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Putting Science into Practice

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MURDOCH LAKE AGROFORESTRY PROJECT

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Abstract: Intercropping has the potential to provide Alberta's farmers with many benefits from moisture trapping to increased crop production. In the Peace River Region of Alberta many farmers raise cattle and grow forage crops. Folks in our region continue to clear land and remove trees so they can farm every acre. However, with the loss of wooded areas exposed forage crops dry out quickly in the summer and cattle are exposed to nasty winter winds.

This field demonstration was designed back in 2002 to show landowners the potential benefits of combining tree crops with traditional agricultural practices. The project area covers 60 acres of land and is surrounded by an eight-foot deer fence and borders a waterfowl rich wetland. A total of 17 000 Walker Poplar hybrids were planted in 2004 with half being planted with plastic mulch and the other half without. The project is setup in three different blocks with on consisting of hay only, the second with hay and trees and the other with trees only and these are repeated three times over the sixty acres. Over the years tree and hay yields were measured. The main purpose of the site is to get local landowners thinking about how they can apply a similar agroforestry system to their farm. The demonstration has attracted folks from across Alberta and British Columbia and is becoming more widely recognized every year. It has also inspired some other agroforestry projects in the region.

Key Words: intercropping, hybrid poplar, tree crop, plastic mulch, forage production

INTRODUCTION

This agroforestry demonstration near Murdoch Lake has been an extremely successful demonstration for local landowners, professionals and landowners from further a-field. Its intent demonstrates the opportunities landowners have to combine tree production with standard agricultural practices. This project has been an excellent learning experience, providing insight into natural enemies for agro-forestry projects, such as voles and competing vegetation, which necessitate the need for innovative strategies.

The initial collaborators for this project include:

North Peace Applied Research Association (NPARA)
Prairie Farm Rehabilitation Administration (PFRA)
Ducks Unlimited Canada (DUC)
Alberta Agriculture and Rural Development (AAFRD)
Daishowa-Marubeni International Ltd. (DMI)

Through subsequent participation, Alberta Environmentally Sustainable Agriculture (AESA) and Reduced Tillage Linkages (RTL) became project partners; and in 2005, the Woodlot Extension Program (WEP) provided an agroforestry specialist, Doug Macaulay, for northern Alberta, and WEP became an active participant.

The project is located on the SE quarter of Section 16-89-23-W5M, about 60 kilometers north of Peace River near the hamlet of Deadwood. It encompasses an area of about 60 acres (24 hectares). Approximately half of this area is seeded to a mixed hay crop, and half planted to hybrid poplar trees (Walker) at a planting density of 1600 stems per hectare. A total of 17,352 trees were planted.

Photo courtesy of Doug Macaulay, Woodlot Extension Program

The basic design of the demonstration is to have three "treatments" represented in each of three replications (Figure 1):

1. one third of each replicate has 'hay only',
2. one third of each replicate has 'trees only', and
3. one third of each replicate has alternating strips of 6 rows of trees, with an equal size strip of hay.

