Growers of Organic Food Yukon
Yukon Legume Study 2007
Research Technician's Report

Prepared by: Cain Vangel

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Introduction

During the 2007 growing season, Growers of Organic Food Yukon (GoOFY) conducted the third season of a five year study examining legume response to soil treatments. This report is intended to present the methods and procedures of data collected from June through September and to provide the results with insights for some findings. It is not intended to interpret or to provide statistical analysis of results.

The study was designed to test the following hypothesis: Soil nutrient balance and adequate fertility are the primary limiting factors to successful legume culture in the Yukon (Gillespie, 2005).

To test the hypothesis six legume species known to grow satisfactorily in the Yukon were used in the study; five perennials including alfalfa, white clover, red clover, alsike clover and sweet clover and field peas the lone annual crop. Each of the six legumes was planted twice in a randomized block design; one block was left untreated, the other block was treated with soil amendments as per a soil audit. Nodulation scores, biomass and protein content of non-amended legumes where compared to legumes receiving soil amendments. At the end of the season soil samples were taken from each block and analyzed by Kinsey Agricultural Services, Inc. Recommendations received from Kinsey Agricultural Services, Inc will be applied next season to alfalfa (1a), red clover (2c), field peas (5f), alsike clover (6d), 9b and sweet clover (10e), the blocks that are to receive the amendments.

The following was completed by the technician during one or more of four site visits at each farm: inspecting and maintaining the plot, reseeding where necessary, applying soil amendments as recommended by Kinsey Agricultural Services Inc., weeding, trouble-shooting with the farmer, taking and drying vegetation samples, checking for root nodulation, visiting each plot after killing frost to take soil samples and make final observations, cutting all sweet clover plants that reach the bud stage, keeping a written and photographic record of all activities related to the project and all observations regarding the research plots. Crop performance was monitored throughout the season; top growth samples were cut and sent to Central Testing Laboratory Ltd. for analysis of crude protein content (see Appendix A. Crude Protein (%) Results) for charted results.

Site Description

Four sites in Yukon were included in this third year of study and were located at: (1) Grant Dowdell's Farm on the Yukon River in Dawson City; (2) Joanne Jackson-Johnson's M'Clintock Valley Farm; (3) Simone and Tom Rudge's Aurora Mountain Farm on the Takhini River Road and (4) Brian Lendrum and Susan Ross's Lendrum/Ross Farm on Lake LeBerge. M'Clintock Valley Farm, Aurora Mountain Farm and Lendrum/Ross Farm are certified organic operations.

Experimental plots were established in 2005 with overall dimensions of 15 metres by 11 metres. Each plot (one plot per farm site) consisted of 12 blocks of 3 metres by 3 metres with a 1 metre buffer separating each block.

The layout as described above for the previous two years of study was used until the third site visit of the 2007 growing season. After consulting with GoOFY, the technician resized each block at each site with exception of Lendrum/Ross Farm to 2 metres by 2 metres to reduce the amount of time required to hand weed the entire plot at each location.

Procedures and Methods

Visit One

The first visit to each farm site involved inspecting plots, reseeding where necessary, weeding all walkways between blocks, assessing survival of legumes in each block, consulting with farmer and applying soil amendments. Each block per plot was photographed to provide a visual record of area progress (see Appendix E. Photographs: Visit One).

Procedures

All blocks with the target species emerging were hand weeded, carefully removing all competing weeds. Blocks showing none or very little legume growth were reseeded with the desired legume species and oats (used as a nurse crop). As field peas are an annual they were replanted at all four sites.

Blocks with none or very little legume growth were tilled and reseeded according to the Yukon Legume Study protocol, with the exception of the field peas as a precision garden seeder tool was not available. To reseed the field peas, furrows were hand dug 20 cetimetres apart and broadcast seeded with the seeds falling into the furrows and creating rows. Ideally, alternating plantings of peas with fava beans was to occur during the course of the five year study; at the time of planting an alternative source of suitable seed was not available and field peas were sown.

Walkways were kept clear through the growing season and not planted to any cover crop as this did not appear to be effective in the previous two years of study as reported in the GoOFY Legume Study 2006 Technician's Report. Weeding the walkways was accomplished through the use of a sharpened shovel to cut the weeds and lift the sod that was growing and overtaking the walkways.

Results from last year indicated requirements of the plants were slightly different as was the soil analysis results for each plot. To achieve the fertilizing protocol for the 2007 growing season the soil analysis at each plot was averaged to give a per site fertilizer

rate (Ball, 2007). The total area of treated blocks per plot was 54 square metres. Soil amendments based on Kinsey Agricultural Services, Inc. recommendations were applied at each site to blocks 1a, 2c, 5f, 6d, 9b and 10e (see Table 1). Amendments were weighed, combined and divided into six equal bags; each bag was broadcast over the required block using a hand spreader.

Table 1. Soil Amendments applied as recommended by Kinsey Agricultural Services, Inc. for 2007 legume study.

Grant Dowdell's Farm	
0.06 kg	Elemental Sulphur
1.1 kg	Rock Phosphate
1.8 kg	Potassium Sulfate
0.03 kg	Borax
0.3 kg	Iron Sulfate
M'Clintock Valley Farm	
0.15 kg	Elemental Sulphur
1.1 kg	Rock Phosphate
1.8 kg	Potassium Sulfate
Aurora Mountain Farm	
0.15 kg	Elemental Sulphur
1.1 kg	Rock Phospate
1.8 kg	Potassium Sulfate
Lendrum/Ross Farm	
0.4 kg	Elemental Sulphur
3 kg	Rock Phosphate
12 kg	Calcium Carbonate
1 kg	Potassium Sulfate
0.12 kg	Borax
0.05 kg	Copper Sulfate
0.1 kg	Zinc Sulfate

Visit Two

The second visit to each site involved inspecting plots, weeding, maintaining walkways and assessing vegetation growth. Vegetation growth assessments were conducted and recorded. Each block per plot was photographed to provide a visual record of area progress (see Appendix F. Photographs: Visit Two).

Procedure for Vegetation Growth Assessment

Foliar Cover: To obtain percent of foliar cover a visual assessment of crop growth in each block was completed and the percentage of area of crop, bare ground and weed cover was recorded to equal 100 percent.

Height Assessment: To obtain height assessment an average of ten measurements were taken at each block; ten plants were each measured from soil level to the uppermost stem growth and recorded.

Stage of Growth: To obtain stage of growth a visual inspection of each block was completed and the percentage of leaf, bud, flower, green seed and mature seed was determined and recorded to equal 100 percent.

Visual assessment of crop growth included qualitative notes such as noticeable weeds, plant or soil disease, rodent or wildlife incidence, uniformity of growth and other notable findings, if any.

Visit Three

The third visit to each site involved inspecting plots, weeding, maintaining walkways and assessing vegetation growth and legume root nodulation and collecting vegetation samples for biomass assessment. Vegetation growth assessments were conducted and recorded according to Procedure for Vegetation Growth Assessment as outlined under heading Visit Two above. Root nodulation assessments were conducted and recorded (see Appendix D. Root Nodulations Scores) for results and vegetation for biomass assessment was collected (see Appendix C. Biomass Assessment Analysis) for results. Each block per plot was photographed to provide a visual record of area progress (see Appendix G. Photographs: Visit Three).

After an unreasonable amount of technician time was spent hand weeding the 3 metre by 3 metre blocks during the first and second visit, each block was reduced in size to 2 metres by 2 metres. This involved measuring and re-staking the blocks to the new size. In resizing the blocks, an effort was made to incorporate the best established portion of the old block within the new boundary.

The Lendrum/Ross Farm site was not resized on this or any subsequent visit due to this plot being newly established and the nature of the irrigation system in place. After discussion with the farmer, the blocks were left at 3 metres by 3 metres at least until the first visit in the 2008 growing season when resizing of the blocks may be reconsidered.

Procedure for Root Nodule Assessment

Root nodulation was based on the field assessment criteria established by W.A. Rice (1977). Nodulation was scored by evaluating the colour of nodules, number of nodules per plant, position of nodules and size of nodules. Table 2. shows nodule characteristics, criteria and score.

Four plants including complete rooting systems and top growth were randomly selected, dug up from each block and assessed. Plants were soaked in water to loosen soil from the roots. Nodules were counted on each plant and measured. Position was determined by assessing the ratio of nodules within 5 cm of the crown to the remaining nodules and nodules were cut open to determine colour.

Table 2. Root Nodulation Characteristics and Scores

Nodule Characteristics	Criteria	Score
Colour	90 to 100 % pink	4
	70 to 89 % pink	3
	50 to 69 % pink	2
	30 to 49 % pink	1
	0 to 29 % pink	0
Number per plant	5 to 20/plant	3
	>20/plant	2
	1 to 5/plant	1
	None	0
Position within 5cm of crown	60 to 100 % crown	2
	20 to 59 % crown	1
	0 to 19 % crown	0
Size	3 to 10 mm diam	1
	<3 mm diam	0
	>10 mm diam	0

Procedure for Vegetation Biomass Assessment and Crude Protein Content

The preferred timing of harvest is around 10 to 20% bloom. A 50 cm by 50 cm sampling square was randomly placed near centre of each block. In this square all vegetation was cut at 6 cm to 8 cm from ground level. All weeds were removed from the crop of interest. Each sample was placed in its own paper bag and labeled with the following information: GoOFY Legume Study, date, location, crop and block number. Bags containing samples were left open to prevent from molding and brought to the Yukon Agriculture Branch vegetation oven to dry. After drying, samples were weighed and a portion (minimum of 50 grams) was packaged and shipped to Central Testing Laboratory Ltd for crude protein analysis.

Visit Four

The fourth visit to each site occurred after killing frost and involved inspecting plots, final weeding, clearing walkways and collecting soil samples. Seed samples were not collected as no dry seed was observed. Each block per plot was photographed to provide a visual record of area progress (see Appendix D. Photographs: Visit Four).

A soil sampling probe was used to collect soil samples to a depth of 15 cm. Twelve soil cores were collected per block; consisting of four cores per row by three rows and evenly spaced throughout the block (see Appendix J. Soil Sample Collection Sites). The 12 soil cores collected per block were combined to form one sample, placed in a labeled plastic bag and shipped to Kinsey Agricultural Services Inc. for analysis.

Sweet Clover Control

This year there was a requirement to cut all sweet clover when it reached the bud stage to prevent plants from setting seed. Sweet clover control in blocks 3e and 10e was required at the second, third and fourth visit to Dowdell's Farm. Sweet clover control at M'Clintock Valley Farm occurred in block 10e in mid July between the second and third visit. Sweet clover control at the Lendrum/Ross Farm occurred in blocks 3e and 10e on August 23, 2007.

The sweet clover was cut as close to the ground as possible and in all but the first cutting at the Dowdell Farm was left were it fell on the block. The first cutting at the Dowdell Farm was exceptionally bulky, raked off the block and removed from the plot after cutting.

Farmer Data Records

Farmer data (see Appendix I. Farmers' Data Records) was received for the Dowdell Farm; Lendrum/Ross Farm and M'Clintock Valley Farm. Aurora Mountain Farm reported data was being collected via a weather station located on their property and operated by the Yukon Agriculture Branch. Varied information was collected by each farmer including approximate rainfall, site visits by technician, wildlife incident and other worthy observations.

Observations and Results for Site Conditions

Soil Temperature

Soil temperature was recorded in all blocks during visit two and three at each plot and during visits one at the Dowdell Farm and M'Clintock Valley Farm (see Appendix K. Technician Data Sheets) for results.

Moisture Depth

Although soil moisture depths were not recorded some general observations and possible influences on moisture depth are worth noting; Grant Dowdell's Farm consistently showed moisture at the soil surface. A drip tube irrigation system was set-up in the plot at the Lendrum/Ross Farm on July 2, 2007. As reported by the farmer the drip tubes ran east to west, each one crossing four blocks with five tubes per block making a total of fifteen tubes. The land slopes down from east to west, so it is probable the blocks on the west side received more water than the blocks on the east.

First Visit and Reseeding

As field peas are an annual crop, field peas were reseeded in all plots in both amended (5f) and non-amended (12f) blocks. For all other blocks if very few or no plants were observed reseeding occurred. At the Dowdell Farm the farmer was consulted for his opinion and a decision was made based on discussion and careful examination of the plot. It was found many tiny white clover plants were emerging under the mat of vegetation from the previous year's growth. Besides field peas no other crop was replanted on the Dowdell Farm. At the Lendrum/Ross Farm each block within the plot except alfalfa (non-amended:7a) was reseeded. In addition to field peas, four test crops were reseeded at Aurora Mountain Farm: sweet clover (amended:10e), sweet clover (non-amended:3e), white clover (amended:9b) and white clover (non-amended:4b). Along with field peas, sweet clover (non-amended:3e) was the only block to be reseeded at M'Clintock Valley Farm. The technician was unable to determine why there were very few to no plants present in the blocks that were reseeded; possibly due to poor establishment from the previous season.

