YUKON AGRICULTURE

RESEARCH and DEMONSTRATION
2009 PROGRESS REPORT

Energy, Mines and Resources

EXECUTIVE SUMMARY

In 2009, the Agriculture Branch's research and demonstration program included a forage demonstration of various grasses and legumes, wheat and pea variety trials, biodegradable mulch evaluation, oilseed production for biodiesel evaluation, and a raspberry input management and economics of production trial.

The 2009 growing season was a great success in Yukon terms. This growing season had the warmest recorded temperatures since 2004.

The forage demonstration is an ongoing project at the Agriculture Branch research farm. The yields of field peas were very high, with over 10 tonnes/ha of forage produced. The smooth bromegrass continued to provide the best yields for the grasses. The yield of the smooth bromegrass one cut system, at over 5 T/ha, outpaced the double cut system. The meadow brome and creeping red fescue yielded well in the double cut system.

The decomposition of a biodegradable and compostable mulch film from BioTelo™ was evaluated in 2009. It is a non-toxic corn starch based raw material that is promoted as being easily degradable. This biodegradable mulch appears to be a good choice for row crops, providing all the benefits of a standard mulch, yet decaying in the field so it does not present a disposal concern.

Wheat and pea trials were added in 2009 to explore different management practices and new varieties. The yields at the central Yukon site were much greater and of superior quality than the wheat grown in the Whitehorse area. A second year trial will be initiated to see if further trends can be determined from the different seeding dates and varieties. The field peas grew very well in 2009 with consistent maturity and yields that were higher than expected. At both the research farm and McCabe Creek sites, regardless of variety, yields were over 4.4 T/ha. McCabe Creek had the highest yields, with the Polstead variety at 6.5 T/ha.

The oilseed trial for the production of biodiesel evaluation finished its final year. In 2009, the production was much higher than the other years. *Brassica napus* performed well at all sites, producing between 0.13 to 3.66 T/ha of seed. Most of the numbers were well above the Canadian averages for canola yield with eleven samples above 2 T/ha. The *Camelina sativa* and *Linum usitatissimum* (flax) varieties did favorably at the McCabe Creek site.

The raspberry orchard assessment continued to evaluate input management and the economics of production. Producing high yielding Kiska raspberries, using a U-pick business model, and keeping expenses low showed an opportunity to run a profitable raspberry orchard in southcentral Yukon. The high tunnel row cover had a positive effect on the raspberry production, producing berries sooner in the season and yielding close to optimum yields. The irrigation system provided the orchard with the required water and fertilizer. As with previous years a lower fertilizer rate appears to yield better results.

PREFACE

This document is a record of agricultural demonstrations and studies conducted in Yukon. This 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

The Yukon Agriculture Branch would like to thank all agricultural producers who participated and contributed with site location, data collection and field monitoring. Recognition is also extended to the Forest Management Branch and the Department of Energy, Mines and Resources. In addition, the Agriculture Branch would like to thank Kevin Falk and Richard Gugel (AAFC, Saskatoon Research Centre), Clair Langlois (BC Grain Producers Association), Brad Barton (Agriculture Branch research technician), Jake Loos (Agriculture Branch summer student), and all the raspberry pickers.

CONTACT

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

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

Jennifer Taylor
A/Agriculture Research Technician

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1.0 INTRODUCTION

The Yukon government's Agriculture Branch began conducting its own 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. Projects are still conducted in partnership with industry in south and central Yukon. The co-operation with industry takes advantage of on-farm expertise and site variation. Multiple sites provide insight into the diversity and the 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:

- forage demonstration of various grasses and legumes;
- wheat and pea variety trials;
- biodegradable mulch evaluation;
- oilseed production for biodiesel evaluation; and
- raspberry input management and economics of production trial.

1.1 Agriculture Regions

Yukon agriculture has been divided into four defined agricultural regions:

- Whitehorse;
- Central Yukon;
- Haines Junction; and
- Watson Lake.

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

The Whitehorse and surrounding area accounts for a majority of Yukon agricultural activity. This region is composed of the Takhini River valley and the Yukon River valley between Marsh Lake and Lake Laberge.

The central Yukon region is the largest region and is recognized for having the warmest growing season. The region is also historically one of the first areas in Yukon that was developed for agriculture because of the demand for fresh food from the influx of miners at the turn of the 20th century. The central Yukon agricultural region lies in the Yukon, Pelly, Stewart and McQuesten River valleys stretching from Carmacks to Dawson City and includes Pelly and Mayo.

The Yukon government research and demonstration projects are located within the Whitehorse and central Yukon regions.

The Haines Junction region has a cool growing season and high incidence of frost. It has been identified as an agriculture region because historically it was home to an Agriculture Canada research station from 1944 to 1968 and is still considered to be a strong agriculture community.

The Watson Lake region has warm continental temperatures and receives more precipitation than the other regions. This area has been identified as having an enhanced agriculture potential and currently has a small agriculture industry, serving some local needs.

There is currently no research being conducted by the Agriculture Branch in the Haines Junction or Watson Lake agriculture areas.

1.2 Site Descriptions

The bulk of the research and demonstration projects are conducted in the Whitehorse area at the Agriculture Branch research farm (identified as site RF). In 2009, the research farm supported forage demonstrations, a raspberry orchard production assessment, an oilseeds evaluation, wheat variety trials, pea trials, and a biodegradable mulch evaluation. 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 forest. 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, aspen, spruce, lodgepole pine, and under-brush 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; pH is 7.0 with organic matter levels around 2%.

A field location (site SM) near Whitehorse has been involved in various research trials since 2006 thanks to Steve and Bonnie MacKenzie-Grieve and their continued support. Site SM, Yukon Grain Farm, was the location for a second Whitehorse area oilseeds evaluation this year. Site SM is located in the Yukon River valley, near the southern tip of Lake Laberge. This site is located within the warmest summer microclimate in the Whitehorse area. The field experiments were located on the northwest corner of a large 50 hectare field. The soils in the area are a range of medium to coarse loamy sand to sand which is moderately well to rapidly drained; pH is around 7.2 and organic matter is between 2% to 3%.

In 2009, a new site was selected in central Yukon at McCabe Creek, site MC. This site is within the central Yukon climatic region and provides research results that are applicable for farms between Carmacks, Dawson and Mayo. Research was conducted at McCabe Creek in the 1990s and the Agriculture Branch is excited to partner with Cathy and Jerry Kruse again. The site was involved in the forage demonstrations, oilseed production, wheat, and pea trials. The site is located on the east side of the Yukon River, on the north side of a large hay field providing excellent solar radiation and frost drainage. The soils in the area are fine sandy loam to silt loam which are moderately well drained; pH is around 7.5 and organic matter levels are around 2%.

1.3 Climate Monitoring

Climate is the major limiting factor for agriculture in Yukon. There is a short frost free period and a precipitation deficiency in most areas. That being said, the 2009 growing season was a great success in Yukon terms. This growing season had the warmest recorded temperatures since 2004.