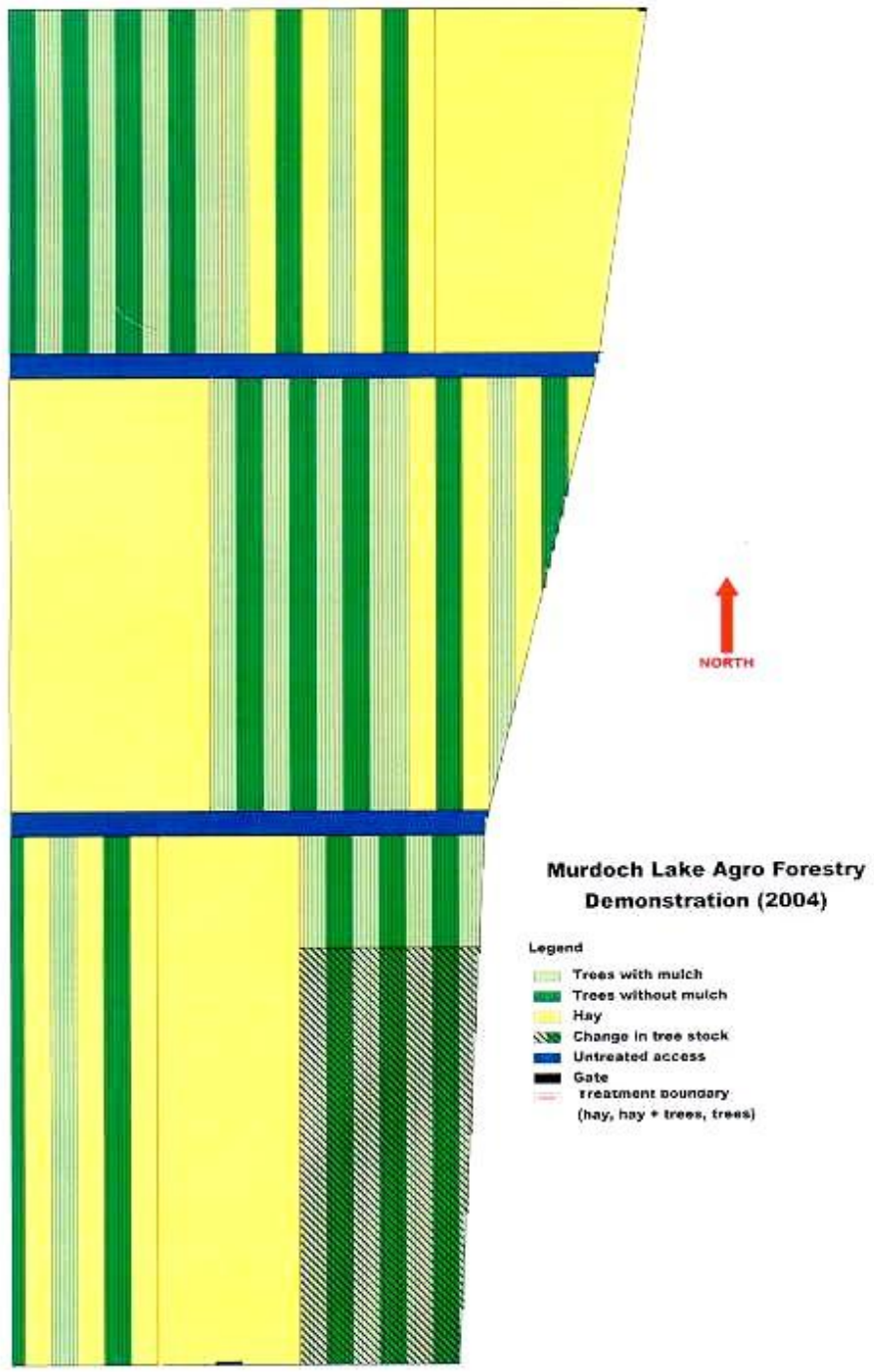


Figure 1. Map showing layout of Murdoch Lake Demonstration.

Each replication is about 8 hectare in size, and each treatment within each replicate about 2.4 hectare. Strips between replications and around the project perimeter are retained for access and are therefore non-treatment areas and total about 2.4 hectare. Total treatment area planted to trees and hay is shown in Table1.

Table 1. Treatment Area Planted to Trees vs Seeded to Hay*

Replicate →	1		2		3	
Treatment ↓	Trees (ha)	Hay (ha)	Trees (ha)	Hay (ha)	Trees (ha)	Hay (ha)
Trees	2.4	0	2.4	0	2.4	0
Trees+Hay	1.2	1.2	1.2	1.2	1.2	1.2
Hay	0	2.4	0	2.4	0	2.4
Total per Rep	3.6	3.6	3.6	3.6	3.6	3.6

Total Trees	10.8 ha
Total Hay	10.8 ha

*Strips left for access are also seeded to hay and make up the remaining 2.4 hectares.

In addition to the three basic treatments, half of the trees (8,676) had plastic mulch applied, and half did not. Those without the plastic mulch had competing vegetation controlled by mechanical and chemical means. The purpose of including the plastic mulch was to provide a basis for landowners to determine whether the initial cost to apply mulch was offset by increased tree productivity and cost of repeated entries to control vegetation in non-mulched trees.

The initial hypothesis of this project was that, by alternating hay and tree production in the same field, the overall productivity of the site would increase. The trees would retain snow fall, increasing available soil moisture for hay production; hay strips would allow the trees to have access to more sunlight therefore stimulate increased tree growth. Although only preliminary results in hay yield and tree growth are available, reasonable forecasts can be made regarding the costs and benefits of such an operation.

Key Adaptations made to the Original Project

There were several significant changes to the original project:

1. Prior to establishment, all collaborators agreed to replicate the treatments to provide a basis for statistical analysis rather than establish the site purely for demonstration purposes. In hindsight, this was an excellent decision. It provides more credibility to the hay yield and tree growth rates, plus creates an interest by other professionals to use the site for other related research questions.