Observations and Results for Crop Performance

Dowdell Farm

At the Dowdell Farm the average percent weed cover was thicker in non-amended blocks when compared to amended blocks; Figure 1. illustrates this consistent trend established over the growing season. Figure 2. shows two small alsike clover plants in non-amended block 8d in a tangle of weeds and pictured with a screwdriver to put in perspective the relative size of plants, numerous weeds and block dimension.

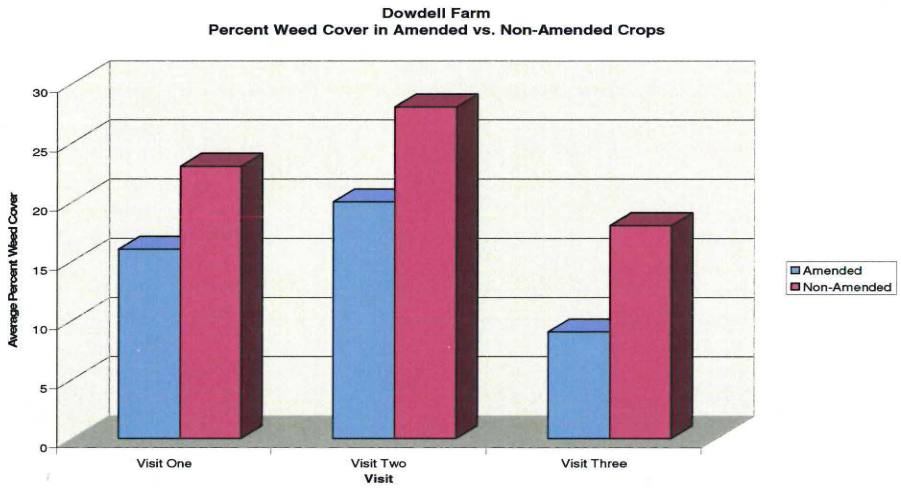


Figure 1. Graphic showing percent weed cover in amended vs. non-amended crops during visit one; visit two and visit three at the Dowdell Farm.

Figure 2. Visit one at the Dowdell Farm: Block 8d – finding alsike clover in a tangle of weeds. A screwdriver pictured in the red box to the right; the screwdriver in the same place as seen in the picture to the left to show the magnitude of weeds in comparison to the small plants and block size.

During the second and third visit nine and ten height measurements were taken respectively. Average heights for all amended blocks except alfalfa (1a) and field peas (5f) were greater than average heights for corresponding non-amended blocks. Figure 3. illustrates average height in amended vs. non-amended crops at visit two. Figure 4. illustrates average height in amended vs. non-amended crops at visit three.

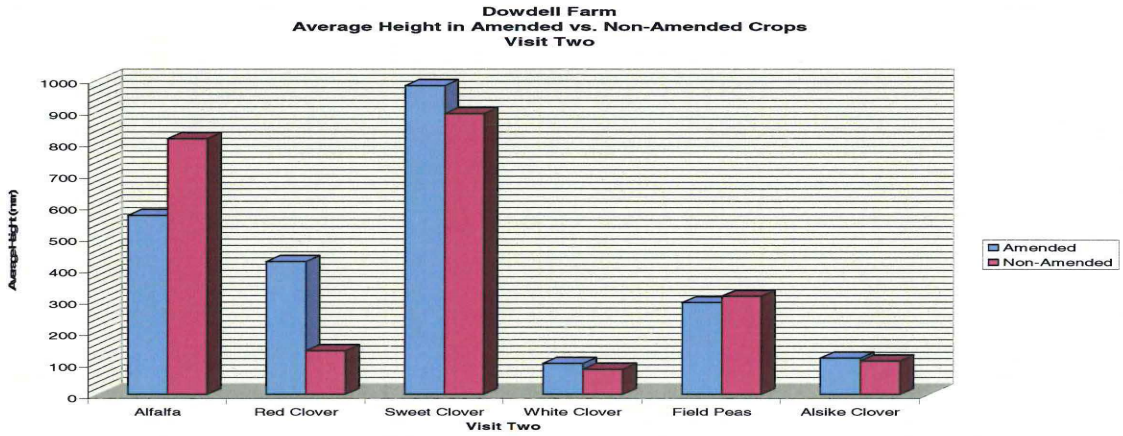


Figure 3. Graphic showing average height in amended vs. non-amended crops during visit two at the Dowdell Farm.

Alfalfa (1a) and field peas (5f) growth may have been influenced due to the position of their blocks at the top of the hill relative to their non-amended counterparts. Measurements for both white clover (amended:9b) and (non-amended:4b) averaged the same height during visit three, but white clover (non-amended:4b) showed a combined total of flower and green seed production of 90 percent compared to 50 percent on the white clover (amended:9b) block.

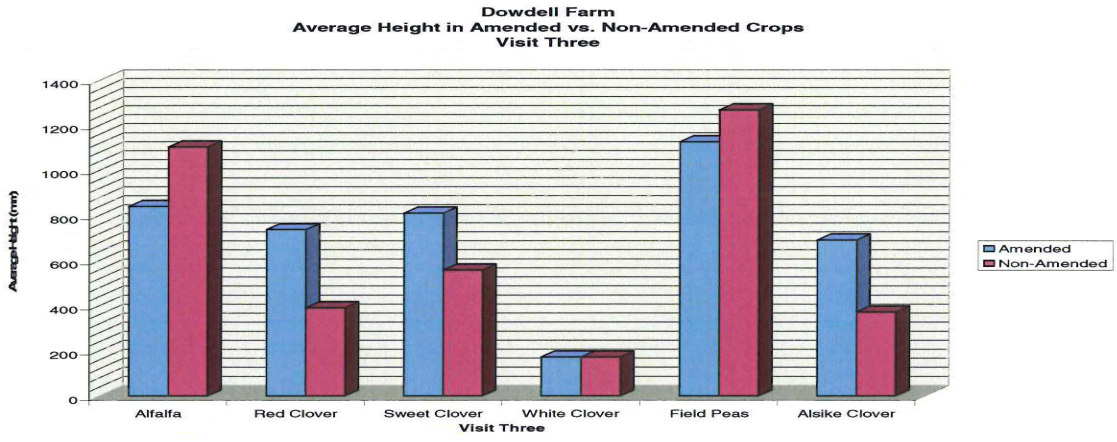


Figure 4. Graphic showing average height in amended vs. non-amended crops during visit three at the Dowdell Farm.

Crop cover ranged from 60 to 100 percent on the third visit. The white clover (amended:9b) crop reached 60 percent cover and red clover (amended:2c), alsike clover (amended:6d) and alfalfa (non-amended:7a) crops all reached 100 percent cover.

On visit two crop cover for sweet clover (amended:10e) and (non-amended:3e) was 55 and 40 percent respectively, flowering and cut at this time. At visit two crop cover for sweet clover both (amended:10e) and (non-amended:3e) reached 85 percent, was flowering and cut at this time. By the third visit the sweet clover crop cover (amended:10e) and (non-amended:3e) reached 90 and 75 percent respectively, was flowering and cut at this time.

Lendrum/Ross Farm

During the second and third visit nine and ten height measurements were taken respectively. Average heights for all non-amended blocks except red clover (amended:2c) on the second visit and white clover (amended:9b) on the third visit were greater than average heights for corresponding amended blocks. Figure 5. graphically illustrates average heights in amended vs. non-amended crops during visit two at the Lendrum/Ross Farm. Figure 6. graphically shows average heights in amended vs. non-amended blocks during visit three to the Lendrum/Ross Farm.

At this plot, non-amended blocks are situated at the bottom of the slope. It is possible soil at the bottom of the hill may be healthier compared to the soil at the top of the hill where the amended blocks are situated and it is likely due to the sloping nature of the plot, blocks of the bottom are receiving increased moisture from the irrigation system. Figure 7 pictures the irrigation system and plot layout as described.

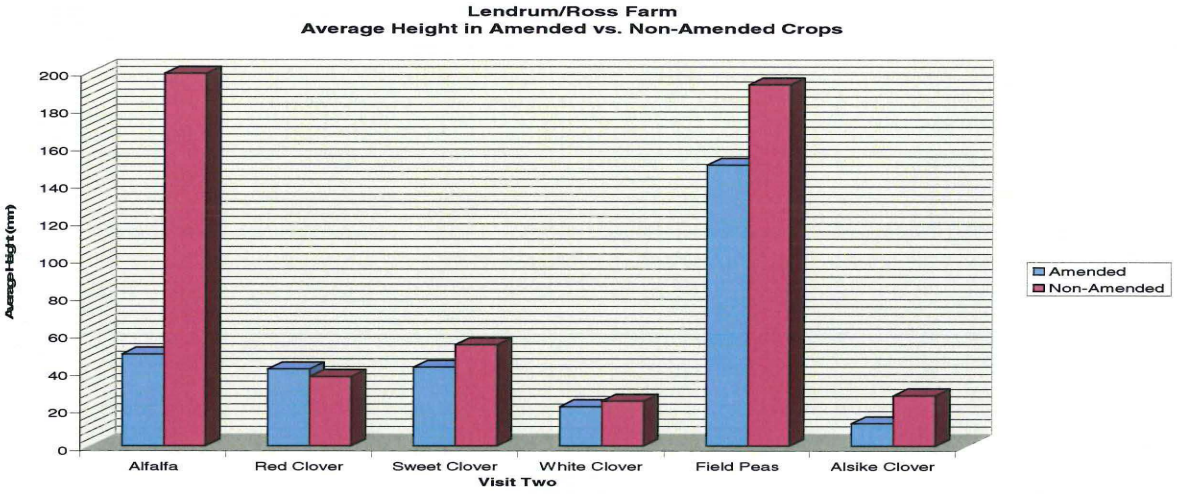


Figure 5. Graphic illustrating average height in amended vs. non-amended crops during visit two at the Lendrum/Ross Farm.

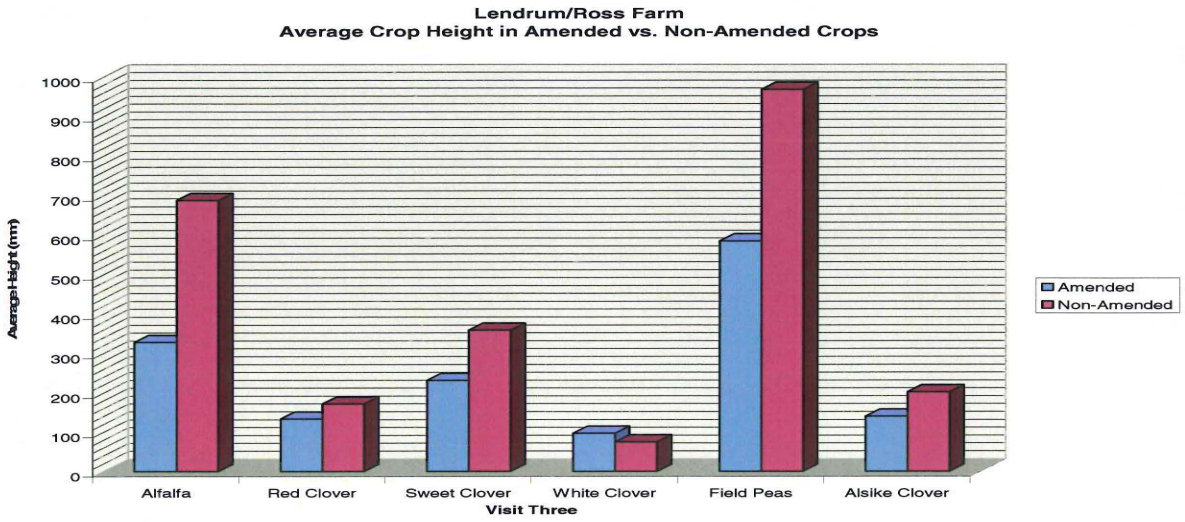


Figure 6. Graphic illustrating average height in amended vs. non-amended crops during visit three at the Lendrum/Ross Farm.

Figure 7. At the Lendrum/Ross Farm plot showing drip irrigation tubing as well as slope in land.

At the Lendrum/Ross Farm crop cover ranged from 75 to 100 percent. By the third visit the alfalfa (non-amended:7a) crop showed the least cover at 75 percent; this was the only block in this plot that was not reseeded. Approximately three to seven alfalfa plants per square metre were observed during the first visit. Figure 8. pictures small alfalfa (non-amended:7a) plants in the centre block at the Lendrum/Ross Farm. Observing this crop reach 75 percent cover was impressive based on the low plant density. The field peas (non-amended:12f) was the only crop to reach 100 percent cover. It is important to note all blocks at this plot except for alfalfa (7a) was reseeded this year and became well established probably due to irrigation and gopher control by the participating farmer.

Figure 8. Small alfalfa plants observed in block 7a on visit one at Lendrum/Ross Farm.