Table 1.1: 2009 season summaries and average from the previous 10 years

Region	Station	Parameter	2009	10-Year Average
Whitehorse Area	Whitehorse Airport (EC)	EGDD	1,236	1,066
		Start of growing season	1-May	7-May
		End of growing season (first killing frost -2.2°C)	27-Sep	18-Sep
		Land capability class	Class 2	Class 3
		Number of frosts during growing season	17	12
	RF (YTG)	EGDD	682	833
		Start of growing season	1-May	8-May
		End of growing season (first killing frost -2.2°C)	25-Jul	16-Aug
		Land capability class	Class 5	Class 5
		Number of frosts during growing season	43	25
Central Yukon	Pelly Farm (YTG& EC)	EGDD:	1,462	1,239
		Start of growing season:	30-Apr	3-May
		End of growing season (first killing frost -2.2°C)	18-Sep	8-Sep
		Land capability class	Class 1	Class 2
		Number of frosts during growing season	17	15
	Mayo Airport (EC)	EGDD	1,410	1,270
		Start of growing season	1-May	4-May
		End of growing season (first killing frost -2.2°C)	27-Sep	15-Sep
		Land capability class	Class 1	Class 2
		Number of frosts during growing season	12	11
	Dawson Airport (EC)	EGDD	1,288	1,095
		Start of growing season	1-May	5-May
		End of growing season (first killing frost -2.2°C)	27-Sep	2-Sep
		Land capability class	Class 2	Class 3
		Number of frosts during growing season	20	14
	Haines Junction (EC)	EGDD	1,055	907
		Start of growing season	1-May	7-May
		End of growing season (first killing frost -2.2°C)	14-Sep	2-Sep
		Land capability class	Class 3	Class 4
		Number of frosts during growing season	46	23
Southern Yukon	Watson Lake Airport (EC)	EGDD	1,270	1,138
		Start of growing season	2-May	9-May
		End of growing season (first killing frost -2.2°C)	30-Sep	22-Sep
		Land capability class	Class 2	Class 3
		Number of frosts during growing season	14	9

Climate data is collected from Environment Canada, the Yukon government and portable weather stations in the four regions to better understand the diverse weather patterns and the season-to-season variability in growing conditions. The multitude of information from climate monitoring can provide growing season analysis for both producers and research projects.

The climate data from the past growing season is collected and used to calculate agroclimatic capability. The agroclimatic capability is a measure of the degree of limitation imposed by climate on agricultural production and a measure of 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 (-2.2°C), daily average temperature and day length. Table 1.2 defines the agroclimatic classes which range from Class 1 (no restrictions) to Class 6 (severe limitations for cultivated agriculture). The agroclimatic capability is based on Growing Degree Days (GDD). GDDs are calculated using the average daily temperature minus a basic mean temperature of 5°C required for cool season crop growth. For example, if the daily mean temperature is 16°C, GDD equals 11. However, in the instance that an average temperature is 5°C or lower, GDD would equal 0.

GDD is calculated beginning the fifth consecutive day of the year with daily mean temperatures above 5°C and terminated 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 the specific killing frost temperature differs between crops, for the purpose of determining the end of the growing season from year to year for the Yukon a temperature of -2.2°C is used as a standard killing frost for cool season crops.

Table 1.2: 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.

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° latitude, the GDD is adjusted upward and reported as Effective Growing Degree Days (EGDD) as outlined in the calculation of the day length factor in the Land Suitability Rating System for Agriculture Crops. For example, the 1,065 GDD recorded at Whitehorse Airport, is multiplied by a factor of 1.16 and becomes 1,236 EGDD. The daylight factor changes with latitude, for example in Dawson a factor of 1.18 is used and for Watson Lake a factor of 1.14 is used.

The Whitehorse airport weather station reported 1,236 effective growing degree days (EGDD), 340 more EGDD than in 2008. Table 1.1 (page 9) shows the 2009 climate summaries and ten year average.

Precipitation for the 2009 season was slightly less than the 10 year average with the most rainfall occurring in the Watson Lake area. Graph 1.1 shows the precipitation for each month from May to September and table 1.3 shows the growing season total precipitation and the 10-year average of the different regions.

Graph 1.1: Precipitation for May to September, 2009

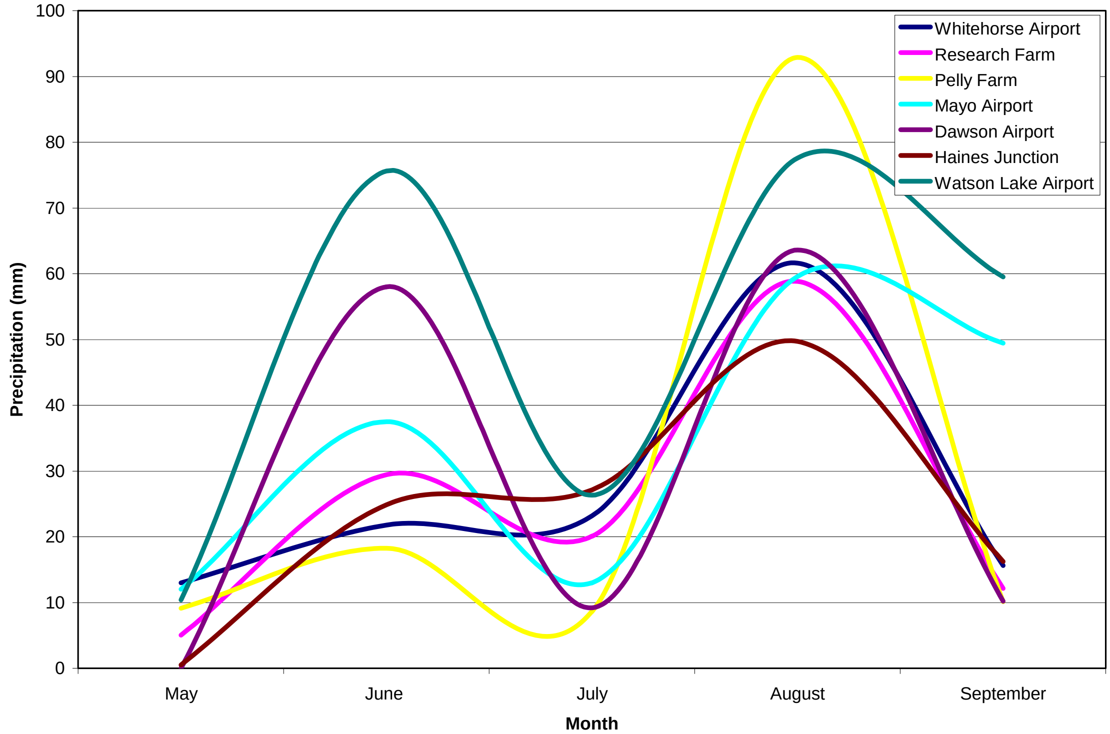


Table 1.3: Precipitation Totals for May to September and 10-Year Average

Location	2009 Total (May to September)	10 Year Average (May to September)
Whitehorse Airport	135.2	163.1
Research Farm	125.55	147.2
Pelly Farm	139.03	183.7
Mayo Airport	171.5	210.2
Dawson Airport	141	181.9
Haines Junction	118.44	138.8
Watson Lake Airport	249.4	254.8

2.0 FORAGE DEMONSTRATION

Location: Research Farm (Site RF), Whitehorse
Funding: Government of Yukon
Objective: To assess the yield and hardiness of various forage species under different harvest management regimes.

2.1 Introduction

A series of 24 forage demonstration plots were initially set up in 2005. The primary purpose of the trial was to demonstrate the behavior of various grasses in southcentral Yukon under different harvest management regimes.

2.2 Materials & Methods

The forage plots were established on the south side of the two hectare research farm (RF), slightly shaded by the adjacent forest and on a flat to slightly north facing aspect. Irrigation and fertilizer were applied to provide optimum conditions. Soil samples were analyzed prior to the growing season to determine the fertilizer requirements. Fertilizer was applied in early June; 100-60-60-10 for grasses and 0-60-60-10 for the legumes. The plots were irrigated through late May to early August; approximately 100 mm of water was applied.

An overwintering assessment was carried out in the early summer to quantify winterkill from the previous growing season. A percent cover intercept method was used to determine the percent cover and infer the rate of winterkill. A transect line from west to east was used through the middle of each plot. At half metre paces along the line, the end of a bar was put down randomly on the ground and what the end contacted was recorded as weeds, grass/legume, bare ground, or dead plant. If more than one contact was made both points were recorded. With the results, the inferred winter survival was estimated (see table 2.1).

Biomass yields were assessed at various intervals throughout the summer. Each forage plot was divided into three sections; one for a single cut system, cut July 21; one section for a double cut system, cut July 3 and August 13; and one section for the total biomass, cut August 20. Samples were harvested from one square metre, placed in paper bags, dried and weighed. The resulting weights were extrapolated to tonnes per hectare.

Samples were submitted for analysis to Central Testing Laboratory in Winnipeg, Manitoba.

