creek	Dryland	APCM397107	-	4.2	-
		Meadow	-	4.9	-
		Polstead	-	4.7	-
	Irrigated	Agassiz	-	-	11.9
		APCM397107	-	6.7	5.5
		CDC Golden	-	-	4.8
		Meadow	-	11.2	3.6
		Peace River	-	-	3.4
		Polstead	-	7.5	4.3
Research Farm	Dryland	Agassiz	4.2	5.1	1.8
		APCM397107	-	6.4	3.9
		CDC Golden	-	-	2.6
		Meadow	3.7	4.6	2.5
		Peace River	-	-	2.5
		Polstead	3.3	5.6	2.4
	Irrigated	Agassiz	6.1	6.4	2.4
		APCM397107	-	5.5	3.7
		CDC Golden	-	-	4.4
		Meadow	5.4	6.5	3.7
		Peace River	-	-	2.8
		Polstead	3.6	4.7	2.1

*(-) indicates variety was not sampled or tested

There was very poor germination in the dryland plots at McCabe Creek and forage samples were not collected. In the irrigated plots yields were not as high as the previous year, but still above yields at the Research Farm. Only two samples were collected per plot and variability amongst all the varieties was significant. Agassiz produced unusually large yields and without previous years' data to examine, it is difficult to say if a sampling error occurred or the variety truly yielded twice the dry biomass of other varieties.

Yields at the Research Farm have varied considerably over the past three years of the trial. Irrigated management continues to improve yields when compared to dryland. In 2011, yields were very similar, but it should be noted that dryland plots were not harvested until October, almost two months after the irrigated plots due to late germination. Had dryland samples been collected on the same date as irrigated samples, the yields would have been significantly lower.

Results – Seed:

Maturing field peas at the Research Farm has seen limited success over the past three years. 2010 was the only year in which both the irrigated and dryland peas matured (See Table 11). Not surprisingly, in 2010 there were 1008 Effective Growing Degree Days, 156 more than the ten year average. Pea samples showed significant variability, and did not produce definitive results on varietal performance. It appears the first challenge at the Research Farm is to develop a management regime that consistently matures peas or conclude that the climate is simply not conducive to pea seed production. Other locations in the Whitehorse area have greater EGDD and would have better success.

Table 11: Average yellow pea seed production over three years (t/ha)

Average Yellow Pea Seed Yield (t/ha)				**Year**	
Site	**Management**	**Variety**	**2010**	**2011**	**2012**
McCabe Creek	Dryland	Meadow	n.m.	0.6	n.m.
		Polstead	n.m.	1.1	n.m.
		APCM397107	n.m.	1.0	n.m.
	Irrigated	Meadow	2.5	2.0	3.1
		Polstead	3.7	2.9	4.9
		Agassiz	3.0	-	1.5
		APCM397107	-	1.7	3.0
		Peace River	-	-	3.0
		CDC Golden	-	-	4.2
Research Farm	Dryland	Meadow	1.7	n.m.	n.m.
		Polstead	1.7	n.m.	n.m.
		Agassiz	1.7	n.m.	n.m.
	Irrigated	Meadow	2.5	n.m.	n.m.
		Polstead	1.9	n.m.	n.m.
		Agassiz	2.8	n.m.	n.m.

* n.m. indicates peas did not reach maturity
** (-) indicates variety not tested

At the McCabe Creek site, pea seed reached maturity every year (2010-2012) under irrigated management. Maturity in the dryland plots was only seen in 2011 and yields were very low. Early season moisture is critical to ensure timely germination and the longest growing season possible. Small plots without replication make it difficult to statistically compare varieties at McCabe Creek. Statistical analysis did not find any differences between varieties, however, Polstead was consistently the top producer at McCabe Creek over the trial’s three years (see Figure 6).