Aurora Mountain Farm

Ten measurements were taken at each of the second and third visit. Average heights for red clover (non-amended:11c) and sweet clover (non-amended:3e) were greater compared to red clover (amended:2c) and sweet clover (amended:10e). All other amended blocks had greater average heights compared to non-amended blocks. The same pattern was recognized during visit two and three. Figure 9. and Figure 10. graphically illustrates average heights in amended vs. non-amended blocks.

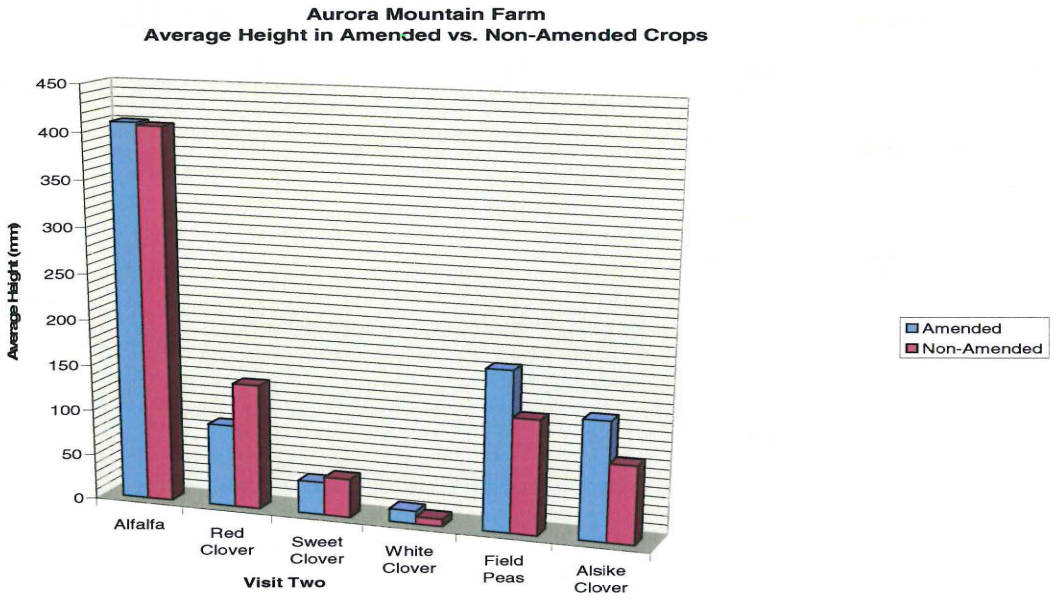


Figure 9. Graphic illustrating average height in amended vs. non-amended crops during visit two at Aurora Mountain Farm.

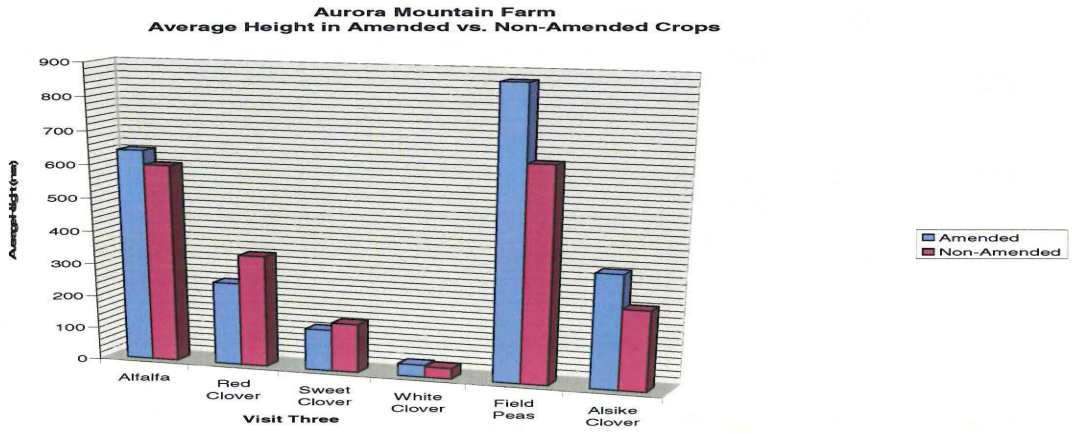


Figure 10. Graphic illustrating average height in amended vs. non-amended crops during visit three at Aurora Mountain Farm.

On the third visit crop cover ranged from a low 45 percent to a high 90 percent. White clover (amended:9b) showed the least crop cover at 45 percent and field peas (amended:5f) showed the greatest cover at this plot. Based on observations and overall performance, amended and non-amended blocks appear to be similar in characteristic. All reseeded blocks, except field peas (5f) and (12f) showed poor establishment.

Gopher activity was apparent as indicated by gopher holes found within the plot and possibly influenced crop cover as holes and/or excavated soil was within some of the blocks. Whole plants did not appear to have been grazed although flowers in blocks of alfalfa (amended 1a), red clover (amended:2c) and red clover (non-amended:11c) appeared to have been removed; whether this was caused by gopher activity or some other phenomenon is unclear.

The third visit showed a difference between amended (5f) and non-amended (12f) field peas; non-amended (12f) field peas were yellowing possibly due to frost damage and no longer actively growing compared to field peas (amended:5f), which appeared more alive and green. Figure 11. pictures field peas (amended:5f) and field peas (non-amended:12f) to show differences in the crops after a suspected light frost.

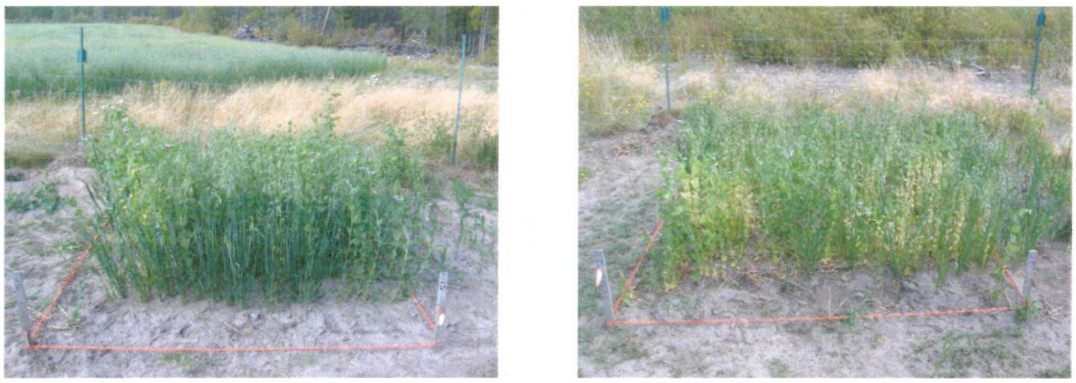


Figure 11. Comparing blocks 5f and 12f after suspected frost at Aurora Mountain Farm.

M'Clintock Valley Farm

On the first visit sweet clover (non-amended:3e) showed 50 percent cover in horsetails and was reseeded. On the third visit crop cover ranged from a low 25 percent for sweet clover (non-amended:3e) and alfalfa (non-amended:7a) to a high 90 percent for field peas (amended:5f). During the second and third visit nine and ten height measurements were taken respectively. Average heights for all amended blocks were greater than corresponding non-amended blocks. Figure 12. and Figure 13. graphically illustrates average heights in amended vs. non-amended blocks.

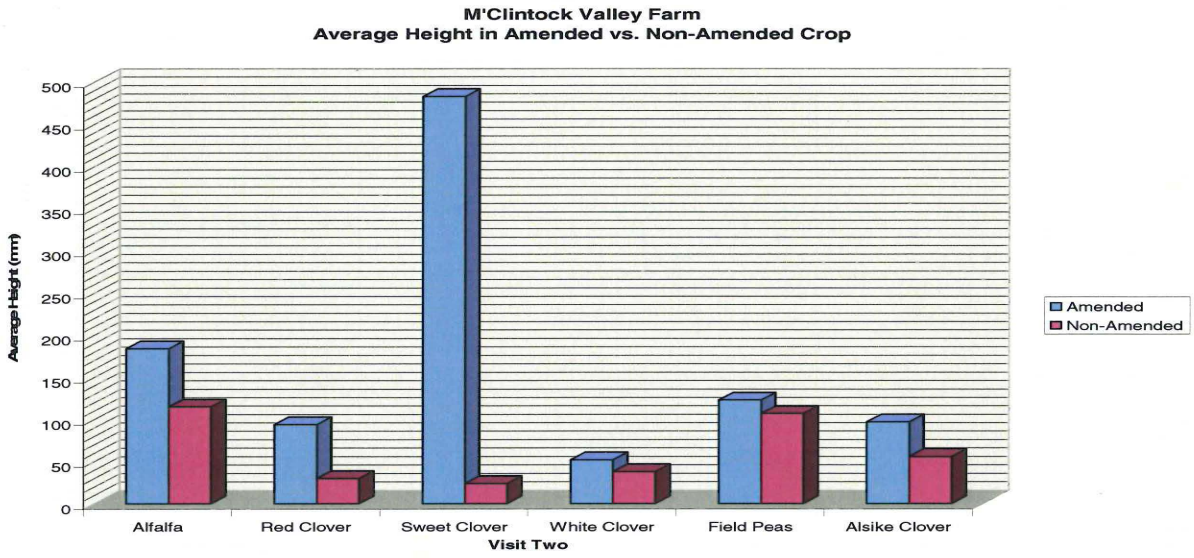


Figure 12. Graphic illustrating average height in amended vs. non-amended crops during visit two at M'Clintock Valley Farm.

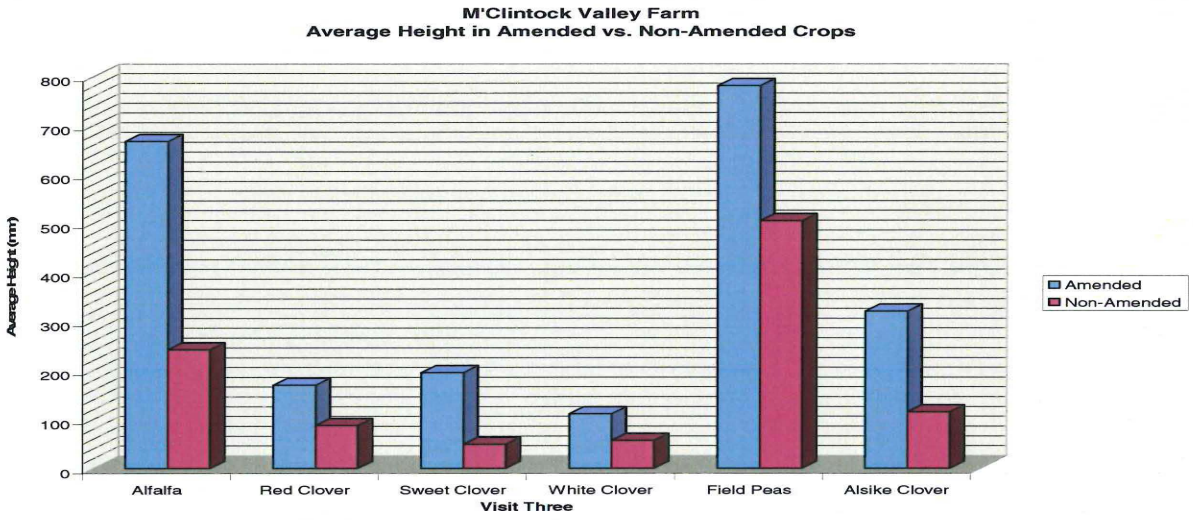


Figure 13. Graphic illustrating average height in amended vs. non-amended crops during visit two at M'Clintock Valley Farm.

In all aspects most amended blocks at M'Clintock Valley Farm consistently appeared to perform better than non-amended blocks. Figure 14 pictures field peas (amended:5f) compared to field peas (non-amended:12f) after a suspected light frost. It appears the amended field peas remained greener and more erect than the non-amended field peas after the suspected frost.

Figure 14. Comparing blocks 5f and 12f after suspected frost at M'Clintock Valley Farm.

Stage of Crop Maturity

A percentage of all plants in all blocks matured to green seed at the Dowdell Farm. A percentage of alsike clover matured to green seed at Aurora Mountain Farm and M'Clintock Valley Farm. No plant matured to green seed at Lendrum/Ross Farm possibly because all but non-amended alfalfa was newly established this year. No dry seed was observed at any site.

Crude Protein Content and Biomass

An effective measure of crop success and suitability as a green manure is the measure of crude protein content and biomass; each measured from the top growth of the plant. Where top growth was plentiful a sample was sent to the lab for analysis. A comparison for crude protein and biomass between amended and non-amended blocks in each plot is visually featured in the graphs provided (see Appendix B. Crude Protein Content Analysis and Appendix C. Biomass Assessment Analysis). All samples were measured in grams and adjusted to reflect a one metre square area.

Dowdell Farm

At the Dowdell Farm the alfalfa (non-amended:7a) crop showed more than two times greater crude protein production per square metre when compared to the alfalfa (amended:1a) crop. All other amended blocks including red clover (2c), sweet clover (10e), white clover (9b), field peas (5f) and alsike clover (6d) had greater crude protein production per square metre when compared to corresponding non-amended blocks.