The majority of weeds were hand pulled. The main problem species were hawksbeard and scorpion weed. There was very limited disease incidence.

2.3 Results & Discussion

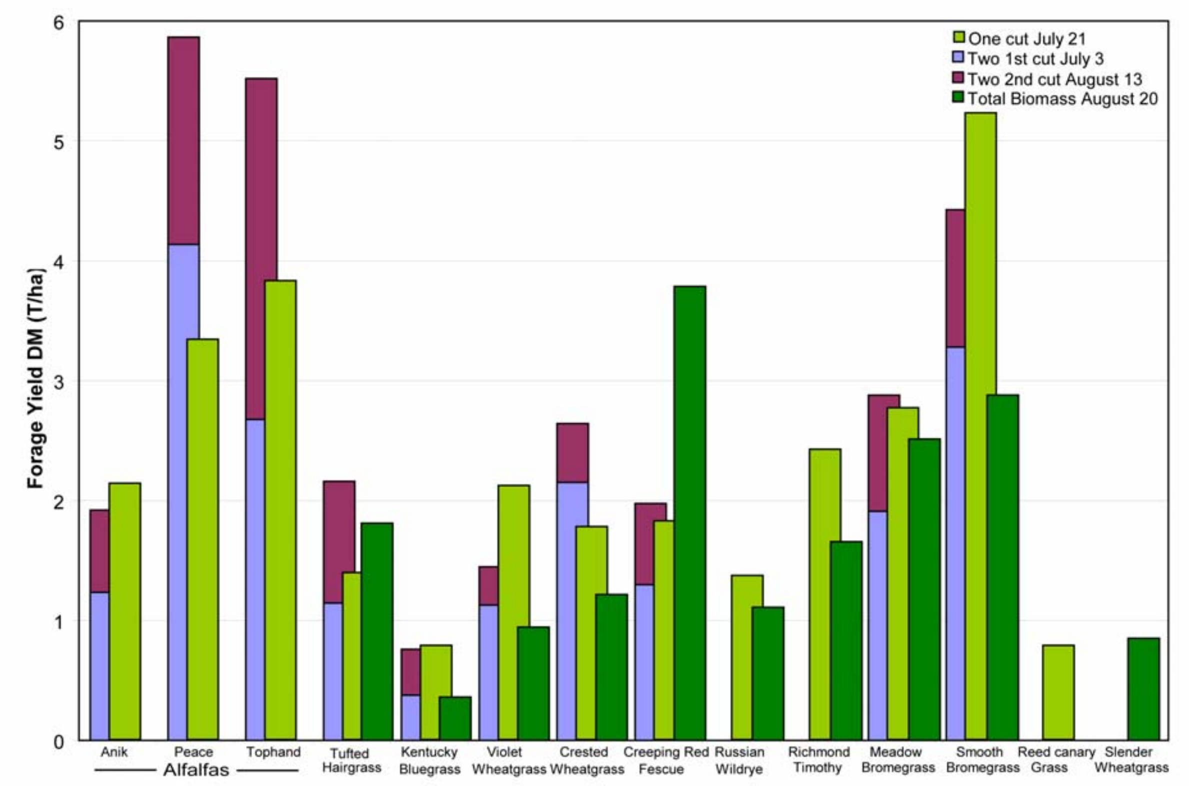
Table 2.1 shows the inferred winter survival for the various forage varieties.

Table 2.1: Inferred Winter Survival

Species (variety)	Inferred Winter Survival (%)
Alfalfa (Peace)	75
Kentucky Bluegrass	68
Creeping Red Fescue (Boreal)	65
Tufted Hairgrass	56
Slender Wheatgrass	56
Violet Wheatgrass	50
Smooth Bromegrass (Carlton)	50
Crested Wheatgrass (Kirk)	45
Russian Wildrye	44
Alfalfa (Tophand)	43
Timothy (Richmond)	38
Meadow Bromegrass (Fleet)	38
Alfalfa (Anik)	32
Reed Canarygrass (Bellevue)	5
Orchardgrass (Okay)	0

It was surprising to see overwintering success with the alfalfa varieties this year. In previous years the inferred winter survival was very low. The snow depth over the winter of 2008/09 was the highest on record. In addition, there was no winter melt to remove the snow layer. This would have insulated the crop and reduced winterkill. Most grass demonstrations overwintered successfully. Kentucky bluegrass and creeping red fescue had the highest inferred survival of the grasses.

Graph 2.1: Single vs. Double Cut Forage Management Estimated Yields



As in the previous years, the Carlton smooth bromegrass produced more than the other forage grasses, both in a single or double cut system as illustrated in graph 2.1. As was noted last year and repeated this year, the double cut smooth bromegrass did not produce more forage than the single cut. The single cut system produced over five tonnes per hectare.

Some grasses responded very well to the double cut system. As with the previous two years, the Boreal creeping red fescue had higher production under a two cut system.

The surprise this year was the performance of the alfalfas. After successfully overwintering, all performed very well, with double cut yields of Peace and Tophand exceeding that of smooth bromegrass. Peace yielded 5.86 T/ha.

The harvesting of some of the less competitive grasses led to encroachment of other grasses and weeds. In the following cases it was not possible to harvest all the sections of each plot for analysis:

- slender wheat grass in the single and double cut systems was lost;
- reed canary grass total biomass and double cut system was lost; and
- wildrye and timothy double cut plots were lost.

The less competitive varieties in the double cut system are not able to repopulate the plot fast enough to avoid weeds from encroaching. This resulted in a lower density of the seeded crop, which may have benefited from reseeding.

Table 2.2: Protein values of forages under different harvest management

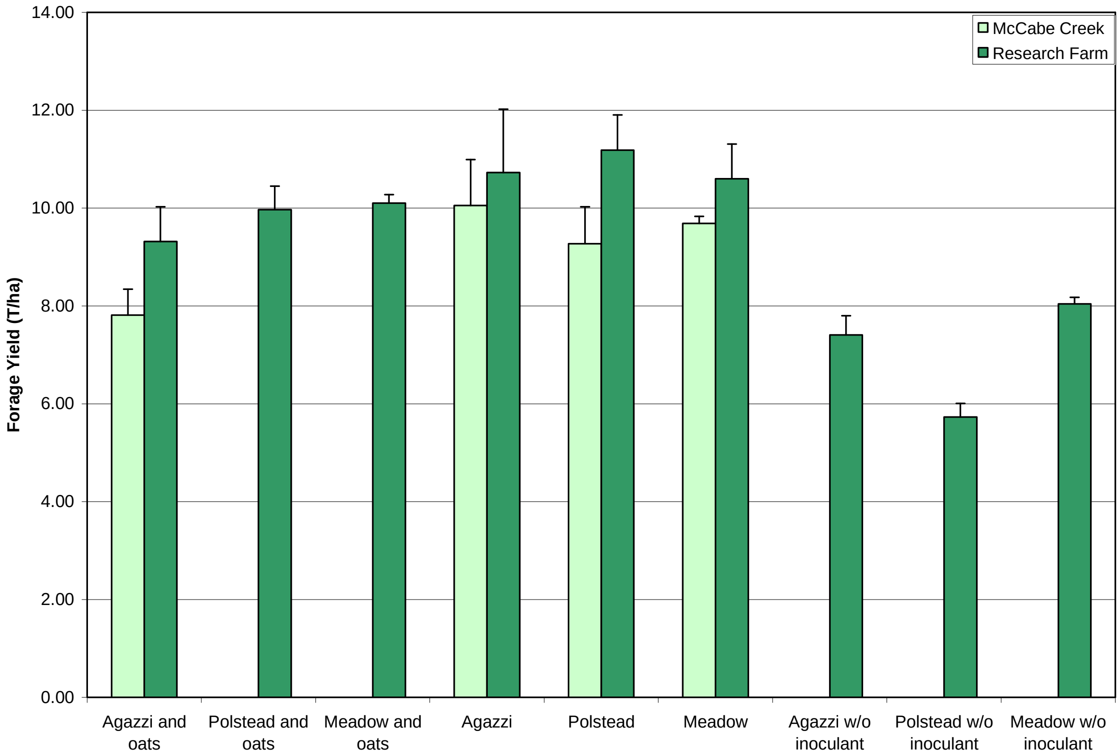
Variety	Harvest Date	Dry Matter Protein	Management
Anik	July 2,1 2009	17.65	Single cut
	July 3, 2009	21.49	Double cut
	Aug 13, 2009	23.03	Double cut
Peace	July 21, 2009	18.43	Single cut
	July 3, 2009	20.34	Double cut
	Aug 13, 2009	23.72	Double cut
Tophand	July 21, 2009	19.13	Single cut
	July 3, 2009	24.54	Double cut
	Aug 13, 2009	25.64	Double cut
Violet Wheatgrass	July 21, 2009	13.28	Single cut
	July 3, 2009	18.21	Double cut
	Aug 13, 2009	14.6	Double cut
	Aug 20, 2009	14.07	End of season
Crested Wheatgrass	July 21, 2009	13.8	Single cut
	July 3, 2009	12.31	Double cut
	Aug 13, 2009	14.51	Double cut
	Aug 20, 2009	9.04	End of season
Creeping Red Fescue	July 21, 2009	9.86	Single cut
	July 3, 2009	12.63	Double cut
	Aug 13, 2009	7.89	Double cut
	Aug 20, 2009	7.71	End of season
Meadow Bromegrass	July 21, 2009	10.02	Single cut
	July 3, 2009	23.77	Double cut
	Aug 13, 2009	7.96	Double cut
	Aug 20, 2009	7.79	End of season
Smooth Bromegrass	July 21, 2009	9.58	Single cut
	July 3, 2009	14.77	Double cut
	Aug 13, 2009	12.24	Double cut
	Aug 20, 2009	9.82	End of season