2. During the first fall/winter after planting (2004), voles, feeding on the bark and phloem of the young trees (and living under the mulch safe from predators) girdled most of the trees. When the girdling was observed the following spring, the decision was made to cut

off every stem below the girdle to allow new stems to coppice from the stump. This was done in May 2005 by summer students with some trepidation due to the young age of the tees. The decision, however, was a wise one. All decapitated trees re-sprouted with multiple stems; a small number of trees not cut off, because the girdle did not totally encompass the stem, subsequently died.

3. Innovative strategies were implemented to reduce the vole population including nesting boxes for raptors, brush piles for weasels and compressing the mulch with quads.

4. The year following the decapitation, all trees had to be "singled" due to the coppicing of multiple stems. In May, 2006 summer students singled every tree by leaving the dominant stem and removing all others. A small portion of trees had to be singled again in 2007.

5. Introduction of grazing was to have occurred in 2007. In the spring of 2007, and again in 2008, the decision was made to delay the grazing until 2009 to provide for additional growth on the smaller (unmulched) trees. A meeting was held in October of 2008, and all collaborators agreed to move ahead with the grazing in 2009.

6. Permanent Sample Plots (PSPs) were established in Year 2 rather than Year 1; and measured in year 2 and 4 instead of annually. PSPs will be measured in the spring of 2009 prior to the introduction of grazing. Collaborators will decide on tree measurement interval in conjunction with the grazing protocol when it is developed.

Technology Transfer

Technology transfer to date has included:

1. Tours - There has been a minimum of one tour annually since the establishment of the site in 2004, with two tours in 2006 and three in 2007. Tours are often accompanied by a member of the local press with subsequent articles in local papers. Tour guides/speakers for the Murdoch Lake demo include representatives from the collaborators, usually someone from NPARA and/or DMI. NPARA has regularly included Murdoch Lake in the annual tours they provide for landowners to showcase their research projects. The tours have generated significant interest in this type of planting both from landowners and professionals, and usually result in subsequent communications as individuals request further information and follow-up.

2. NPARA publications – Articles have occurred in the 2005, 2006 and 2007 Annual Reports to date, and the "2005 Trials" booklet.

3. Article in Ducks Unlimited Newsletter (summer 2004)

4. WEP Murdoch Lake Brochures – The first brochure was prepared by Doug Macaulay in 2006, and has been updated regularly.

5. Presentations at WEP workshops and conferences – Since 2005 Doug Macaulay hosted several workshops on behalf of WEP. A presentation on the Murdoch Lake Demonstration was prepared for these workshops.

6. Newsletters prepared and circulated by WEP

7. A sign erected at the demonstration site - This detailed sign showing the treatment layout and the collaborators was provided and erected by Alberta AAFRD in October 2004.

8. News articles in local papers such as the "Peace River Record Gazette" and the "Peace Country Sun".

Collection and Housing of Data

Hay data is collected and analyzed by NPARA; tree data is collected and analyzed by DMI. It was decided that the complete data would be housed both at NPARA and DMI. Others can request the data as required.