Alfalfa (non-amended:7a) produced three times greater biomass than alfalfa (amended:1a) per square metre. White clover (non-amended:4b) and field peas (non-amended:12f) produced more biomass when compared to corresponding amended crops of white clover (9b) and field peas (5f). All other amended blocks including red clover (2c), sweet clover (10e) and alsike clover (6d) produced more biomass per square metre than corresponding non-amended blocks.

Lendrum/Ross Farm

Each of alfalfa (non-amended:7a) and field peas (non-amended:12f) showed greater crude protein content and biomass when compared to corresponding amended blocks. All other amended blocks including red clover (2c), sweet clover (10e), white clover (9b) and alsike clover (6d) showed greater crude protein content and biomass when compared to corresponding non-amended blocks.

Aurora Mountain Farm

Aurora Mountain Farm crops of white clover (amended:9b) and (non-amended:4b) did not grow to merit a sample cutting for either crude protein content analysis or biomass. The sweet clover (non-amended:3e) crop did not grow to merit a sample cutting for crude protein analysis. Alfalfa (non-amended;7a) had a greater crude protein content than alfalfa (amended:1a). All other amended blocks including red clover (2c), sweet clover (10e), field peas (5f) and alsike clover (6d) showed a greater crude protein content when compared to corresponding non-amended blocks.

Sweet clover (non-amended:3e) had a slightly greater biomass than sweet clover (amended:10e). All other amended blocks including alfalfa (1a), red clover (2c), field peas (5f) and alsike clover (6d) had a greater biomass when compared to corresponding non-amended blocks.

M'Clintock Valley Farm

Crop growth on all non-amended blocks except field peas (12f) was insufficient to merit a sample cutting to be sent to the lab for crude protein content analysis. Consequently, all amended blocks including field peas, of which a sample was analyzed for protein content, outperformed all corresponding non-amended blocks. Each amended block provided a greater biomass when compared to its corresponding non-amended block.

Root Nodulation Scores

In theory, root nodulation scores reflect crop ability to fix environmental nitrogen; higher scores indicate greater nitrogen fixation. A comparison of root nodulation scores between amended and non-amended blocks of the same crop may indicate if amendments are improving crop ability to fix nitrogen (see Appendix D. Root Nodulation Scores) for a graphic comparison of data provided for each plot.

Dowdell Farm

Overall root nodulation scores ranged from three to eight. Average scores for amended blocks compared to non-amended blocks ranged from 5.5 to 6.75 (amended) and 4.75 to 6 (non-amended) respectively. All amended blocks showed a higher average score when compared to corresponding non-amended blocks.

Lendrum/Ross Farm

Overall root nodulation scores ranged from zero to ten. Average scores for amended blocks compared to non-amended blocks ranged from 0 to 2 (amended) and 1.25 to 7.5 (non-amended) respectively. All non-amended blocks showed higher average scores when compared to corresponding amended blocks. Sweet clover (amended:10e) was the only amended crop at this plot to register a score greater than zero.

Aurora Mountain Farm

Overall root nodulation scores ranged from zero to ten. Average scores for amended blocks compared to non-amended blocks ranged from 0 to 5.25 (amended) and 0 to 7.25 (non-amended) respectively. Average scores for alfalfa (amended:1a), red clover (amended:2c) and sweet clover (amended:10e) were higher than corresponding non-amended blocks. Average scores for each of white clover (amended:9b) and (non-amended:4b) was zero and field peas (amended:5f). Field peas (non-amended:12f) showed a higher average score when compared to field peas (amended:5f). Alsike clover (non-amended:8d) showed the greatest range from zero to ten and showed a higher average score compared to alsike clover (amended:6d).

M'Clintock Valley Farm

Overall root nodulation scores ranged from zero to nine. Average scores for amended blocks compared to non-amended blocks ranged from 5.5 to 6.75 (amended) and 0 to 7 (non-amended) respectively. Sweet clover (non-amended:3e) had the lowest average score at zero and sweet clover (amended:10e) had the highest average score at 6.75. Amended blocks including alfalfa (1a), red clover (2c), sweet clover (10e) and field peas (5f) showed higher average scores than corresponding non-amended blocks. White clover (non-amended:4b) and alsike clover (non-amended:8d) showed higher average scores than corresponding amended blocks.

Soil Samples

For all blocks at each plot soil samples were collected and analyzed for nitrogen, sulfate, phosphates, calcium, magnesium, potassium, sodium, boron, iron, manganese, copper and zinc. Based on their analysis Kinsey Agricultural Service, Inc. will provide recommendations for amendments to be added in year four of the Yukon Legume Study. Recommendations from Kinsey Agricultural Services, Inc. for the next growing season are pending; results will be incorporated as an addendum to this report as soon as they become available.

Discussion

It is important to note the above observations and results were collected and provided for year three of a five study and are not compared to the previous two years of study. Consequently, the data provided may be too limited to permit rigorous analysis during this point in time in the study and may not stand alone. Therefore, it is worthwhile to note a speculative discussion outlining some possible explanation of results will ensue.

Location

A general observation to note is the Dowdell Farm had the earliest growth and appeared to outperform all other plots; most likely due to the location of the farm being nearer to Dawson and the nature of the climate in the Dawson area compared to the other three farms located in the Whitehorse area.

Influence of Plot Layout and Irrigation

At the Dowdell Farm and Lendrum/Ross Farm the plot is positioned on a slope with blocks 1a, 5f and 9b located at the top of the slope. These amended blocks generally did not perform as well as their non-amended counterparts, possibly due to differences in soil quality and moisture availability between such blocks. M'Clintock Valley Farm and Aurora Mountain Farm plots appeared to be on level ground and not effected by sloping terrain. Of the three Whitehorse area plots the only one that seemed to perform well with all blocks reaching near 100 percent cover was the Lendrum/Ross plot, quite possibly due to consistent irrigation.

Sweet Clover

It is possible the routine cutting of sweet clover does not allow for a true comparison between the other legumes that were not cut. It is interesting to note, despite being cut

to the ground monthly, sweet clover showed an ability to regenerate and produce flowers consistently after repeated cuttings. It should also be noted by removing the canopy of sweet clover this allowed the establishment of more weeds and as a result created more weeding on the part of the technician. After each subsequent cutting the quality of the sweet clover stand decreased as evidenced by crop height. Figure 15. pictures the sweet clover (amended:10e) crop portraying crop height at each visit. It would be interesting to note if late season cuttings influence winter survival.

Figure 15. At the Dowdell Farm block 10e – amended sweet clover crop showing crop height at visit one (top left); visit two (top right); visit three (bottom left) and visit four (bottom right).

Wildlife Incident

Moose tracks were observed at the first visit at the Dowdell Farm and M'Clintock Valley Farm. At each site it looked like a moose walked through the plot without grazing as it was early in the season prior to much plant growth, if any at all.

Gopher activity was evident at the Lendrum/Ross Farm and Aurora Mountain Farm. During the first visit at the Lendrum/Ross Farm it was clear gophers had grazed some of the emerging alfalfa plants. Different strategies to control gopher activity within the plots were attempted at each farm. At the Lendrum/Ross Farm a small mesh fence was

skirted around the perimeter of the existing fence. As the farmers observed gopher activity within the fence an effort was made to locate and block the point of entry and live-trap and re-locate the gopher outside the fenced area. This strategy appeared to be effective.

At the Aurora Mountain Farm several sound emitting devises were used to deter gopher activity within the plot. This method seemed to deter gophers from grazing legumes, but did not prevent gophers from burrowing in and around the plot. After identifying gophers were not staying out of the plot, part way through the season an attempt was made by the farmers to skirt the perimeter fence with chicken wire as was done at the Lendrum/Ross Farm.

There was no evidence of any gopher activity at the Dowdell Farm or M'Clintock Valley Farm.

Conclusion

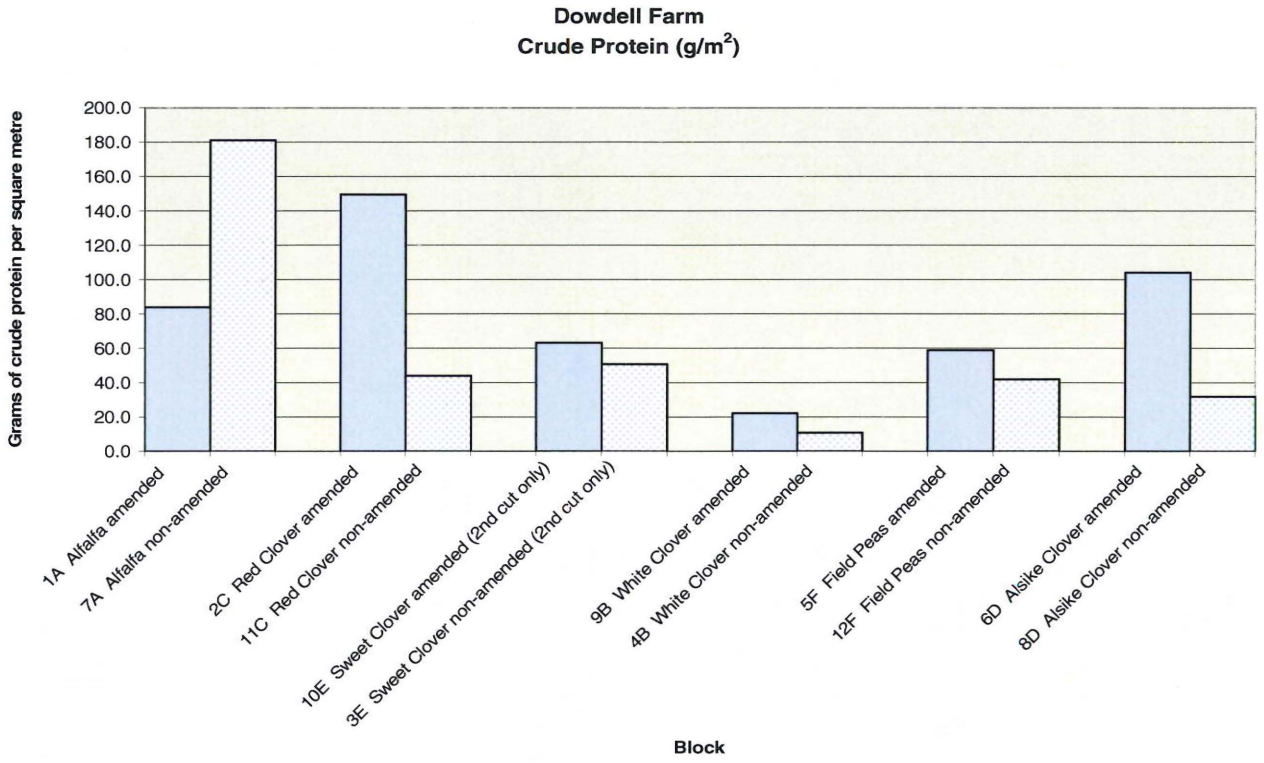
In conclusion, this report provides data collected for year three of a five year study. Based on current observations and results alone, it appears data varies within the same plot and between plots; however, it is not within the scope of this report to conclude at this point in the study whether soil nutrient balance and adequate fertility are the primary limiting factors to successful legume culture in the Yukon.