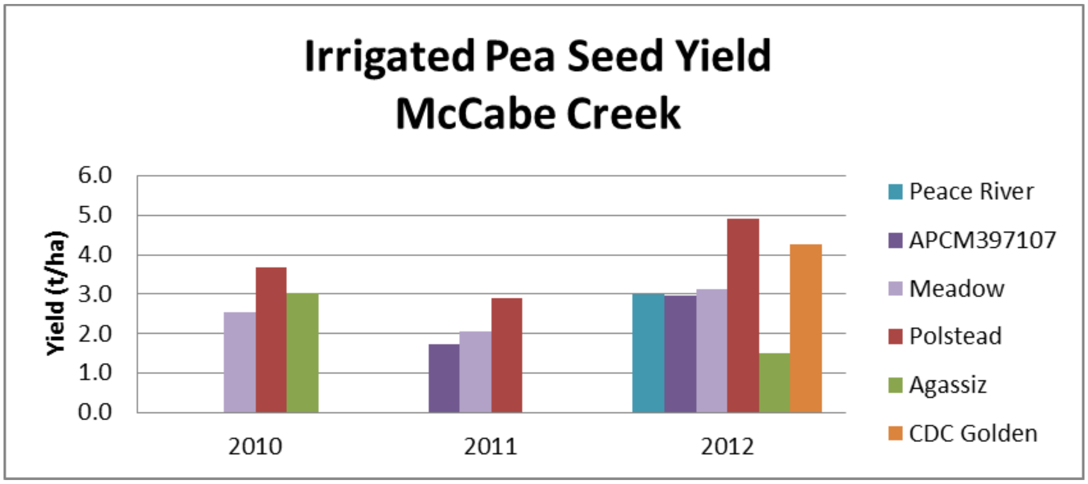

Figure 6: Three year irrigated yellow pea seed yield at McCabe Creek

In 2012, Polstead samples were considerably higher than the other varieties – two out of three samples were approximately 4 t/ha with one sample at almost 7 t/ha. The large sample is most likely an outlier and 4 t/ha is a more accurate estimation of yield in 2012. Further trials and possibly larger sample sizes will be required to determine whether this is simply chance or if Polstead does perform best in the central Yukon climate.

The Peace Region of British Columbia and central Yukon have similar climate conditions, though the Peace receives significantly more precipitation. The same field pea varieties have been tested at the BC Grain Producers Association research farm in Dawson Creek. Over the past 10 years, the range of yields in Dawson Creek have been about 2.5-8 t/ha[3]. Yields at McCabe Creek were between 1.5-4 t/ha, approximately half of what is seen in BC.

Conclusion:
Field peas continue to offer an option for Yukon producers interested in a multi-purpose crop that can be used as green manure, forage/silage or, in warmer regions, for seed. Field pea biomass provides between 4 to 10 t/ha of silage and fixes nitrogen to provide a good green manure plow down. Seed yield in the central Yukon under irrigated conditions is between 1.5 to 4 t/ha which provides an attractive protein replacement in some feed mixes. Although field peas are showing good results in the central Yukon, field trials will be required on desiccation of live plants to allow crop harvest.

One of the challenges with maturing peas in Yukon is that they attract wildlife. Both McCabe Creek and the Research Farm are surrounded by green space that serves as travel corridors for animals such as deer, coyotes, foxes, and occasionally moose. Evidence that animals were munching on crops was detected in 2012 at both sites and may explain a portion of the sample variability. When considering cultivating field peas on a large scale, wildlife management should be part of planning.

References:
Research [internet]. 2012. [Place of Publication Unknown]: BC Grain Producers Association; [cited 2012 January 4]. Available from: http://www.bcgrain.com/research.html

[3] BC Grain Producers Association data was converted from bushels to tonnes using the Alberta Ministry of Agriculture and Rural Development's Bushel/Tonne Converter at http://www.agric.gov.ab.ca/app19/calc/crop/bushel2tonne.jsp.

5.0 WHEAT VARIETY TRIAL

Location: Government of Yukon Research Farm and McCabe Creek Test Plots
Initiated: 2009
Funding: Government of Yukon and Canada-Yukon Growing Forward Program

Objective:
To assess varietal performance of wheat in two different Yukon regions.

Introduction:
Wheat research trials have been conducted throughout Yukon going back to 1917 at Swede Creek just south of Dawson City. Wheat was grown as part of the Yukon Crop Development trials and as part of the Yukon government's research work in the 1990s. In most years growing wheat around Whitehorse led to very poor results. New varieties have since been developed that warrant further testing to see if maturity is possible in southern Yukon. This trial is also being conducted in the central Yukon, where growing conditions and climate generally support wheat production.

Materials and Methods:
Five wheat varieties were seeded at the Research Farm and at McCabe Creek. The seeding at both these locations provides a comparison of growing conditions in these areas.