Note: Some of the low yielding forages were not submitted to the lab for analysis

Protein values varied according to the management of the crop. As expected the alfalfa protein values were higher than those of the grasses, the highest protein values were in the second cut of the double cut system of Tophand at 25.6% (table 2.2). The double cut management for alfalfa yielded higher protein values than the single cut because of harvest timing. The early first cut was just prior to flowering and the second cut from the regrowth was prior to 10% bloom. The same result was evident in the grasses where an early cut resulted in higher protein values, but generally reduced yields (graph 2.0).

In addition to the grasses, yields of field peas were assessed for forage. Three varieties previously untested in Yukon were seeded with a range of treatments. The varieties were mixed with oats, seeded stand alone, and seeded without inoculants to determine total forage yield. A replicate was seeded at McCabe Creek to determine yields in central Yukon. Yields were exceptional this year with over 10 T/ha from the stand alone field pea plots (table 2.3). The combination of peas and oats yielded just slightly less. Yields of uninoculated plots were the lowest as was expected as the pea requires specific bacteria for nitrogen production. Yields in central Yukon were slightly lower than those at Whitehorse. Field peas are considered a cool season crop and heat stress may have led to the lower yields.

Table 2.3: Pea Forage Estimated Yields



2.4 Conclusion

This year the success of the overwintering and subsequent yields of alfalfa were noteworthy as were the results from the field peas. The protein levels for Peace and Tophand in the double cut system combined with the high yields made this an exceptional crop for the 2009 growing season. The yields of field peas were very high, with over 10 T/ha of forage produced. The smooth bromegrass continued to provide the best yields for the grasses. The yield of the smooth bromegrass one cut system, at over 5 T/ha, outpaced the double cut system. The meadow brome and creeping red fescue yielded well in the double cut system.

For the alfalfa and field peas the results are very encouraging, results in 2010 will help determine if this was an anomaly.

New alfalfa varieties, perennial cereal rye and cicer milkvetch were added in 2009 at the research farm. A range of perennial forages were also planted at McCabe Creek and results will be available in fall 2010.

3.0 BIODEGRADABLE MULCH EVALUATION

Location: Research Farm (Site RF), Whitehorse
Funding: APF Science and Innovation
Objective: To evaluate the use and breakdown of a biodegradable mulch.

3.1 Introduction

With the increased availability of biodegradable agricultural mulches entering the market, a demonstration project was conducted to further assess the mulches for:

- durability and ease of use;
- water requirements of a perforated mulch;
- impact on yields; and
- degradation rate in Yukon conditions.

The only component of this trial that remained for 2009 was the assessment of the degradation of the mulch in Yukon conditions.

Mulches in the past have been shown to improve soil temperature, limit weeds, prevent erosion, and protect fruit and edible parts from direct contact with the ground. Using plastic mulches can be cumbersome to remove and once removed are not recyclable in Yukon.

The biodegradable & compostable mulch film from BioTelo™ that was used in this evaluation was a black micro-perforated mulch made of Mater-Bi™, a non-toxic corn starch based raw material that is promoted as being biodegradable and compostable. Temperature, humidity, and micro organisms in the ground break down the mulch into water, carbon dioxide, and biomass which saves on removal, recycling and land fill costs associated with non-compostable plastic mulches. The micro perforations in the mulch are designed to allow for the penetration of rains and overhead irrigation into the soil.

The mulch was evaluated with drip irrigation and with overhead sprinkler irrigation. The mulch was held down with soil parallel to the rows.

3.2 Review of 2008 results

There is no hard evidence indicating the need for drip irrigation under the perforated mulch, although based on the research conducted there were some indications that a drip line improved yields or at the least was a good management strategy for conserving water.

The majority of the broccoli with drip irrigation was harvested about a week earlier than the broccoli without drip irrigation; however, the mulch did allow for overhead water penetration.

The mulch combined with drip irrigation provided the highest yields. The mulch cover did reduce weed growth. Germination of the crop under the mulch occurred later than without the mulch cover.

3.3 Conclusion

By the end of the 2008 season the mulch was more brittle than at the start of the season. Although the mulch was intact, it was decomposing. There was concern that the mulch would get wrapped up in the rototiller blades the next spring. However, by the spring of 2009 the mulch had mostly decomposed and was worked into the soil. There were a few scattered remnants of the mulch, but nothing that caused a problem for field preparation. By the middle of summer there was only small fragments of mulch left. In comparison to previous mulches used at the site (there are still pieces of plastic mulch used during the strawberry trial five years past) this mulch is easily disposable. This biodegradable mulch appears to be a good choice for row crops, providing all the benefits of a standard mulch, yet decaying in the field so as not to be a disposal problem.

4.0 WHEAT VARIETY TRIAL

Location: Research Farm (Site RF), Whitehorse
Funding: Government of Yukon
Objective: To assess varietal performance in different management regimes.

4.1 Introduction

Wheat 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 research work in the 1990s. In most years growing wheat around Whitehorse led to very poor results so in this trial, different management practices with some new varieties were tested to see if quality and yields could be improved.

4.2 Materials and Methods

Two different management techniques and three varieties were used in the trial at the research farm. Each treatment was planted into a 5 m x 30 m block, with half of the planting after freeze up into frozen ground and the other half in the spring after thaw. It is important to make this distinction as there has been limited success with winter wheat, therefore spring wheat was planted into frozen ground as opposed to winter wheat which is seeded in the early fall and allowed to germinate before freeze up. The three varieties were also seeded at McCabe Creek in the spring to look at varietal performance in central Yukon.

Thanks to Clair Langlois, Research Manager of the BC Grain Producers Association, who assisted with varietal selection. The following provides information on the three varieties of hard red spring wheat seeded:

Variety	Supplier	Location
ACS Intrepid	Borek Farms	Dawson Creek, BC
Alvena	Spruce Vista Seed Farm	Berwyn, AB
CDC Osler	Supplier Hill Farm Ltd.	Fort St John, BC

An Allis Chalmers Precision Seeder was used to seed the plots, the winter seeding was done on October 16, 2008 at 100 kilograms per hectare and spring seeding was done on May 21, 2009 at 135 kg/ha.