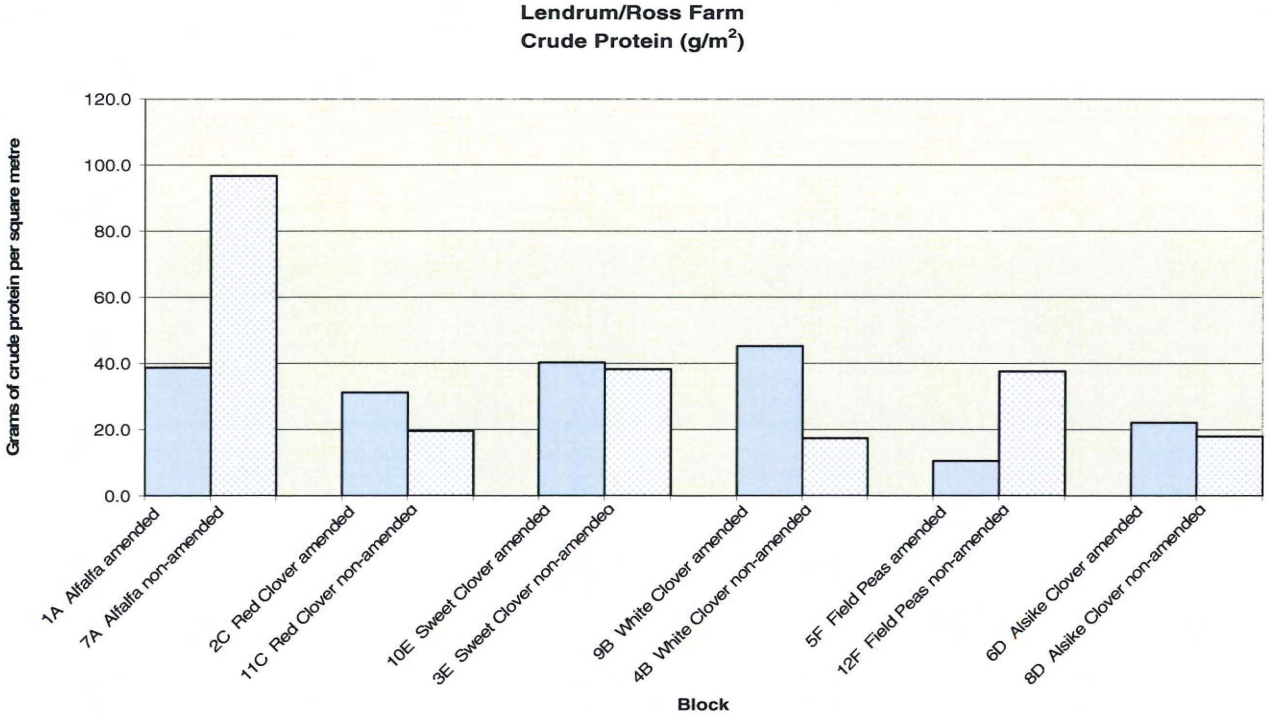
APPENDIXES

APPENDIX A. CRUDE PROTEIN (%) RESULTS

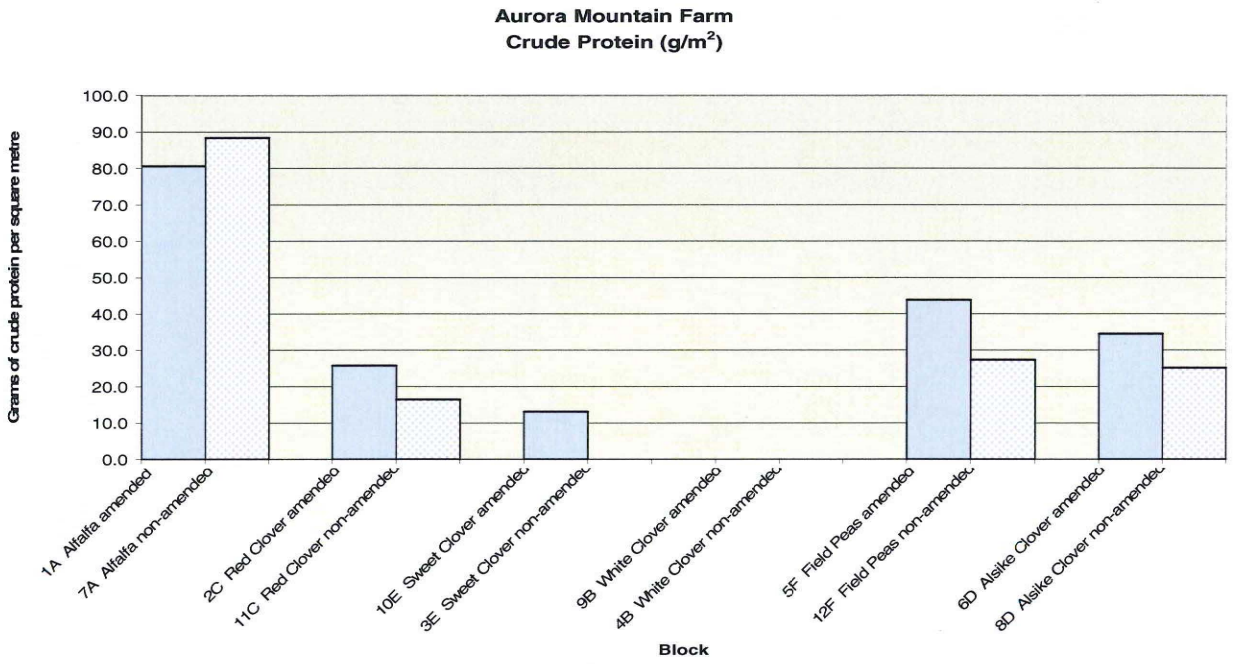
Plot	Farm	Moisture as received (%)	Dry Matter (%)	Crude protein as received (%)	Crude protein of dry matter (%)	Crop weight per m2 (g)	Protein per m2 (g)
1A Alfalfa amended	JJJ	6.44	93.56	13.95	14.91	280	39.06
7A Alfalfa non-amended	JJJ	Not enough sample to send to lab				32.8	n/a
2C Red Clover amended	JJJ	7.48	92.52	19.63	21.22	120.4	23.64
11C Red Clover non-amended	JJJ	Not enough sample to send to lab				39.2	n/a
10E Sweet Clover amended (1st cut)	JJJ	4.17	95.83	15.86	16.55	375	59.47
10E Sweet Clover amended (2nd cut)	JJJ	12.28	87.72	24.14	25.52	91.2	20.42
3E Sweet Clover non-amended	JJJ	Not enough sample to send to lab				19.6	n/a
9B White Clover amended	JJJ	16.58	83.42	15.98	19.16	146	23.34
4B White Clover non-amended	JJJ	Not enough sample to send to lab				39.6	n/a
5F Field Peas amended	JJJ	7.97	92.03	16.56	17.99	344	56.95
12F Field Peas non-amended	JJJ	11.78	88.22	14.33	16.24	202	28.94
6D Alsike Clover amended	JJJ	13.54	86.46	13.47	15.58	322.8	43.48
8D Alsike Clover non-amended	JJJ	Not enough sample to send to lab				34	n/a
1A Alfalfa amended	rudge	7.44	92.56	13.66	14.76	590	80.60
7A Alfalfa non-amended	rudge	7.13	92.87	15.17	16.33	582.8	88.39
2C Red Clover amended	rudge	8.23	91.77	10.75	11.71	240.4	25.83
11C Red Clover non-amended	rudge	8.05	91.95	11.84	12.88	139.6	16.53
10E Sweet Clover amended	rudge	7.62	92.38	24.72	26.76	53.2	13.15
3E Sweet Clover non-amended	rudge	Not enough sample to send to lab				56	n/a
9B White Clover amended	rudge	Not enough sample to send to lab				n/a	n/a
4B White Clover non-amended	rudge	Not enough sample to send to lab				n/a	n/a
5F Field Peas amended	rudge	6.63	93.37	11.88	12.72	369.2	43.85
12F Field Peas non-amended	rudge	6.68	93.32	10.96	11.75	250	27.41
6D Alsike Clover amended	rudge	7.58	92.42	13.38	14.48	258.4	34.58
8D Alsike Clover non-amended	rudge	7.45	92.55	13.92	15.04	180.8	25.17
1A Alfalfa amended	dowdell	5.86	94.14	23.24	24.96	357.2	83.93
7A Alfalfa non-amended	dowdell	6.95	93.05	15.62	16.79	1159.2	181.10
2C Red Clover amended	dowdell	4.74	95.26	19.18	20.13	780	149.57
11C Red Clover non-amended	dowdell	6.46	93.54	18.6	19.88	236.8	44.03
10E Sweet Clover amended	dowdell	6.98	93.02	17.4	18.71	364	63.35
3E Sweet Clover non-amended	dowdell	7.04	92.96	18.31	19.7	277.2	50.76
9B White Clover amended	dowdell	6.11	93.89	24.97	26.59	88.8	22.17
4B White Clover non-amended	dowdell	6.28	93.72	6.28	6.7	171.2	10.75
5F Field Peas amended	dowdell	6.23	93.77	22.63	24.13	260.4	58.92
12F Field Peas non-amended	dowdell	4.35	95.65	10.77	11.26	389.6	41.96
6D Alsike Clover amended	dowdell	4.39	95.61	21.63	22.62	482	104.24
8D Alsike Clover non-amended	dowdell	6.02	93.98	14.05	14.95	226.8	31.87
1A Alfalfa amended	lendrum	6.53	93.47	15.48	16.56	250.4	38.76
7A Alfalfa non-amended	lendrum	7.34	92.66	14.63	15.79	660.8	96.68
2C Red Clover amended	lendrum	6.99	93.01	17.27	18.57	180.8	31.23
11C Red Clover non-amended	lendrum	4.32	95.68	14.23	14.87	137.6	19.58
10E Sweet Clover amended	lendrum	5.13	94.87	16.46	17.35	244.8	40.29
3E Sweet Clover non-amended	lendrum	6.54	93.46	21.44	22.94	178.4	38.25
9B White Clover amended	lendrum	4.35	95.65	17.28	18.07	261.6	45.21
4B White Clover non-amended	lendrum	3.94	96.06	16.6	17.28	104.4	17.33
5F Field Peas amended	lendrum	6.77	93.23	15.27	16.38	68.8	10.51
12F Field Peas non-amended	lendrum	6.48	93.52	17.14	18.33	219.2	37.58
6D Alsike Clover amended	lendrum	4.54	95.46	13.11	13.73	168.8	22.12
8D Alsike Clover non-amended	lendrum	4.38	95.62	13.34	13.95	134.4	17.93

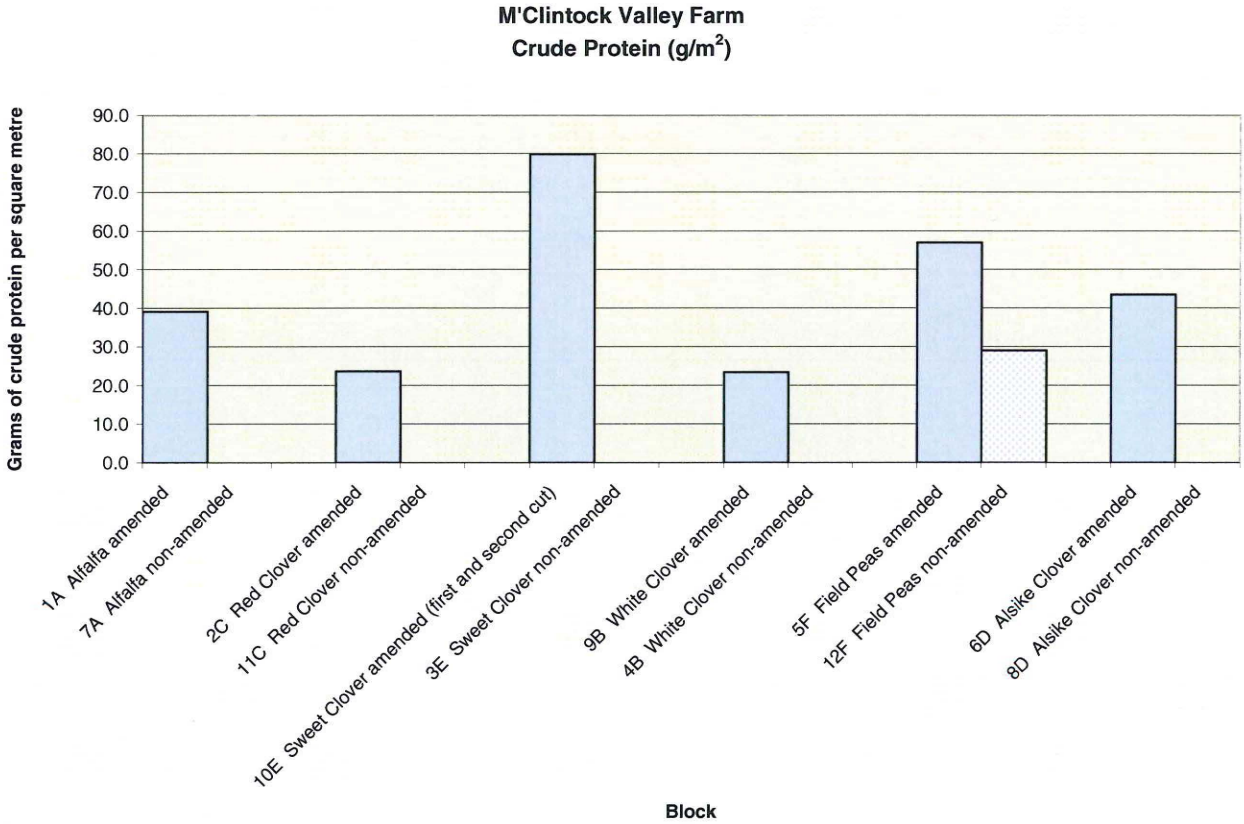
APPENDIX B. CRUDE PROTEIN CONTENT ANALYSIS