Table 12: Selected hard red spring wheat

Variety	Supplier	Location
ACS Intrepid	Clifford Cyre	Barrhead, AB
Alvena	Gerald McDonald	Grand Prairie, AB
CDC Osler	Hill Farms Ltd	Fort St John, BC
Low Bed Blue	Hill Farms Ltd	Fort St John, BC
5604 HR CL	Viterra Seed	Calgary, AB

* Thank you to Clair Langlois, Research Manager of the BC Grain Producers Association, for assistance with varietal selection.

The Jang Seeder was used at both sites and adjusted to seed in four rows at a rate of 125 kg/ha.

At the Research Farm, wheat plots were delineated based on the size of the seeder and tractor wheels. Each pass with the tractor and seeder was divided into two plots, 1 x 5 m. Each variety was seeded twice. Seeding occurred on May 19 at the Research Farm and fertilizer was applied June 6 following soil analysis. The wheat plots received:

326 kg/ha	Urea
44 kg/ha	Super P
100 kg/ha	Potassium Sulphate

McCabe Creek was seeded May 14 with the Jang seeder; the seeder can be converted to a small hand-push size for tighter spaces. The smaller site at McCabe Creek does not allow for the use of the tractor. The plots were seeded into 1 x 5 m strips or two passes with the seeder. Fertilizer was applied following soil analysis in early June.

Irrigation for both sites was provided and applied as required. The irrigation management for each site was different due to the rainfall in 2012. A low pressure centre pivot system was used to irrigate the Research Farm. Forty mm of irrigation was applied over the summer and 189 mm of precipitation fell at the Research Farm between May 19 and September 30. Weeds were controlled by conventional methods and MCPA Amine 500 was applied at a rate of 550 mL/h in early July.

McCabe Creek saw 183 mm of precipitation between May 19 and September 30, significantly less than in 2011, which had a total of 261 mm over roughly the same period. Sixty-five mm of moisture was added to the irrigated plots for a total of 248 mm. Weeds were removed by hand picking.

The wheat at McCabe Creek had hard kernels in the middle of September and was harvested on September 20. Ideally the wheat would have been left on the field a little longer; the weather was unseasonably warm and could have dried down the seed further to allow for field combining. Due to the nature of the location, 240 km from Whitehorse, another trip was not scheduled. Three ½ m^2 samples were collected from each variety.

Wheat was sampled much later at the Research Farm, with samples being taken the week of October 22-26. 5604 HR CL was the only variety to reach a hard kernel at the Research Farm and three ½ m^2 samples per plot were collected. The four other varieties were marginal and only one sample from each plot was collected. The samples were stored at 2-6°C and the seed was separated by agitation in canvas bags before being cleaned. Seed was weighed to the nearest gram.

Results:
McCabe Creek showed earlier, more successful maturation of wheat, as expected. All varieties were at the hard kernel stage in mid-September. Due to the small sample size, there was considerable variability within samples making it difficult to draw any conclusions on which variety performed best. It can be noted, however, that yields were comparable with 2010 and higher than 2009 and 2011. The varieties yielded between 4.3-5.7 t/ha respectively.

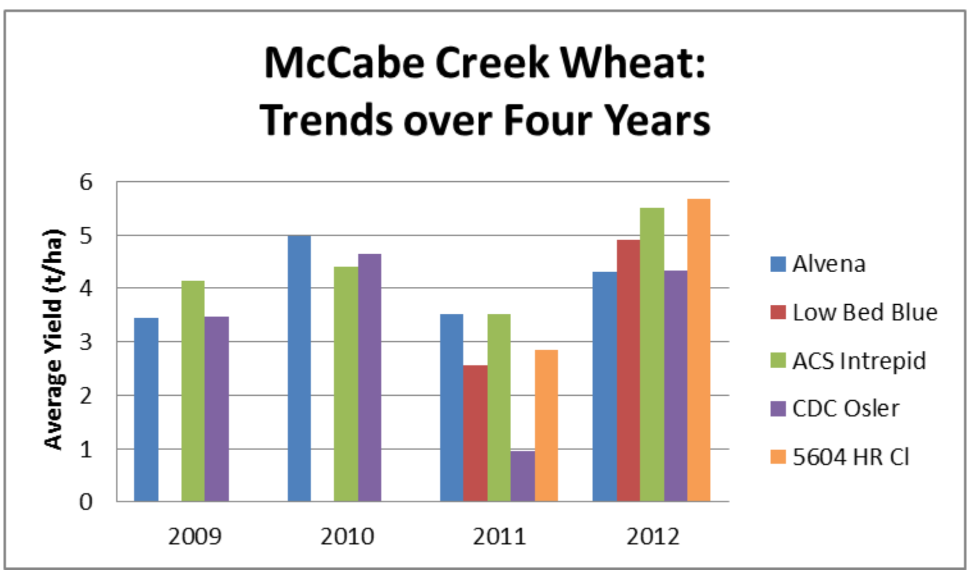

Figure 7: McCabe Creek wheat yields over four years (t/ha)