Irrigation was applied as required equaling approximately 130 mm from late May to early August. Fertilizer was applied following soil analysis recommendations in early June (100-45-50-9 kg/ha).

On June 12, 2009, an application of 2,4-D Amine 500 was used to control shepherd's purse and narrow leaved hawksbeard, a full rate was used on the winter seeded plots and a half rate on the spring seeded plots.

4.3 Results

Initially it looked as though the winter seeding was going to mature much faster than the spring seeding as the winter seeding was at the two leaf stage when the spring wheat was being seeded, as observed on May 21, 2009. As the season progressed, the early advantage of the winter seeding was lost and the results showed limited difference between the two seeding dates. Graph 4.0 shows the difference in bushels per hectare between the winter seeded and spring seeded wheat at Whitehorse as compared to wheat grown in Central Yukon conditions. The winter seeding as shown on the graph was corrected for the difference in seeding rate used, therefore the actual difference in yields in Alvena and Osler were not substantial, but there does appear to be a difference with Intrepid. As has been shown in previous research, yields in central Yukon were more favorable.

The quality of the wheat from McCabe Creek was rated as good, whereas the wheat grown at the research farm was rated as poor. A poor quality of wheat would make it only suitable for animal feeds.

Graph 4.0: Wheat Yield at Research Farm and McCabe Creek for 2009

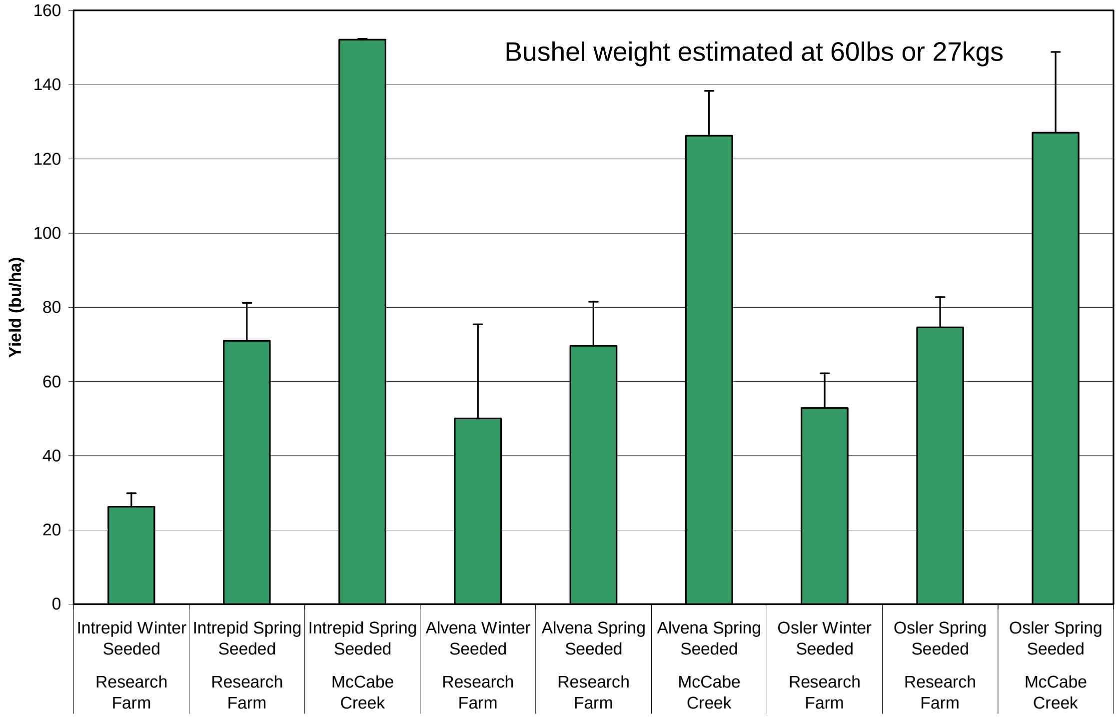


Photo 1: Spring seeded spring wheat at Research Farm, September 2009

4.4 Conclusion

The winter seeded wheat did not promote high yields as was expected. The yields in central Yukon were much greater and of superior quality than the wheat grown in the Whitehorse area. A second year of research will be conducted to see if further trends can be determined from the different seeding dates and varieties.

5.0 FIELD PEA VARIETY TRIAL

Location: Research Farm, Whitehorse
Funding: Yukon Government
Objective: To assess varietal performance in different management regimes.

5.1 Introduction

Peas have been planted in various past trials in Yukon. Attempts through the 1980s to mature peas around Whitehorse were met with limited success. The variety Tipu, which is still available today, was the most successful. Anecdotally, there have been successes in some years from some producers. Trials in central Yukon have generally produced fully formed peas. This trial focused on new, shorter season varieties that offer hope of consistent maturity in the Whitehorse area. Field peas provide a good feed grain or, if the seed does not form, can be used as forage. In the Peace River region of Alberta and British Columbia field pea seed can achieve yields of over 5 T/ha when grown in the presence of irrigation and fertilizers.

5.2 Materials and Methods

The trials were laid out at the research farm in 1.5 m x 15 m blocks. Each of these blocks were split into the three varieties. One block was treated with inoculant (field pea seed should be inoculated with *Rhizobium leguminosarium* bacteria to enhance nitrogen fixing ability); one block was left without inoculant; and in the last block, the peas were mixed with oats (this block is further described in the forage trial). At McCabe Creek each variety was inoculated and seeded into a 1 m x 5 m plot with no further treatment.

The varieties used were:

- Meadow
- Polstead
- Agazzi

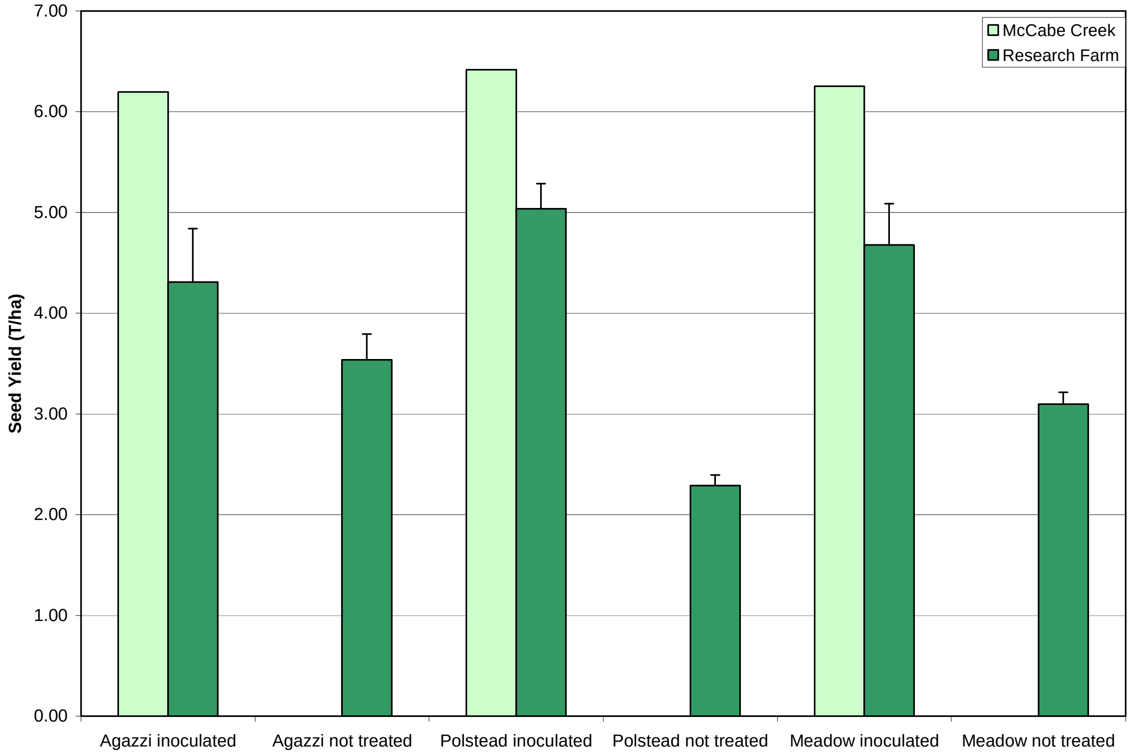
Seeding occurred May 29, at a rate of 210 kg/ha. All sites were irrigated and fertilized according to soil test recommendations. Fertilizer was applied June 9 (0-60-60-10). Over the course of late May to July approximately 90 mm of water was applied.