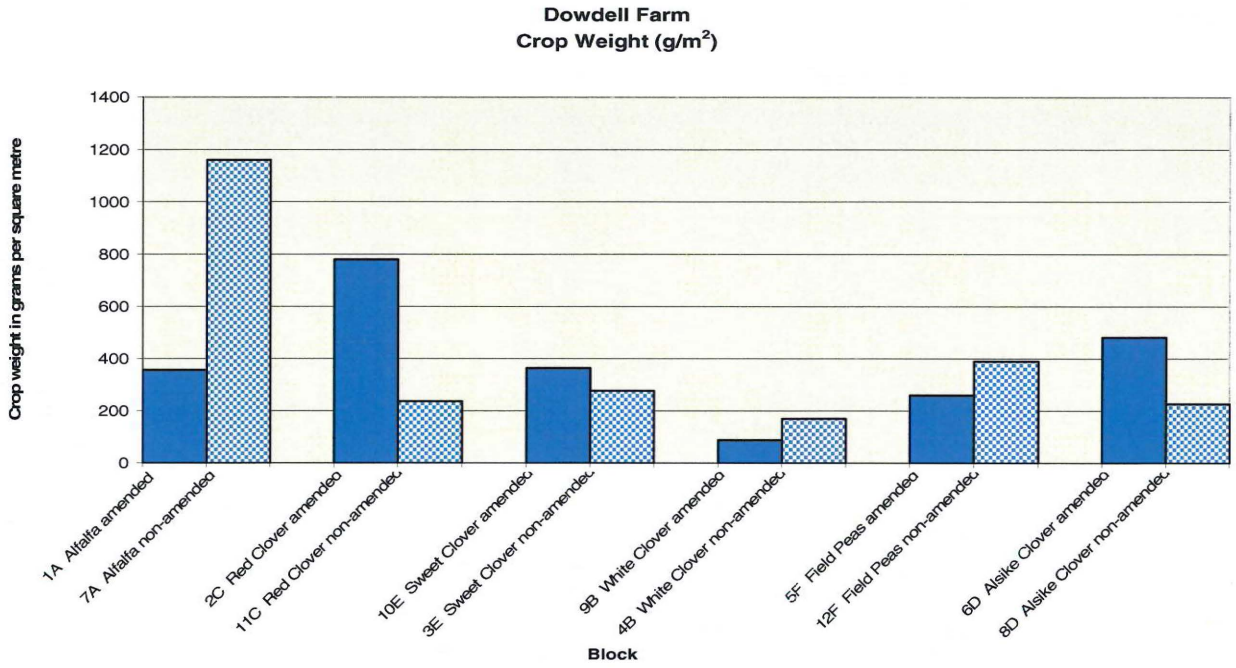


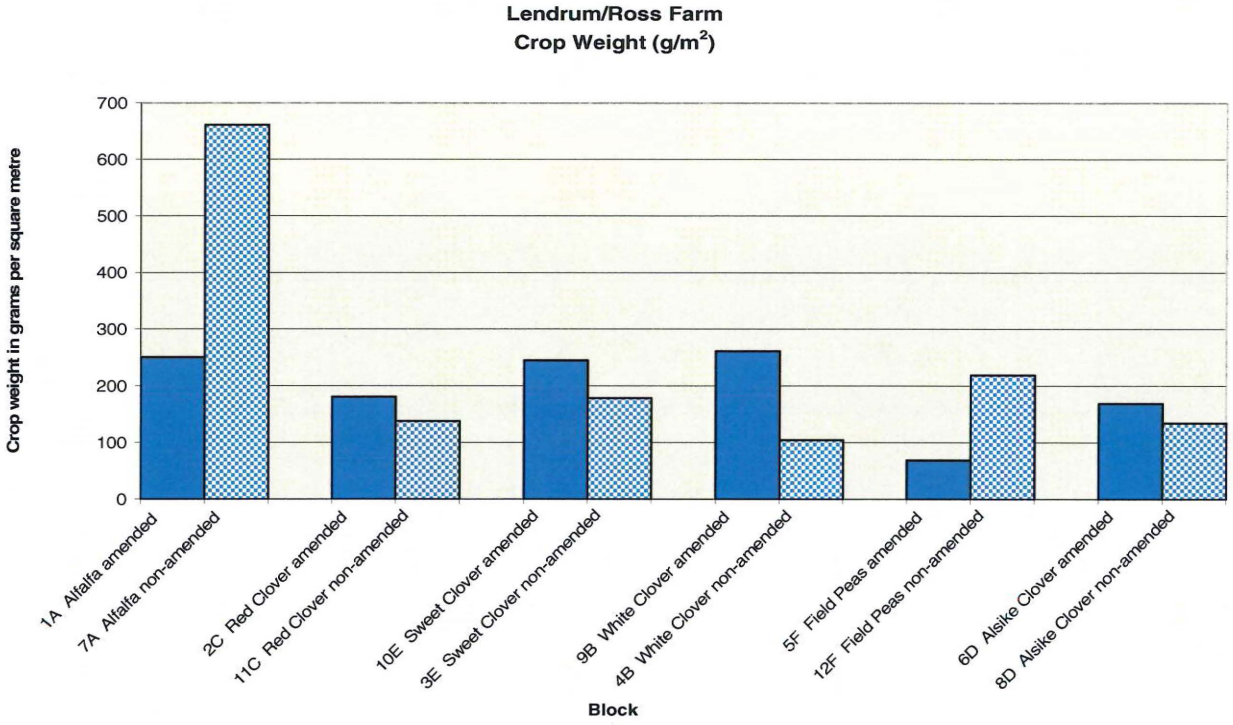
APPENDIX B. CRUDE PROTEIN CONTENT ANALYSIS





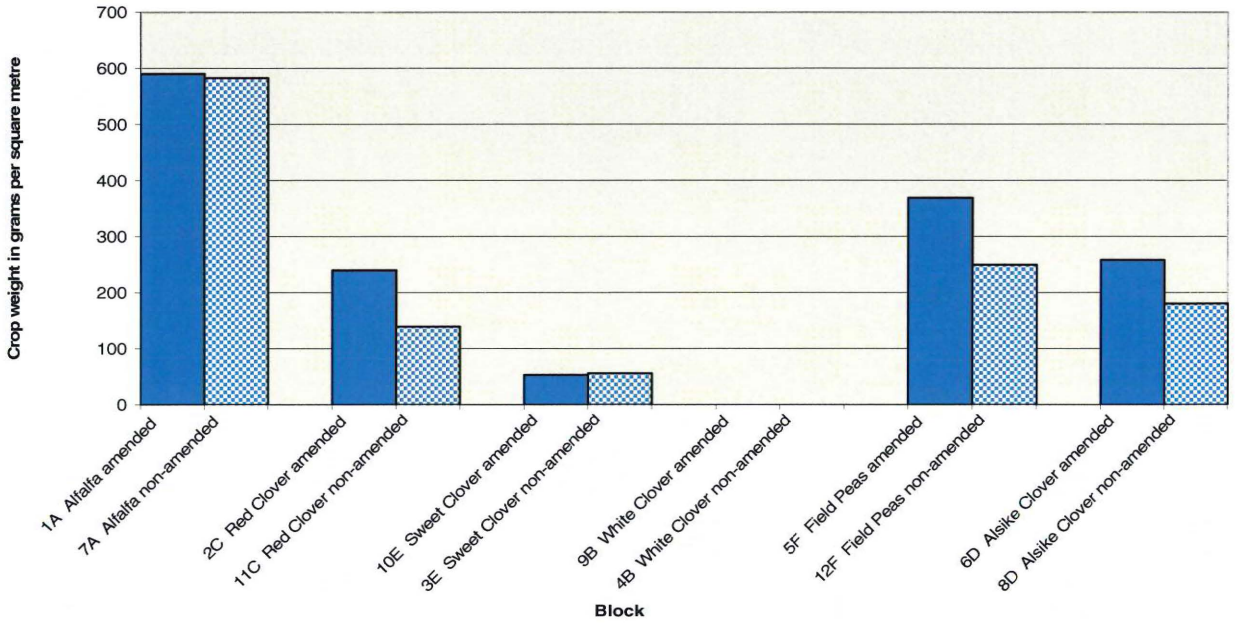
APPENDIX C. BIOMASS ASSESSMENT ANALYSIS



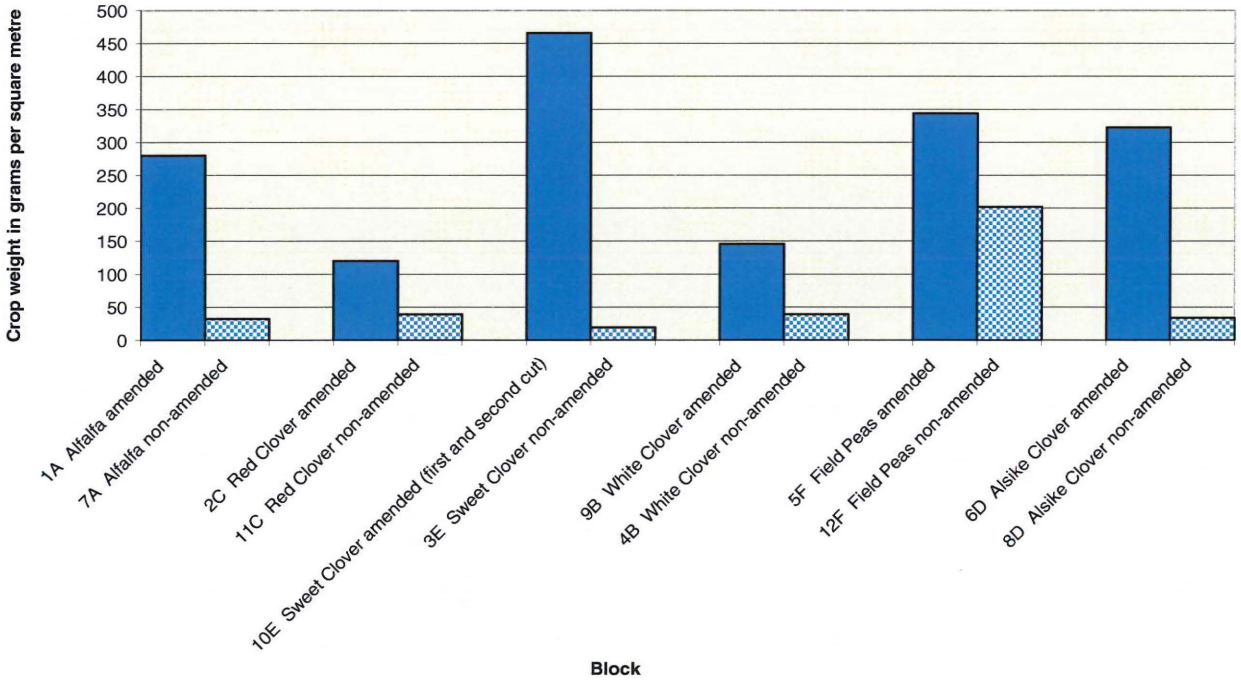


APPENDIX C. BIOMASS ASSESSMENT ANALYSIS

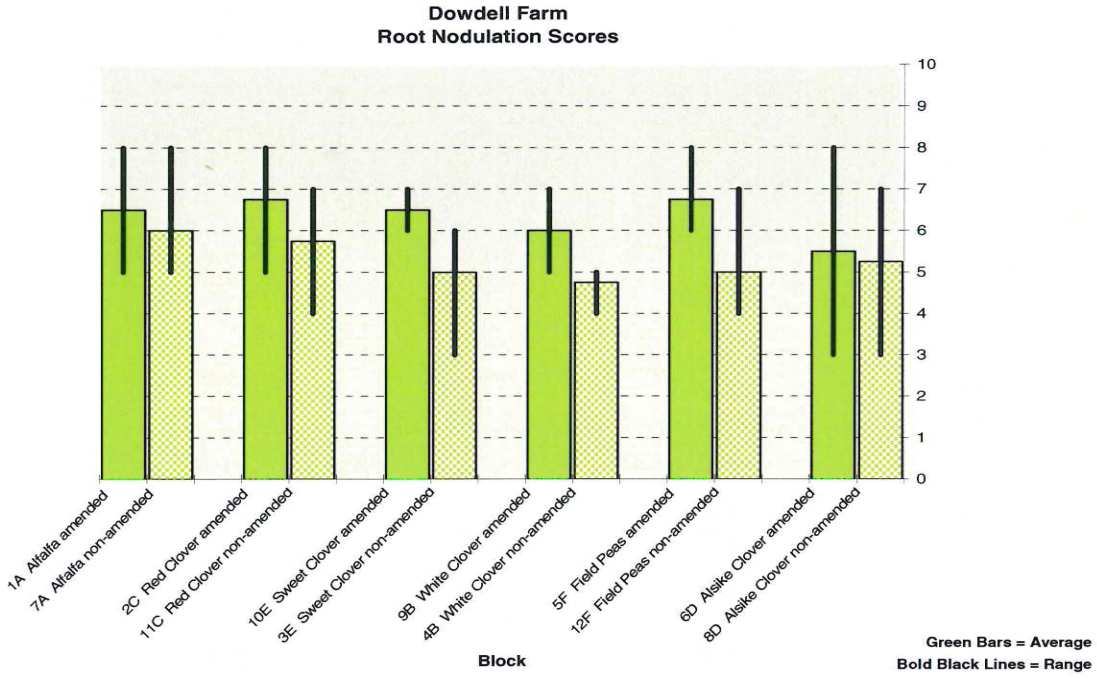
Aurora Mountain Farm
Crop Weight (g/m^2)