At the Research Farm, wheat performed better than the previous year, though still only marginally matured when harvested in mid-October. 5604 HR CL was considerably farther ahead than other varieties, however, it would have required mechanical drying. Yields were comparable to 2009, significantly less than 2010, and much better than in 2011 when none of the varieties reached maturity. Low Bed Blue and 5604 HR CL performed the best, yielding 1.8 and 2 t/ha. Alvena produced the lowest yield at 1.2 t/ha. CDC Osler and ACS Intrepid displayed such variability that comparisons were not practical. The Jang seeder provides accurate rates of seeding, but based on the cups used, it did not deposit seed uniformly.

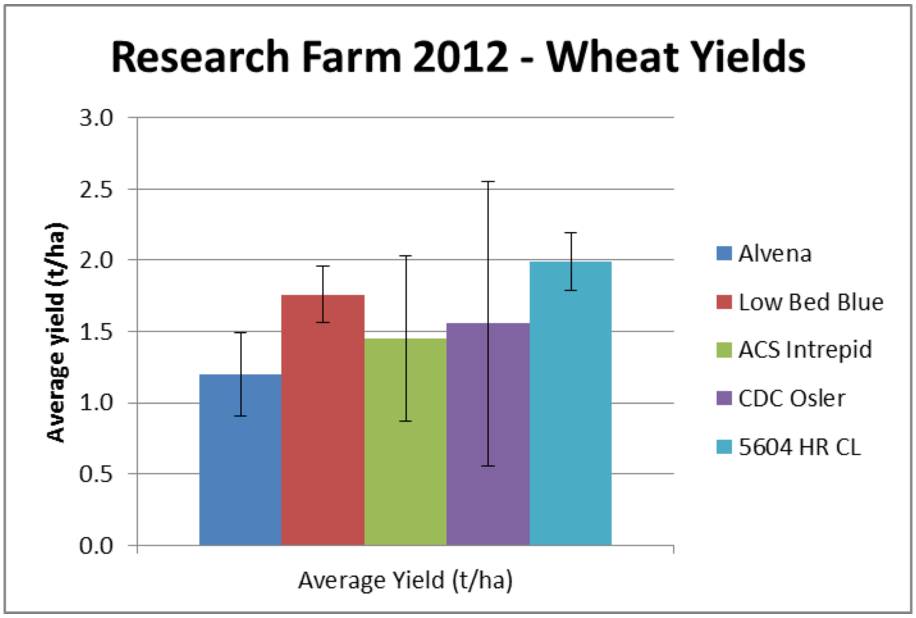

Figure 8: Average wheat yields at the Research Farm by variety (t/ha)
* error bars indicate 95% confidence limits (we are 95% sure that the true average yield falls within that range)

Conclusion:
Wheat provides limited options for use other than as a feed grain. In cold seasons, as seen in 2011 around Whitehorse, wheat does not mature. Yields in the central Yukon continue to outperform the Whitehorse area and make wheat an attractive crop option with yields between 2-6 t/ha. The highest yield seen at the Research Farm in four years of testing was only 3.7 t/ha by ACS Intrepid in 2010.

Variety performance data collected by the BC Grain Producers Association shows a similar range of yields to central Yukon. Though they have not tested Low Bed Blue, the other four varieties demonstrated yields between 1.5 and 7 t/ha since 2001 at their Dawson Creek test site[4] (see Table 13). The Peace Region has considerably higher precipitation and does not require irrigation, but moisture deficiency in central Yukon can be remedied. Irrigation increases input cost, but guarantees early germination and adequate moisture.

[4] The BC Grain Producers Association reported all yields in bushels/acre – a pound per bushel conversion factor was provided for each variety and we converted pounds/acre values to tonnes/hectare using standard conversion factors.