Photo 2: Mature peas at McCabe Creek, September 2009

5.3 Results

Yields at McCabe Creek were higher than those at Whitehorse, yields were over 6 T/ha across all varieties at McCabe Creek. Varietal differences at the research farm were more variable, with Polstead achieving over 5 T/ha, Meadow yielding 4.6 T/ha, and Agazzi yielded 4.4 T/ha. All of these yields are exceptional and compare favorably with the results found in southern Canada.

Graph 5.1: Pea seed yields for each variety



In all varieties the lack of inoculant resulted in lower yields. This reinforces the requirement to add inoculant when seeding or buy treated seed in order to maximize yields.

5.4 Conclusion

Field peas grew very well in 2009 with consistent maturity and yields that were higher than expected. At both the research farm and McCabe Creek, regardless of variety, yields were over 4.4 T/ha. McCabe Creek had the highest yields, with Polstead at 6.5 T/ha. This trial will be repeated in 2010. Field peas may prove to be a good crop choice as part of a rotation for feed rations or forage.

6.0 OILSEEDS PRODUCTION FOR BIODIESEL POTENTIAL

Locations: Research Farm (Site RF), Yukon Grain Farm (Site SM),
McCabe Creek (Site MC)
Funding: Advancing Canadian Agriculture and Agri-Food (ACAAF)
Objective: To evaluate oilseed production in Yukon.

6.1 Introduction

The evaluation of oilseed production in Yukon has been conducted over the last four years to determine:

- if oilseed production is viable for producing biodiesel in the Yukon;
- which oilseeds produce the best yields and total oil content; and
- which agricultural areas are more suited to oilseed production.

The first two years of the trial demonstrated some potential for growing oilseeds in Yukon; 2008 was a cold growing season that limited oilseed production and 2009 proved to be a success with the highest oil content of the four year trial. The study demonstrated the year-to-year variability of agricultural production in the Yukon.

The four oilseed varieties that were used for the study were false flax (*Camelina sativa*), Polish canola (*Brassica rapa*), Argentine canola (*Brassica napus*) and Flanders flax (*Linum usitatissimum)*. Seed selection was made with consultation from Kevin Falk, Ph.D., and Richard Gugel, M.Sc., from Agriculture and Agri-Food Canada, Saskatoon Research Centre, and Scott Horner, HyTech Production Ltd. Genetically modified species were not used for the study.

6.2 Materials and Methods

The trial utilized the same oilseed crops over the four years. Table 6.1 provides the detailed information for the oilseeds tested in 2009.

Table 6.1: Oilseeds evaluated in 2009 and seeding rates

Species	False Flax	Polish Canola	Argentine Canola	Flanders Flax
	Camelina sativa	*Brassica rapa*	*Brassica napus*	*Linum usitatissimum*
Seed name/ variety	CN30476	SW Spirit River	6803-01	Flanders
Supplier	Crop Development Centre	Bonis & Co. Ltd.	HyTech Productions Ltd.	Se-Can Association
Breeder	Crop Development Centre, Saskatoon	Svalof Weibull Ltd.	DSV Canada	Crop Development Centre, Saskatoon
Seeding rate	5 kg/ha	8 kg/ha	8 kg/ha	30 kg/ha

The varieties selected were planted at two sites in the Whitehorse area (the research farm (Site RF) and Yukon Grain Farm (Site SM)) and one site in central Yukon (McCabe Creek (Site MC)). Forty-eight plots were used for the oilseeds trial with 16 plots at each of the three sites. Each variety was planted into four 2 m x 2 m plots per site in a completely randomized design.

The plots were seeded at end of May as noted in table 6.2. At the time of seeding composite soil samples were sent to Exova Laboratories and analyzed to assess optimum fertilizer rates. Fertilizer was added according to these results in early June.

Table 6.2: 2009 Seeding and Harvest Dates

	Seeding Dates	Harvest Dates
Site MC	May 22	August 26, September 4 and 22
Site RF	May 20	September 21 and 29
Site SM	May 26	October 9

The oilseed plots were irrigated as required. Site MC received approximately 180 mm and site RF received approximately 135 mm of irrigation between May and early August. These numbers are approximations as it is difficult to measure the exact volume of water the plots receive.

At minimum, monthly visits were made to each site to record presence of species, stage of growth, plant height, and pod stage. Climate monitoring was conducted at the RF and SM sites and climate data was obtained from a local weather station for the MC site. Climate data was collected to assess the growing season and heat units at each site.

A standard area of 1 m^2 was harvested from each plot using hand trimmers and a 1 m^2 frame. Harvest was conducted from August to October based on crop maturity.

The harvested plants were put through a small seed thresher. The threshing separated the seeds from the plant stock and straw material. Further cleaning was done by a Clipper Seed Separator which separated the seed from the left over scrap material. The samples were weighed to determine yields for 2009 and then sent to Agriculture and Agri-Food Canada in Saskatoon for oil and protein content analysis. Near infra-red (NIR) technology was used to determine the percent oil and protein in the seeds.

Photo 3: Oilseed plots at McCabe Creek, June 2009

6.3 Results and discussion

The 2009 growing season was the warmest since 2004. Fewer frosts and a longer season provided optimal conditions for the oilseed trial.

Table 6.2 shows the oil and protein percentage of the four varieties at the different locations and the yield per hectare. The yield values were extrapolated from $1m^2$. The four plots with each variety were averaged. Unfortunately, some of the McCabe Creek *B. Rapa* and *L. usitatissimum* (flax) samples were lost to mice at the storage facility.