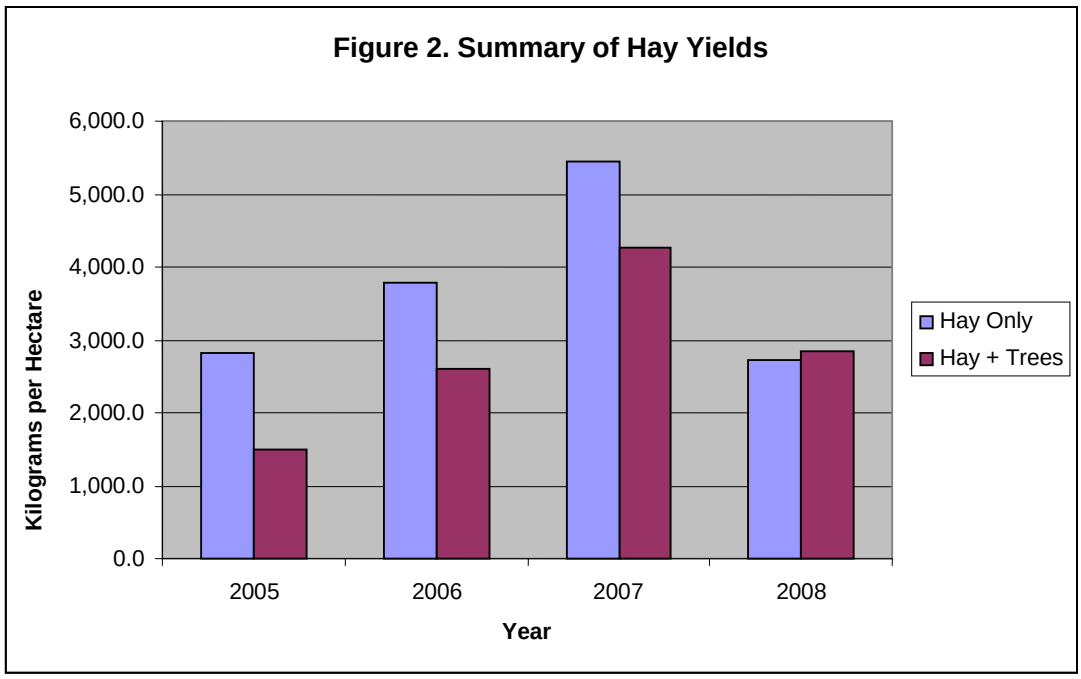
RESULTS

Hay

NPARA is responsible for all hay activities. As requested by DUC, hay cannot be harvested until after July 15 due to the potential for nesting birds earlier in the season.

The first year of harvest was 2005. In 2005, 2006 and 2007, amount of hay by treatment was determined by the weight and number of round hay bales. In 2008, NPARA used random sampling with "quarter meter cuts". Small plots (1x1m) were placed at random within each treatment; the hay was clipped by hand, dried and weighed. Based on this sampling, a yield in pounds per acre was calculated for each treatment. Because of the operational difficulty of gathering accurate information using farm sized equipment, NPARA decided that the latter method is preferred and will continue with this method in the future.

To date there appears to be no significant trend in hay yields over the two hay treatments (hay only vs. hay with trees). Hay yields are summarized in Figure 2.