Table 13: Average yield of wheat over four years (t/ha)

Average Yield (t/ha)		Year			
Site	**Variety**	**2009**	**2010**	**2011**	**2012**
Research Farm	**Alvena**	1.9	3.1	n.m	1.2
	Low Bed Blue	-	-	n.m	1.8
	ACS Intrepid	1.9	3.7	n.m	1.5
	CDC Osler	2.0	3.4	n.m	1.6
	5604 HR CL	-	-	n.m	2.0
McCabe Creek	**Alvena**	3.4	5.0	3.5	4.3
	Low Bed Blue	-	-	2.6	4.9
	ACS Intrepid	4.1	4.4	3.5	5.5
	CDC Osler	3.5	4.7	1.0	4.3
	5604 HR CL	-	-	2.9	5.7
Dawson Creek * BC Grain Producers Association Data	**Alvena**	-	2.2	7.3	-
	CDC Osler	3.2	2.7	7.1	3.3
	5604 HR CL	-	2.7	7.1	3.1

*n.m. indicates seed did not mature
**(-) indicates variety was not tested

The quality of the seed at both research sites varies, but would be suitable as part of a feed ration to support the continued growth of the poultry and hog sectors. The new varieties first planted in 2011, 5604 and Low Bed Blue, showed promising results and trials will be continued in 2013.

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6.0 POTATO VARIETY TRIAL

Location: Yukon Grain Farm
Initiated: 2012
Funding: Government of Yukon and Canada-Yukon Growing Forward Program
Partner: Yukon Grain Farm and van Loon Farms

Objective:
To examine the potential of new potato cultivars in southern Yukon growing conditions.

Introduction:
Potatoes are one of the most widespread crops in Canada and the most valuable vegetable crop in the country (Agriculture and Agri-Food Canada 2005). Currently there are more than 150 different varieties being produced in the country. Each variety has different requirements, characteristics and yields. In 2012, the Yukon Agriculture Branch launched a trial of six varieties at the Yukon Grain Farm. The following descriptions are adapted from the Canadian Food Inspection Agency website.

Table 14: Potato variety descriptions

Variety	Type	Year Registered in Canada	Maturity	Agricultural Features	Utilization
Chieftain	Red	1973	Mid-Season	High Yielding Attractive Appearance Well Suited for Washing	Good to excellent for bioing Good for chipping at harvest Excellent for French Frying
Ranger Russet	Russet	1993	Late Season	Medium to High Yielding Good Storability	No boiling sloughing and no after cooking discolouration Good for baking and French frying (soon after harvest)
Russet Norkotah	Russet	1993	Early to Mid-Season	Medium Yielding Attractive Appearance Uniform Tuber Size and Shape Good Storability	Good for boiling, baking, and French frying Unsuitable for chipping
Shepody	White	1980	Mid-Season	High Yielding Uniform Tuber Size and Shape High Percentage of Large Tubers Good Storability	Excellent for boiling, baking, and French frying Unsuitable for chipping
Norland	Red	1960	Early Season	High Yielding Adapts well to different soils Washes well at maturity	Very good for boiling and French frying Good for chipping at harvest Fair for baking
Yukon Gold	White	1980	Mid-Season	Medium to High Yielding Attractive Appearance Excellent Storability	Very good for boiling and French frying Unsuitable for chipping

Materials and Methods:
Seed potatoes of each variety were provided by van Loon Farms. Potatoes at the Yukon Grain Farm were planted May 29, top killed August 7, and harvested by hand on August 17, for a total of 81 growing days. The fields received 130 mm of irrigation, but precipitation data was unavailable. Ten plants were randomly selected from each 70 m row. Potatoes were hand dug and each sample was separated by tubers per plant. Samples were stored for a week at 5-8°C. Each potato was washed, dried, weighed and sized. The largest diameter of the potato was used to determine size. See Table 15 for the sizing chart.

Table 15: Potato sizing chart

Size	Diameter
XS	<2 cm
S	2-5 cm
M	5-10 cm
L	>10 cm

*Not identical to industry standard sizing, but similar.

Results and Discussion:

Small Potatoes (2-5 cm Diameter)

Chieftain produced the highest yield of small potatoes at 7.6 t/ha (see Table 16). Russet Norkotah and Norland plants produced 2/3 of the Chieftain yield at 5 t/ha respectively. Small potatoes are sold as gourmet or baby potatoes in small bags. General cost per kilogram is high, but it is also more labour to market and sell them.