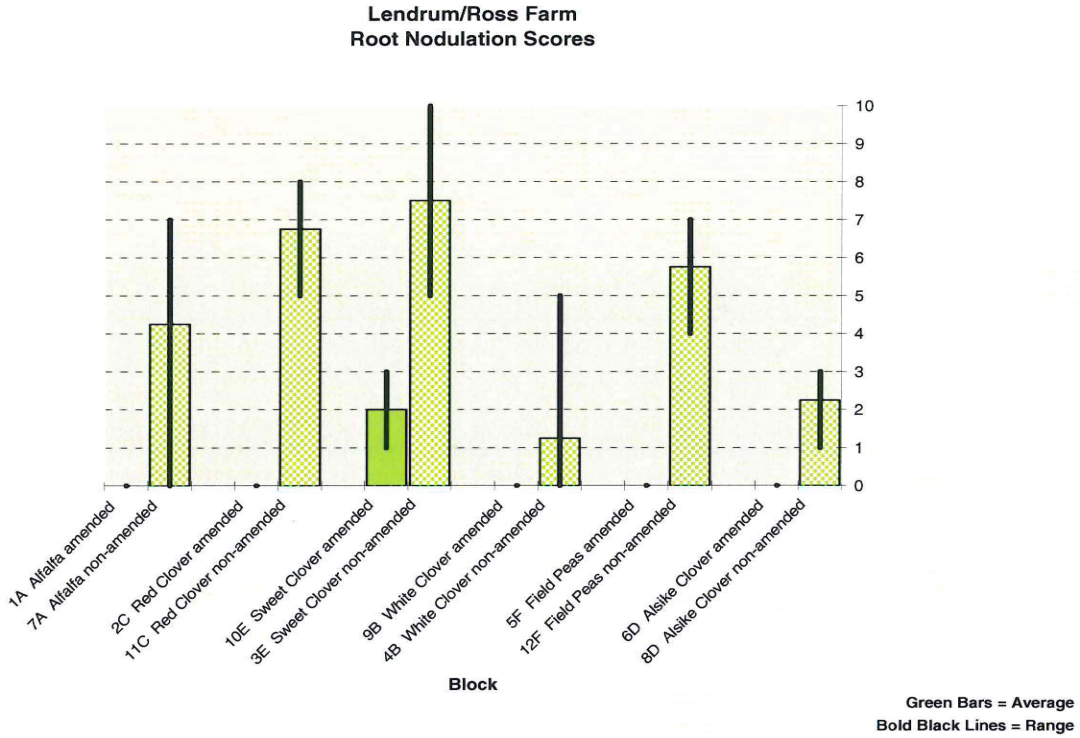


M'Clintock Valley Farm
Crop Weight (g/m^2)



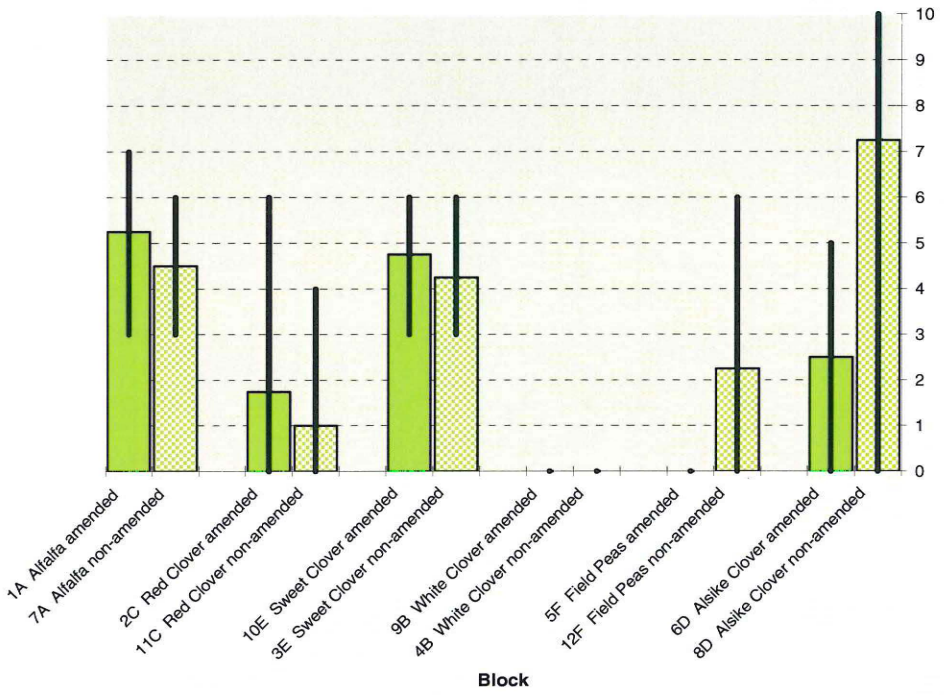
APPENDIX D. ROOT NODULATION SCORES





APPENDIX D. ROOT NODULATION SCORES

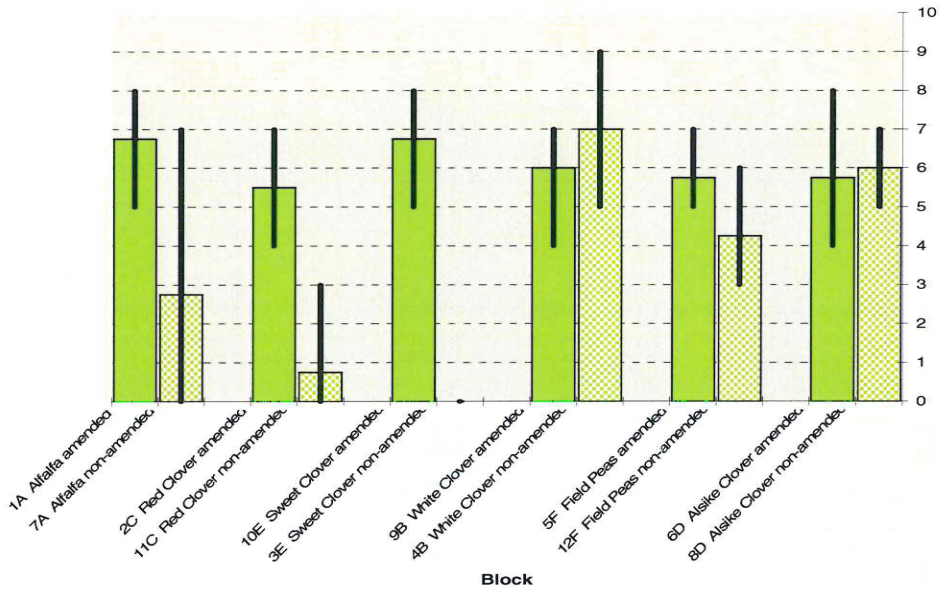
Aurora Mountain Farm
Root Nodulation Scores



Green Bars = Average

Bold Black Lines = Range

M'Clintock Vallely Farm
Root Nodulation Scores



Green Bars = Average

Bold Black Lines = Range

APPENDIX E. PHOTOGRAPHS: VISIT ONE

Dowdell Farm Visit One


1a


2c


3e


4b


5f


6d


7a


8d


9b


10e


11c


12f

APPENDIX E. PHOTOGRAPHS: VISIT ONE

Lendrum/Ross Farm Visit One

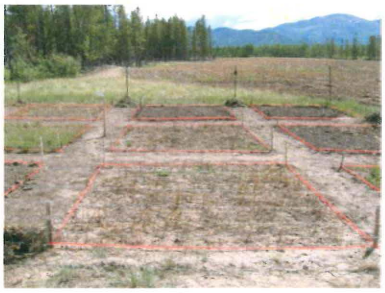
7a

7a and surrounding blocks

APPENDIX E. PHOTOGRAPHS: VISIT ONE

Aurora Mountain Farm Visit One

1a



2c

3e

4b

5f

6d

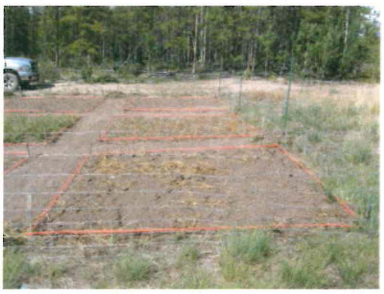
7a

8d

9b

10e

11c



12f

APPENDIX E. PHOTOGRAPHS: VISIT ONE

M'Clintock Valley Farm Visit One

Block 10e showing numerous weeds; before, during and after weeding.

APPENDIX F. PHOTOGRAPHS: VISIT TWO

Dowdell Farm Visit Two

1a

2c

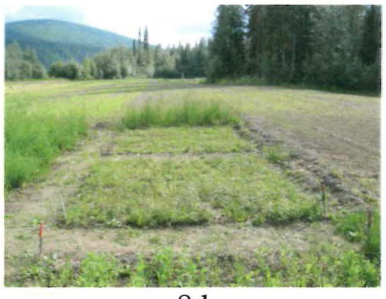
3e

4b

5f

6d

7a



8d

9b

10e

11c

12f

APPENDIX F. PHOTOGRAPHS: VISIT TWO

Lendrum/Ross Farm Visit Two


1a


2c


3e


4b


5f


6d


7a


8d


9b


10e


11c


12f

APPENDIX F. PHOTOGRAPHS: VISIT TWO

Aurora Mountain Farm Visit Two


1a


2c


3e


4b

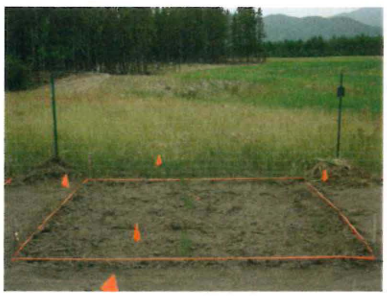

5f

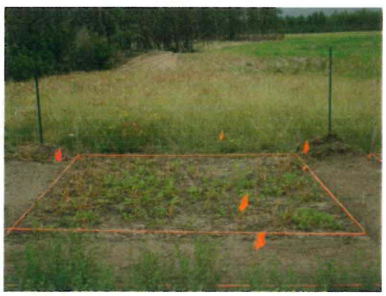

6d


7a


8d


9b


10e


11c


12f

APPENDIX F. PHOTOGRAPHS: VISIT TWO

M'Clintock Valley Farm Visit Two


1a


2c


3e


4b


5f


6d


7a


8d


9b


10e


11c


12f

APPENDIX G. PHOTOGRAPHS: VISIT THREE

Dowdell Farm Visit Three


1a


2c


3e


4b


5f


6d


7a


8d


9b


10e


11c


12f

APPENDIX G. PHOTOGRAPHS: VISIT THREE

Lendrum/Ross Farm Visit Three


1a


2c


3e


4b


5f


6d


7a


8d


9b


10e


11c


12f

APPENDIX G. PHOTOGRAPHS: VISIT THREE

Aurora Mountain Farm Visit Three

1a

2c

3e

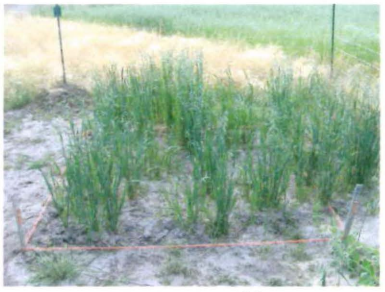
4b

5f

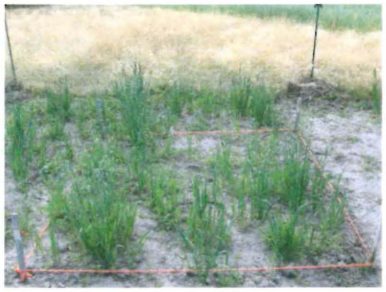
6d

7a

8d



9b



10e

11c

12f

APPENDIX G. PHOTOGRAPHS: VISIT THREE

M'Clintock Valley Farm Visit Three


1a

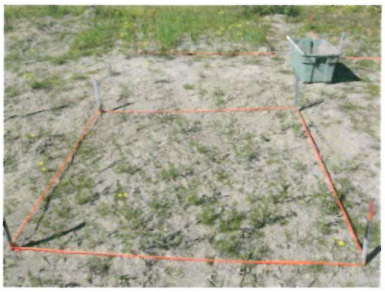

2c


3e


4b


5f


6d


7a


8d


9b


10e


11c


12f

APPENDIX H. PHOTOGRAPHS: VISIT FOUR

Dowdell Farm Visit Four

1a

2c

3e

4b

5f

6d

7a

8d

9b

10e

11c

12f

APPENDIX H. PHOTOGRAPHS: VISIT FOUR

Lendrum/Ross Farm Visit Four


1a


2c


3e


4b


5f


6d


7a


8d


9b


10e


11c


12f

APPENDIX H. PHOTOGRAPHS: VISIT FOUR

Aurora Mountain Farm Visit Four


1a


2c


3e


4b

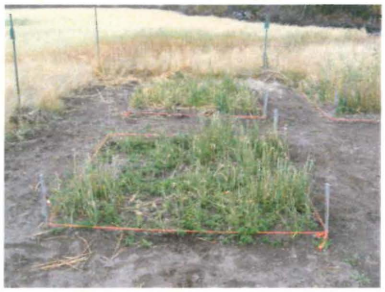

5f


6d


7a


8d


9b


10e


11c


12f

APPENDIX H. PHOTOGRAPHS: VISIT FOUR

M'Clintock Valley Farm Visit Four


1a


2c


3e


4b


5f


6d


7a


8d


9b


10e


11c


12f

APPENDIX I. FARMERS' DATA RECORDS

Lendrum/Ross Farm - Farmers' Notes 2007 (pg. 1 of 3)

June

June 9: Cain tills and replants all blocks except un-amended alfalfa.