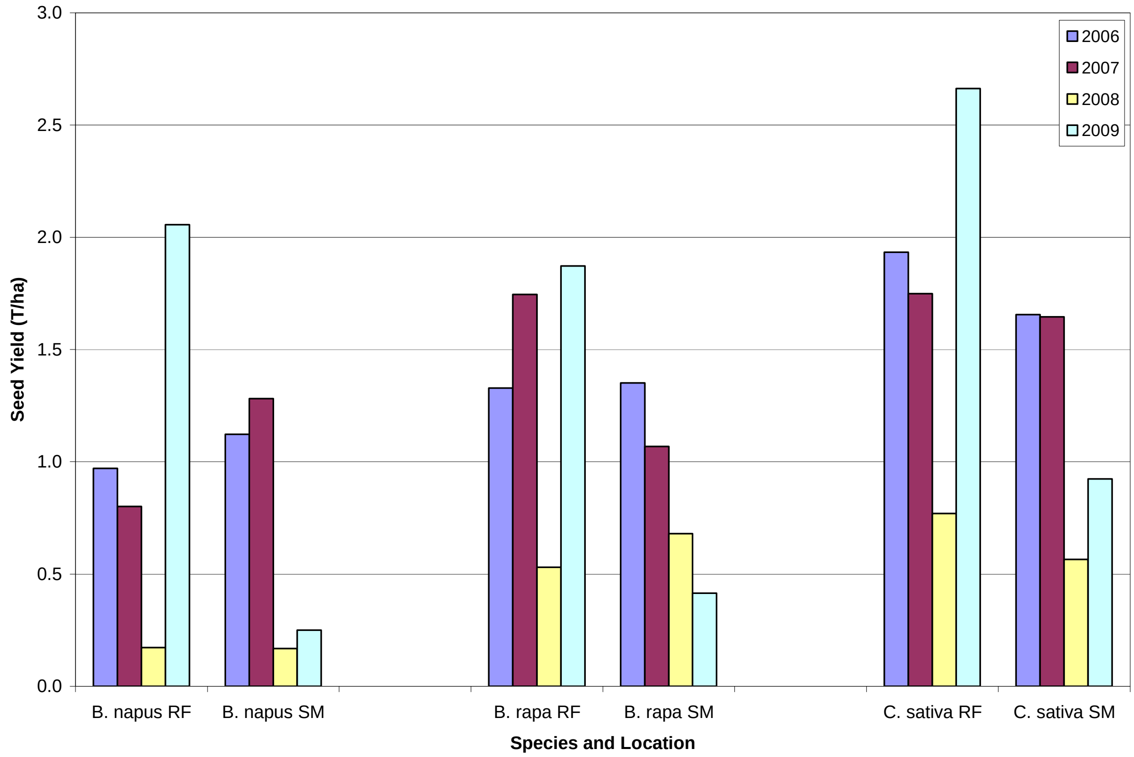
Table 6.2: 2009 Oilseed Results

	RF			SM			MC		
	Yield [1] (T/ha)	Protein (%)	Oil (%)	Yield (T/ha)	Protein (%)	Oil (%)	Yield (T/ha)	Protein (%)	Oil (%)
Camelina	2.76	21.6	47.7	0.9	27.0	41.0	1.9	22.6	45.9
Napus	2.1	21.0	49.0	0.3	23.6	47.0	0.8	18.6	52.3
Rapa	1.9	20.4	49.6	0.4	25.0	43.6	0.9*	21.0	49.5
Flax	1.4	19.6	49.6	0.6	22.8	48.2	1.7**	18.7	51.2

[1]Harvested seed weight in tonnes/hectare
*Average of three samples
** Average of two samples

The oil content averaged between 40.9 to 52.2 percent, with the *B. napus* at McCabe Creek having the highest oil content. The range for protein was 18.7 to 27 percent. Graph 6.1 shows the yield comparison for 2006 to 2009 at the different sites.

Graph 6.1: Oilseed Yield Comparison for 2006 to 2009



The 2009 season was a vast improvement from 2008 in terms of crop growth in Yukon. The 2008 growing season had been one of the coldest in the past 10 years and many of the oilseed trials were aborted. The 2009 season made up for the loss and was quite successful. Furthermore, the addition of the site at McCabe Creek in 2009 provided valuable information on growing oilseeds in central Yukon.

Yields for 2009 were comparable to those in 2006 and 2007 with the exception of the research farm which showed improved growth especially with *C. sativa*.

The *B.napus* performed well at all sites, producing between 0.13 to 3.66 T/ha of seed. Most of the numbers were well above the Canadian averages for canola yield as shown in table 6.3, with eleven samples above 2 T/ha. The *C. sativa* and *L. usitatissimum* (flax) varieties did favorably at the McCabe Creek site.

Table 6.3: Canadian Canola Yield 22-Year Average (Yield in T/ha)

Year	Ontario	Manitoba	Sask.	Alberta	British Columbia	Total Canada
1986 - 2009 Average	0.32	0.25	0.22	0.25	0.22	0.23

* updated Dec 14, 2009 (source: http://www.canola-council.org/acreageyields.aspx)

The purpose of this trial was to grow oilseeds for fuel, generating biodiesel as the final product.

After the oilseeds are harvested there are two options for getting the oil out of the seed, a chemical extraction process which is able to remove 96% of the oil or a mechanical process which is able to extract up to 85% of the oil. The chemical extraction process is more appropriate for large scale, so the data assumes an efficient mechanical extraction. The biodiesel potential in litres for the Yukon oilseed was therefore calculated at an 85% oil recovery using the percent oil content analyzed by NIR combined with the total yield per hectare. The biodiesel potential varied greatly due to the variation in yields in the different varieties and at the different sites. In other studies, a general average for canola ranges from approximately 1000 L/ha to 1350 L/ha.

Once the oil is extracted it is considered a straight vegetable oil and is suitable for burning in some converted diesel engines such as those in late-model Mercedes. The by-product of the mechanical extraction is a mash that is suitable for animal feeds. The value of the oil at this stage is approx $1.00/L and the value of the mash varies but is considered a suitable animal feed and could fetch a price of approximately $0.20/kg.

In order to convert the straight vegetable oil into biodiesel another set of steps is required. Lye and methane must be mixed with the vegetable oil. This additional process requires specific equipment, the appropriate chemicals, and time. At the end of the process one litre of straight vegetable oil equals approximately one litre of biodiesel. There are also additional by-products such as glycerine produced during the process. Once biodiesel is produced, called B100, it can be used in some engines, but more often is cut with diesel to produce lower percentage biodiesel (B20 is 20% biodiesel).

The following economics of production assessment was carried out on the *C. sativa* grown in the Whitehorse area.

Table 6.4: Yields of *C. sativa* Mash and Biodiesel 2006-2009

C. sativa	**Mash (T/ha)**	**Biodiesel (L/ha)**
2006	1.28	726.1
2007	1.07	643.1
2008	n/a	n/a
2009	1.59	1,193.0
Average	**1.31**	**854.1**

The average mash yield over three of the four years of assessment was 1.31 T/ha with the potential price for the mash estimated at $200.00/T. This mash is suitable for hog or cattle rations, but the market must be developed for these sales to occur.

The average diesel yield over the four years of assessment was 854 L/ha. The price per litre at the pumps is currently $1.10/L. The total value of the diesel per hectare would be approximately $939.40. There are a number of expenses that must be factored into this calculation.

Table 6.5: Estimated expenses of growing *C. sativa* per hectare

Ground Preparation*		$50/ha
Seed	5 kg/ha @ $8/kg	$40/ha
Seeding*		$35/ha
Fertilizer	400 kg/ha @ $600/T	$240/ha
Fertilizing*		$15/ha
Weeding/Spraying*		$50/ha
Irrigation*		$250/ha
Harvesting*		$50/ha
Total**		**$730/ha**

* Custom rates estimated from the Yukon cost of development guidelines and the 2008 Alberta Custom rates survey summary
** Does not include the cost of processing, handling, depreciation of equipment or storage.

Table 6.6: The estimated earnings per hectare for growing *Camelina sativa*

Earnings per hectare	
Income	$1,139.40
Expenses	$730.00
Earnings	**$409.40**

6.4 Conclusion

The average earnings from oilseed production per hectare are low. Excluding the poor growing season of 2008, the income generated over the other 3 years would average $1,139.40. Expenses on each farm will vary, as a general rule you might expect a net income of around $400.00 per hectare. In 2009, the production was much higher than the other years and the value per hectare and net income would be greater. If we are to experience warmer, more productive growing seasons in future, or, if the lands used to grow these crops are located in the central Yukon these results show agronomic and economic viability. It is important to note that in 2008, which was a very cold year, most of the crops were lost. Around the Whitehorse area, with the short growing seasons and low average summer temperatures, it will prove difficult to maintain a substantial income year after year from these crops.

7.0 RASPBERRY INPUT MANAGEMENT AND ECONOMICS OF PRODUCTION TRIAL

Location: Research Farm (Site RF), Whitehorse
Funding: Government of Yukon
Objective: To employ best management practices around orchard production and determine the economics of raspberry production in southcentral Yukon.

7.1 Introduction

This trial is a continuation of work initiated in 2002 in collaboration from the Pacific Agri-Food Research Centre in Summerland, B.C. A raspberry orchard was developed at the research farm to evaluate:

- different varieties of raspberries;
- economics of raspberry production;
- effects of row covers to increase production; and,
- best management practices for irrigation and fertilizing.

7.2 Materials & Methods

The raspberry orchard was planted in 2002 and took three years to produce a commercial harvest. The orchard is 30 m x 40 m, divided into 12 rows with four sections per row. Each section varies by the management of fertilizer levels, raspberry variety and the type of cover. An automatic drip irrigation system is used to deliver exact amounts of water and fertilizer. The irrigation system is controlled by a CR-10 computer system which uses data from soil moisture and evapotranspiration (ET) sensors to determine the optimum water requirements for the orchard. The irrigation system is also used to deliver fertilizer to the orchard. Soluble fertilizers were added to each of the irrigation tanks that in turn were added to the orchard through the automated system. Different levels of fertilizer were evaluated to determine the effects of fertilizer treatments on raspberry production. Fertilizer treatments were applied at a full rate based on a B.C. Ministry of Agriculture berry factsheet and at half this rate.