Medium Potatoes (5-10 cm Diameter)

The medium size tuber is targeted for table potatoes from varieties such as Yukon Gold, Shepody or Norland. Norland and Ranger Russet produced the highest yield at 24.9 and 23.5 t/ha. Shepody and Yukon Gold yields were 20.3 t/ha and 18.0 t/ha and Chieftain's yields were well behind the rest at 9.1 t/ha.

Large Potatoes (>10 cm Diameter)

Large potatoes are targeted for baking and French fry production. In southern markets, the Russet varieties are the usual baking potato. Shepody, however, was the only variety that consistently produced oversize tubers. Nine out of ten plants produced a potato over 10 cm in diameter for a total yield of 6.7 t/ha. None of the other varieties produced more than 1 t/ha. The Canadian Food Inspection Agency lists Shepody as an excellent potato for baking and French frying.

Table 16: Total calculated potato yield at the Yukon Grain Farm (t/ha)

Variety	Small Potato Yield (t/ha)	Medium Potato Yield (t/ha)	Large Potato Yield (t/ha)	Total Yield (t/ha)
Ranger Russet	4.2	24.9	<1	29.6
Norland	5.0	23.5	<1	29.5
Shepody	1.4	20.3	6.7	28.4
Russet Norkotah	5.0	21.9	1.0	28.0
Yukon Gold	4.1	18.0	<1	22.1
Chieftain	7.6	9.1	<1	16.8

Ranger Russet, Shepody, Russet Norkotah, and Norland all produced comparable yields between 28.0 and 29.6 t/ha. Yukon Gold yields were less than the other standard lines at 22.1 t/ha. Though the top producer of small potatoes, Chieftain severely lagged behind in total yield at 16.8 t/ha.

Sizing based on diameter can be deceiving. The shape of the tuber plays an important role in determining size as the largest diameter is used. Consider the production of large potatoes: Russet Norkotah produced two potatoes over 10 cm in diameter and Norland didn't produce any. The largest potato by weight produced by Norland, however, was 281 g and Russet Norkotah's largest was 162 g (see Figure 9).

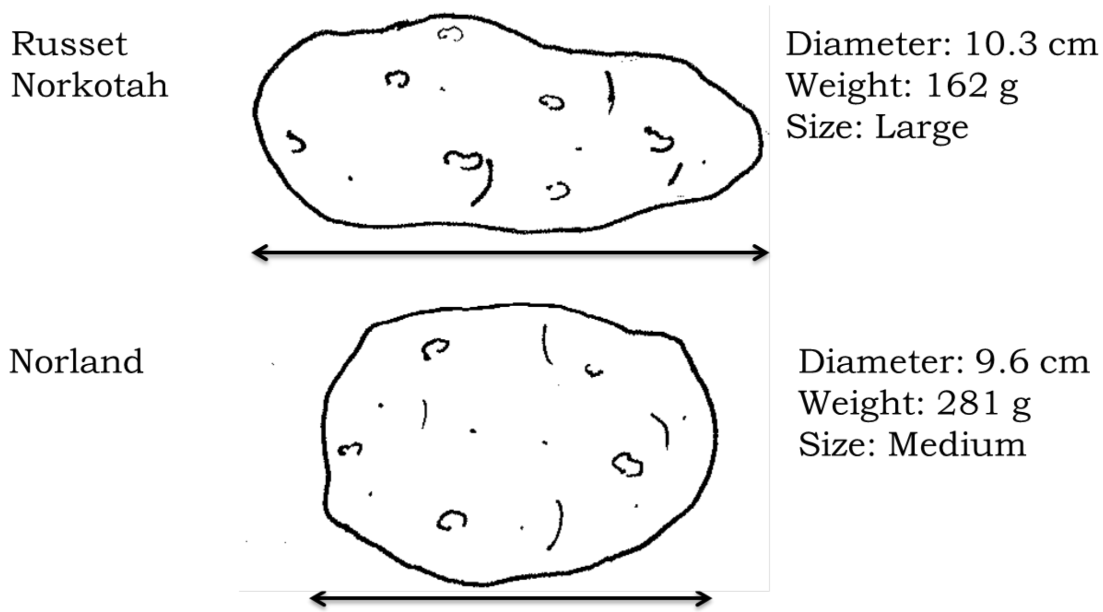

Figure 9: How sizing is affected by tuber shape

Russet Norkotah also produced similar yields of medium potatoes as Shepody (21.9 t/ha to 20.3 t/ha), but the average potato size was significantly different. Russet Norkotah tubers were oblong in shape and sized higher than Shepody tubers with similar weights. The average medium Russet Norkotah potato weighed 58.6 g and average medium Shepody potato weighed 91.0 g.