June 10: One gopher trapped inside fence near plot.

June 11: Cain applies amendments; rain overnight.

June 12: Morning rain gauge shows 4 mm; heavy rain in afternoon and overnight.

June 13: Evening rain gauge shows 14 mm.

June 14: Cloudy but no rain; one gopher trapped inside fence, 60 meters from plot.

June 16: Sunny morning, cloudy with showers afternoon; 10:00 pm: rain gauge wet but negligible; one gopher trapped near plot.

June 17: Heavy rain in very early morning, then mostly sunny day; big thunder storm in evening with rain – at 9:30 pm: rain gauge shows only 4 mm (it seems like we have had more rain than that).

June 19: Sunny day with thunder storm in evening – at 10:00 pm: rain gauge shows 1 mm.

June 25: Gopher trapped at far end of field – 60 meters from plots; no sign of gopher activity in the plots.

June 28: Shower in late afternoon – gauge at 10:00 pm shows 2 mm.

June 29: One goat got inside the fence (don't know how) but did not seem to go near the plots.

July

July 1 & 2: Good rain – gauge at noon July 2 shows 7 mm.

July 2: Started drip tube irrigation system on legume plots and nearby potatoes; the drip tubes run east to west, each one crossing four plots; there are fie tubes per lot making a total of fifteen tubes; the land slopes down from east to west, so the plots on the west side will probably get more water

APPENDIX I. FARMERS' DATA RECORDS (con't)

Lendrum/Ross Farm - Farmers' Notes 2007 (pg. 2 of 3)

than the ones on the east. I drained about 200 gallons through the system (including the plots and the potatoes) but I can not equate this to a quantity of rain falling on the plots.

July 6: Drained the rest of the tank (an additional 300 gallons) on to the plots.

July 7 & 8: Cain's second visit.

July 12: Good rain overnight and showers through the morning; forgot to check rain gauge.

July 13: Half a tank of water on legumes and potatoes.

July 16: Rain all day.

July 18: Half a tank (about 300 gallons) of water on the legumes and potatoes.

July 20: Heavy shower in afternoon; rain gauge shows 19 mm at 10 pm (but it looks as though it has not been checked since July 2). Removed gopher fence from in front of gate to allow truck to drive in.

July 29: Heavy rain in early morning, at noon gauge shows 8 mm.

July 30: Heavy shower in afternoon, at 10:00 gauge shows 8 mm just as another shower begins.

August

August 4: Emptied the whole tank on legumes and potatoes – about 500 gallons.

August 7: At 10:00 pm gauge shows 28 mm – most of this fell yesterday afternoon and overnight.

August 10: Cain started third visit and found gopher in alfalfa and a gopher hole.

August 12: Set gopher trap.

August 14: Emptied water tank on legumes and potatoes.

August 15: Trapped gopher at the edge of the plots near the fence – removed and released it about 1 km away.

APPENDIX I. FARMERS' DATA RECORDS (con't)

Lendrum/Ross Farm - Farmers' Notes 2007 (pg. 3 of 3)

August 23: Cain cut sweet clover.

August 27 & 28: First frosts of the season, no obvious damage.

August 30: Light to moderate rain most of the day; trapped and removed gopher in the evening.

September

Sep.15: Very heavy shower in evening, forgot to check rain gauge.

Sep17: Showers most of the day, then frost overnight. Next day rain gauge shows 20 mm. No significant frost damage yet though peas near the road (uphill) are less green than lower peas. Started cutting peas and oats today.

Sep. 19: Light to moderate rain all day – next morning rain gauge shows 9 mm.

Sep.20: Heavy rain in evening, next morning gauge shows 11 mm.

Sep. 22 & 23: Cain takes soil samples, final photos.

Sep. 24 & 25: Rain; on morning of Sep. 26 gauge shows 28 mm.

October

Oct 20: Several dustings of snow over the past two weeks with some melting; almost no snow on ground; rain gauge shows 20 mm with no ice in it; turned it over to prevent freezing; plots still showing some green.

M'Clintock Valley Farm - Farmers' Notes 2007 (pg. 1of 3)

Rainfall/watering of legume plot information gathered by Joanne Johnson. Measurements were taken from a gauge either in the yard or at the plot.

June

June 5: 1 mm (this is the first measurable rain since the snow melted).

APPENDIX I. FARMERS' DATA RECORDS (con't)

M'Clintock Valley Farm - Farmers' Notes 2007 (pg. 2 of 3)

June 6: 9 mm rain

June 11: 5 mm rain

June 12: showers, no measure

June 13: 1 mm

June 15 & 16: 10 mm over 2 days

June 16: 1 mm overnight

June 19: 3 mm rain

June 20-27: 15 mm measured in gauge at plot, didn't measure daily as too busy with chickens

June 29: rain showers, no measure

July

July 1 & 2: 10 mm by noon July 2

July 6: watered garden and plot, rained in evening a total of 11 mm in gauge at plot

July 13: 10 mm rain at plot

July 15: 5 mm rain at plot

July 16: 16 mm rain

July 20: 12 mm rain

July 28 & 29: 10 mm rain overnight

August

August 6: 10 mm rain

August 8: 9 mm rain

APPENDIX I. FARMERS' DATA RECORDS (con't)

M'Clintock Valley Farm - Farmers' Notes 2007 (pg. 3 of 3)

August 25: 9 mm in gauge at plot

August 30: 5 mm rain

September

September 1-15: 12mm total rain over 2 weeks

September 23-25: 22 mm rain and snow

September 26: 8 mm rain overnight

October

Oct 7: First snow that mostly stayed, with some melt in the open areas

APPENDIX I. FARMERS' DATA RECORDS (con't)

Dowdell Farm - Farmers' Notes 2007 (pg. 51 to 54)

LINDELL

June 2007

Sun	Mon	Tue	Wed	Thu	Fri	Sat
					1	2
3	4	5	6	7	8	9
10	11	12 put up rain gauge	13	14	15	16
17	18	19	20	21	22	23
24	25 5 mm. rain	26	27	28	29	30

CalendarsThatWork.com

DOWDELL

July 2007

Sun	Mon	Tue	Wed	Thu	Fri	Sat
1	2 Cain at plot pm.	3 3 mm. reported by Cain Cain at plot	4 16 mm. heavy downpour	5	6 5 mm	7 1 mm
8	9 3 mm goat kids grazed oats in plot. pm. erected fence	10	11	12 3 mm	13	14 1 mm
15	16	17	18	19	20 1 mm.	21
22	23 14 mm. heavy downpour	24	25	26	27	28 20 mm heavy downpour
29	30 6 mm	31 8 mm				

D IDELL

August 2007

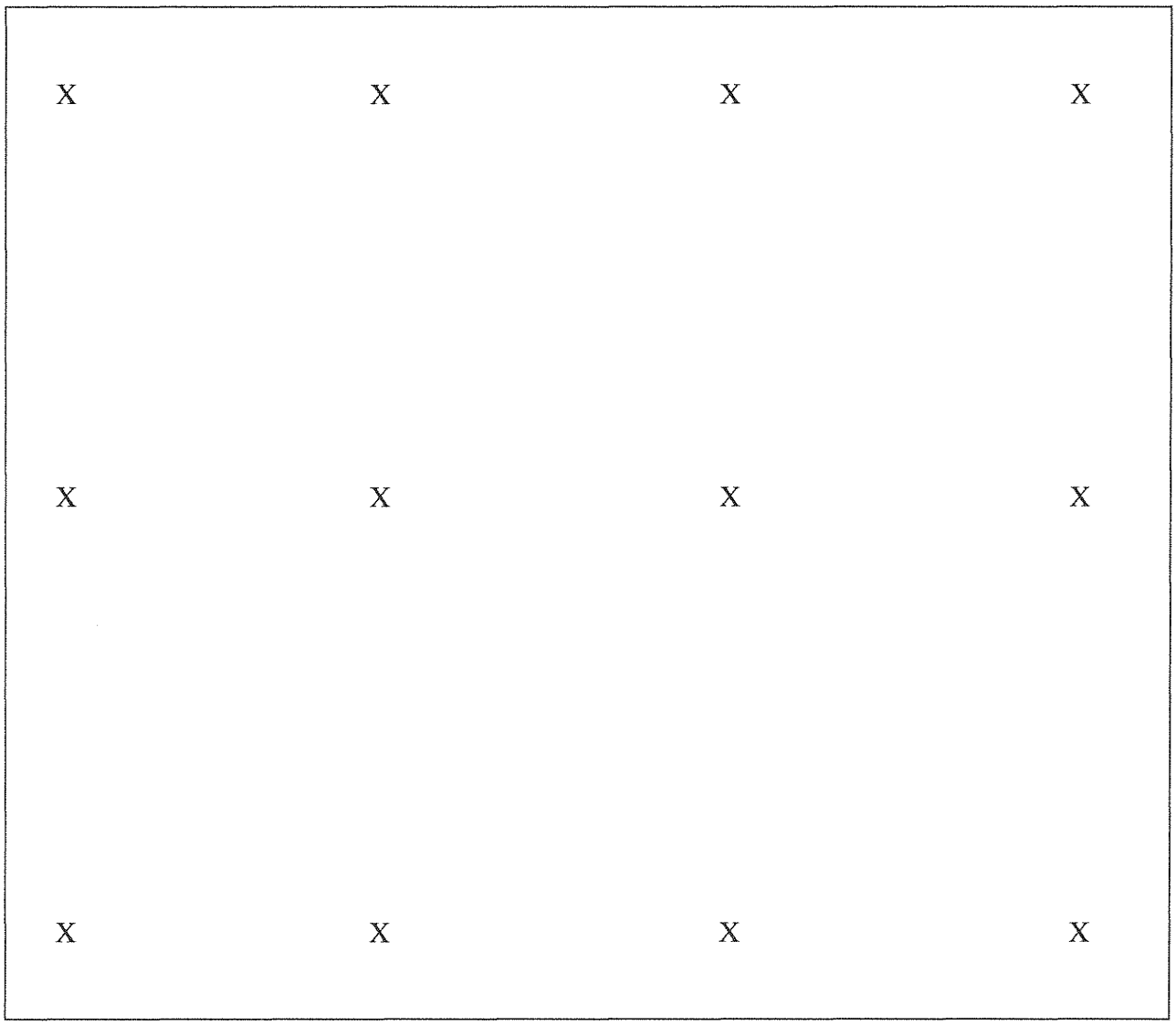
Sun	Mon	Tue	Wed	Thu	Fri	Sat
			1 4 mm	2	3 4 mm	4
5	6 2 mm Louis arrived	7	8	9	10	11 23 mm
12	13 6 mm	14	15 2 mm	16	17 2 mm	18
19	20 2 mm	21 3 mm	22	23 1 mm	24	25
26	27	28	29	30	31	

September 2007

Sun	Mon	Tue	Wed	Thu	Fri	Sat
1	2 1 mm	3	4	5 8 mm	6	7 9 mm
8	9 [illegible]	10	11 5 mm	12 [illegible]	13	14 [illegible]
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30					

APPENDIX J. SOIL SAMPLE COLLECTION SITES

Approximate locations of 12 soil sample collection sites per block.



APPENDIX K. TECHNICIAN DATA SHEETS

Appendix K will be included when final recommendations from Kinsey Agricultural Services Inc. become available.

APPENDIX L. INFORMATION RESOURCES

Ball, M. (2007). Personal Communication.
Agrologist
Government of Yukon Agriculture Branch
Energy, Mines & Resources

Digby, K. (2006). *Growers of Organic Food Yukon Legume Study 2006 Technician's Report.*

Digby, K. (2005). *Research Technician's Report Legume Study, 2005 Growers of Organic Food Yukon (GOOFY).*

Gillespie, G. (2005). *Yukon Legume Study.* Proposal written for Growers of Organic Food Yukon.

Rice, W.A. (1977). *Effects of soil acidity on rhizobia numbers, nodulation and nitrogen fixation by alfalfa and red clover.* In Canadian Journal of Soil Science, Vol 57, pp. 197-203.