Each section of the orchard was planted with either Kiska or Souris and Boyne raspberries. The Kiska is an Alaskan developed variety with a medium size fruit and very tall canes. The Souris and Boyne are similar varieties of raspberries and have been grouped together in the evaluation. The Souris/Boyne is a short season southern variety of raspberry and produces a larger, firmer berry more in line with a tabletop or fresh market berry. There has been some movement of the varieties in the orchard resulting in some sections having a mixed stand of the Kiska and Souris/Boyne. The orchard has been assessed with nine sections of Kiska, 23 sections of Souris/Boyne and the remainder of the plot is mixed stands and buffer rows.

During harvest, pickers collected and weighed the berries from each section. The data was then tabulated and used to determine the effect of the fertilizer treatment, variety, and cover on raspberry yields. Further analysis of the data calculated the economics of the orchard. In economics, of production raspberry production is evaluated against input costs. The raspberry production was calculated based on the total yield for the orchard and on the average and maximum yields for each of the varieties. Value was estimated per hectare based on a combination of market price and operation setup (i.e.
U-pick versus hand harvest operations).

7.3 Results and Discussion

An assessment of the economics of production was conducted on the 2009 yields. The value per hectare was broken down into three categories:

- $3.30/kg ($1.50/lb) represents an estimated B.C. wholesale price;
- $6.60/kg ($3.00/lb) represents a B.C. roadside price and/or a Yukon U-pick price; and,
- $9.90/kg ($4.50/lb) represents a Yukon grown, fresh market price.

The estimated income per hectare was calculated with the three different price ranges minus expenses. The time and expenses noted from managing the research orchard was compared to a modified British Columbia Ministry of Agriculture berry production factsheet. The level of expenses was found to be quite different between B.C. and what was calculated for Yukon. It is important to use costs that are expected on your farm operation. The breakeven price reported in table 7.1 can be used as a starting point for cost analysis.

A pick and package product sold at whole sale prices ($3.30/kg) and at roadside prices ($6.60/kg) would create no profits, and in most cases would result in a loss to the operator. A pick and package operation would achieve profitable income selling at the premium market price of $9.90/kg, although this level of profitability was only applicable to high yielding rows.

A U-pick operation has a much greater opportunity for profit. The profit is dependant on growing high yielding Kiska, keeping expenses low and having a supply of customers willing to pick and pay $6.60/kg.

Table 7.1: Cost Analysis for Raspberry Production

	2009 Yields (kg/ha)	Value per hectare @ $3.31/kg based on estimated BC wholesale price	Value per hectare @ $6.61/kg based on estimated BC roadside sales price	Value per hectare @ $9.92/kg based on estimated Yukon market value	Break even price per kg for a pick and package operation*	Break even price per kg for a U-pick operation**
Total 2009 harvested	786	$2,598.94	$5,197.88	$7,796.83	$16.41	$8.78
Average Souris yields	605	$2,000.87	$4,001.73	$6,002.60	$21.32	$11.40
Highest yielding Souris section	1,592	$5,266.04	$10,532.08	$15,798.12	$8.10	$4.33
Average Kiska yields	1,232	$4,072.76	$8,145.53	$12,218.29	$10.47	$5.60
Highest yielding Kiska section	1,657	$5,480.33	$10,960.65	$16,440.98	$7.78	$4.16
Kiska with row cover	1,408	$4,654.79	$9,309.58	$13,964.38	$9.16	$4.90

* Projected expenses per hectare for a hand pick and package operation estimated at $12,900
** Projected expenses per hectare for a U-pick operation estimated at $6,900

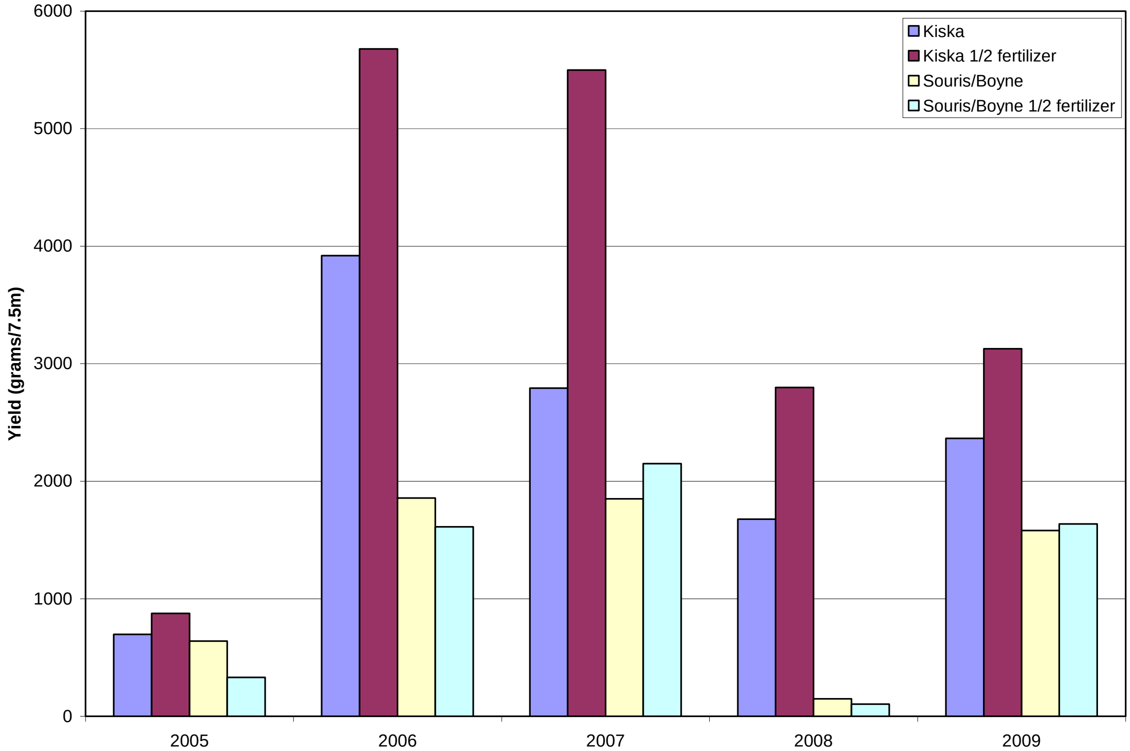
Table 7.2: Summary of total raspberry yields 2005-2009

Year	kg/ha
2005	215
2006	994
2007	1,071
2008	274
2009	786

The raspberry production in 2009 was much improved over 2008 levels (see table 7.2). The total harvest for 2009 was 786 kg/ha.

The installation of the high tunnel row cover helped promote rapid berry set and good yields for Kiska, yields were over 3,000 g/7.5m under cover. The cover did not increase yields for Souris/Boyne (data not shown).

Graph 7.1: Average yield per 7.5 metre with varieties and fertilizer rates



Fertilizer was applied based on recommendations from B.C. Ministry of Agriculture. As with previous years the yields of Kiska under half the optimum rate of fertilizer were better than the Kiska with the application of full fertilizer. The Souris and Boyne variety produced less per linear section than the Kiska with no apparent trend in the impact of fertilizer on yields.

7.4 Conclusion

Producing high yielding Kiska raspberries, using a U-pick business model, and keeping expenses low would provide an opportunity to run a profitable raspberry orchard in southcentral Yukon. The row cover had a positive effect on the Kiska raspberry production, producing berries sooner in the season and yielding close to optimum yields. The irrigation system provided the orchard with the required water and fertilizer. As with previous years a lower fertilizer rate appeared to yield better results for Kiska.


Photo 4: Raspberry orchard with the high tunnel row cover in the background