Conclusion:
Russet Norkotah, Shepody, Yukon Gold and Norland are all considered industry standard lines in the southern provinces (Waterer et. Al 2010). The University of Saskatchewan has been running long term potato variety trials in Saskatoon, SK (see Table 17). Official results are reported in marketable yield, but graphs within the reports have total yields ranging between 30-45 t/ha. This is consistent with results reported by the University of Alaska Fairbanks at their experiment farm just north of Anchorage. Long term data from Alaska was only available on Shepody, reporting an average total yield of 35 t/ha. Culls would reduce total marketable yields, ranging from a very low cull rate if the plants are hand harvested and no disease or growth problems occur, to upwards to 30% in difficult conditions.

Table 17: University of Saskatchewan potato variety research results

Variety	1991-2006 Average Marketable Yield (t/ha)
Norland	20.7
Russet Norkotah	18.5
Shepody	18.6
Ranger Russet	17.2
Chieftain	22.1

A producer must decide on a target market for the potatoes and choose the varieties that will be grown accordingly. Total yield is not the only variable to be considered when choosing a potato variety. Resistance to disease, size, uniformity and many other characteristics are also important in deciding which seed to use each spring.

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7.0 POTATO SPACING TRIAL

Location: Government of Yukon Research Farm and Yukon Grain Farm
Initiated: 2012
Funding: Government of Yukon and Canada-Yukon Growing Forward Program
Partner: Yukon Grain Farm

Objective:
To determine if increasing the in-row distance between seed potatoes increases the average size and maximum size of potatoes produced.

Introduction:
The guidelines for potato production recommend 31 cm (12") in-row spacing. The Agriculture Branch received observations from producers that increasing the distance between seeds appeared to increase the size of the potato without compromising yield. Similar trials at the University of Saskatchewan found that increasing spacing produced larger potatoes, but significantly less yield (Waterer et al. 2010). Another study by the University of California documented the increase in potato size was consistent with an increase in in-row spacing (Wilson et al. 2011). No such study had been conducted north of 60° and in late May a spacing trial was initiated at two sites in the Whitehorse area: the Government of Yukon Research Farm and the Yukon Grain Farm.

Materials and Methods:
<u>Research Farm</u>
Yukon Gold and Norland potatoes were planted at the Research Farm on May 30 and spaced 31 cm (12"), 47 cm (18") and 62 cm (24") apart. Irrigation was applied at a rate of 120 mm over the summer and weed management was through mechanical hilling and hand rogueing. A heavy frost on September 11 effectively top killed the potatoes at the Research Farm. Potatoes were harvested by hand late in the season - October 4 - for expected maximum differentiation of the treatments. Five plants were randomly selected from each of the 24 plots and labelled accordingly. Potatoes were stored for four weeks at temperatures between 2-6°C. Samples were washed, dried, weighed, and sized. The largest diameter of each potato was used to determine size (see Table 15: Potato sizing chart).

<u>Yukon Grain Farm</u>
Potatoes at the Yukon Grain Farm were planted May 29, top killed August 5 and harvested by hand on August 17. The fields received 130 mm of irrigation, but the precipitation data was unavailable. Ten plants were randomly selected from both 31 cm (12") spacing and 62 cm (24") spacing. Potatoes were hand dug and samples were separated into tubers per plant. Samples were then stored for a week at 5-8°C. Each potato was washed, dried, weighed and sized. The largest diameter of the potato was used to determine size (see Table 15: Potato sizing chart).

Results and Discussion:
<u>Research Farm</u>

Yukon Gold
Average weights of small potatoes increased slightly with in-row spacing, yet the average weight of medium potatoes changed very little. Plants spaced 62 cm apart yielded about 25% more small potatoes per plant than plants spaced 31 cm, but the total yield per hectare was significantly less (see Table 18). At 47 cm spacing, the average potato size was slightly larger, but the total yield was ~10 t/ha less than plots with 31 cm spacing.

Table 18: Total potato yield – Research Farm

	Yukon Gold			Norland		
Spacing (cm)	**31**	**47**	**62**	**31**	**47**	**62**
Yield (t/ha)	38.58	28.83	24.94	39.47	25.33	22.21
Average Tuber Weight (g)	85.8	90.8	91.9	77.1	78.2	93.4

Norland
Across the three in-row distances, the average weights of small and medium potatoes showed moderate variation. There was no significant change in tuber size between 31 and 47 cm spacing, yet at 62 cm spacing there was an increase of more than 10 g in average potato size. The number of potatoes per plant at 62 cm spacing did not increase enough, however, to offset the reduction in plants per hectare and total yield was close to half that of standard spacing.

Yukon Grain Farm
Yukon Gold potatoes showed significant difference in growth patterns based on in-row spacing at the Yukon Grain Farm. Plants spaced 31 cm apart produced fewer, smaller potatoes than 62 cm spaced plants.

Table 19: Potato yield at the Yukon Grain Farm by size and average individual potato weight

	Average Individual Potato Weight (g)		Total Yield (t/ha)		Small Potato Yield (t/ha)		Medium Potato Yield (t/ha)	
Spacing (cm)	**31**	**62**	**31**	**62**	**31**	**62**	**31**	**62**
	61.7	82.9	22.1	19.9	4.1	2.1	18.0	17.8

Both sampling groups produced equal amounts of small potatoes per plant, but 31 cm spacing would have twice as large t/ha yield (see Table 19). Sixty-two cm spaced plants produced nearly twice the tonnage of medium potatoes per plant and the average medium potato was 13 g heavier.

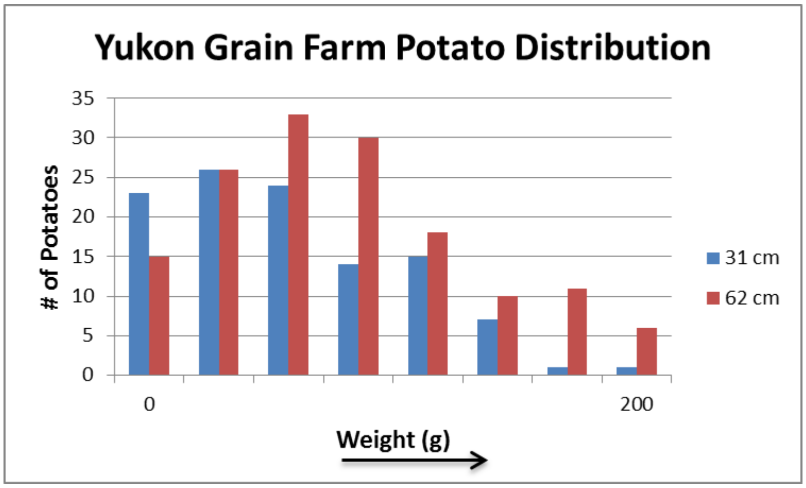

Figure 10: Potato distribution at the Yukon Grain Farm based on individual potato weights (g)

Figure 10 is a frequency distribution showing the count of potatoes in different weight classes between 0 and 200 g. It illustrates the correlation between in-row spacing and tuber size. In-row spacing had a significant effect on tuber size over an 80 day commercial production cycle.

Conclusion:

The two research sites were harvested at different times. At the Yukon Grain Farm, the potatoes were harvested mid-August in accordance with normal commercial production timing. Potatoes at the Research Farm were left in the ground for as long as possible to provide ample opportunity to maximize potato size and yield - not feasible for commercial production. Top killing vines is generally required in order to allow time for skins to harden to prevent skin tearing during harvest and prevent storage loss. Samples at the Research Farm weren't harvested until after a heavy frost to determine if a longer season would produce greater differences between spacing treatments.

At the Research Farm, the tighter spacing yielded significantly better. The Yukon Gold yield was nearly 39 t/ha with 31 cm spacing, whereas the wider 62 cm spacing yielded 25 t/ha. The trend of larger potatoes due to wider spacing was observed at both sites. Yield was not pointedly affected by in-row spacing at the Yukon Grain Farm. There was only a 2.2 t/ha difference recorded between 31 and 62 cm spacing due to the increased number and size of tuber produced by wider spaced plants.

Based on the single year of work it would appear that yields are only depressed slightly by wider spacing when harvested earlier and produce significantly larger potatoes. For a later harvest, the differences between spacing did not result in a larger gap between potato sizes. Spacing was clearly a limiting factor of tuber size at the Yukon Grain Farm. It was also warmer by 45 EGDD which helps warm the soil producing larger potatoes faster. Nutrients were optimized at both sites, indicating that over a commercial season, increasing the in-row spacing of potatoes has the potential to increase tuber size without compromising yield.

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