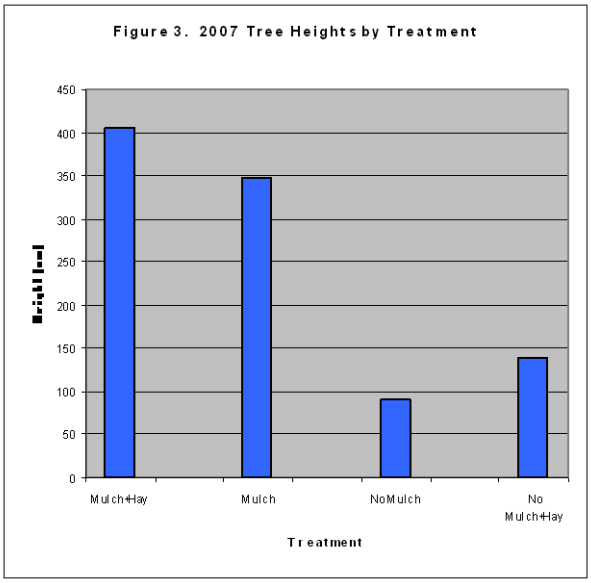


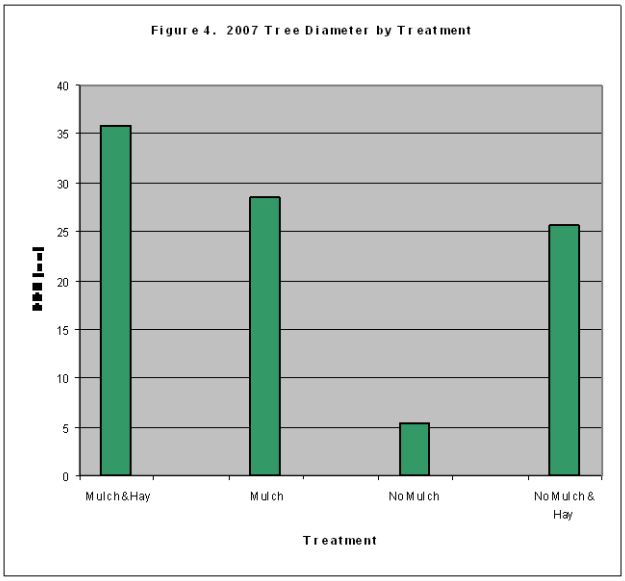
Trees

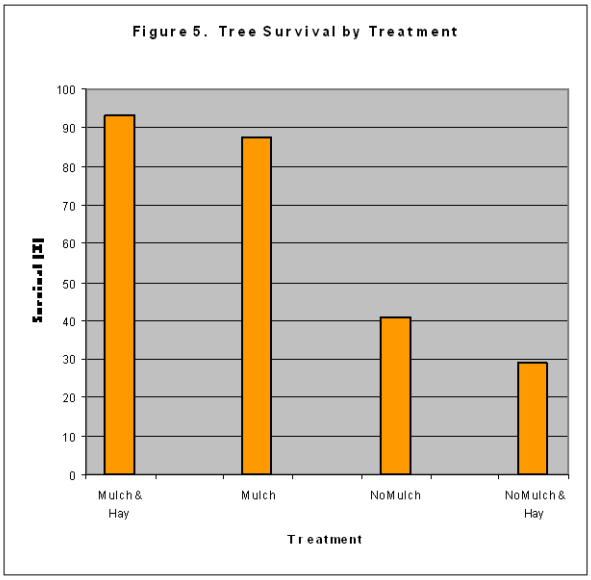
DMI is responsible for all tree activities. Permanent sample plots were established in 2005, and the heights and diameters of trees within these plots measured in 2005 and 2007. It was deemed adequate to measure trees every two years rather than every year as initially planned. They will be re-measured in 2009.

Tree growth in mulched vs. unmulched trees is significantly different, but the difference at this point in time between the 'trees and hay' and the 'trees only' is not significant.

Figures 3, 4 and 5 summarize tree heights, diameters and survival in the four treatment combinations: “trees only” with and without mulch, and “trees and hay” with and without mulch.







Grazing

As previously stated, grazing has been delayed until 2009 because of the slow growth rate of the unmulched trees and the concern of compromising the value of the demonstration site. Presently, proposals are being developed to layout specifically how this grazing should occur. Collaborators agree that it is imperative to ensure the integrity of the existing study is not compromised, but at the same time, a feasible operational method of including livestock into agro-forestry must be demonstrated.

ESTABLISHMENT AND MAINTENANCE COSTS

In communications with landowners, and others potentially interested in agroforestry, a key focus is the cost to establish and maintain the tree portion of the demonstration. To provide that information, the inputs and costs were determined, and per unit costs calculated so individuals could extrapolate costs to a variety of scenarios. The project costs and inputs are outlined in Tables 2 and 3, respectively.

Table 2. Summary of Input Costs

Item or Activity	Year1 (2004)	Year 2 (2005)	Year 3 (2006)	Year 4 (2007)	Year 5 (2008)	Total
Fence	35,392.97	0.00	0.00	0.00	0.00	35,392.97
Seedlings	5,862.60	0.00	0.00	0.00	0.00	5,862.60
Site prep, chemical	1,137.50	0.00	0.00	0.00	0.00	1,137.50
Site prep, mechanical	1,067.32	0.00	0.00	0.00	0.00	1,067.32
Tree planting						
plot layout	1,960.00	0.00	0.00	0.00	0.00	1,960.00
mechanical marking	1,319.75	0.00	0.00	0.00	0.00	1,319.75
planting	6,060.00	0.00	0.00	0.00	0.00	6,060.00
Plastic mulch (41 rolls)	7,339.00	0.00	0.00	0.00	0.00	7,339.00
Application of mulch	6,759.00	0.00	0.00	0.00	0.00	6,759.00
Fertilization	1,064.75	0.00	0.00	0.00	0.00	1,064.75
Turf grass seed	437.00	0.00	0.00	0.00	0.00	437.00
Weeding and Maintenance						
mowing	0.00	2,600.00	1,105.00	0.00	0.00	3,705.00
pre-emergent	0.00	0.00	0.00	0.00	0.00	0.00
in-row chemical	0.00	3,175.00	2,750.00	0.00	0.00	5,925.00
decap, singling	0.00	2,788.00	3,063.00	1,250.00	0.00	7,101.00
Monitoring						
establish PSPs	0.00	763.00	0.00	0.00	0.00	763.00
data collection		750.00	0.00	888.00	0.00	1,638.00
sign, raptor boxes		260.00	0.00	150.00	0.00	410.00
Project Administration*	2,654.00	367.00	180.00	180.00	180.00	3,561.00

* Administration cost is calculated as 5% of the original estimated project cost

Table 3. Summary of Project Details

Total area (ha)	24.0
Total treed area (ha)	10.8
Grass treatment area (ha)	10.8
Grass access area (ha)	2.4
Total number of trees	17,352
Tree spacing	2.5m x 2.5m
Planting density (trees per ha)	1,600
Total area of PSPs (ha)	0.63
Number of trees in PSPs	1,005
Number of trees mulched	8,676
Area (ha) of mulched trees	5.40

Using the information from Tables 2 and 3, unit costs were calculated on a 'per hectare' and a 'per tree' basis. These figures are presented in Table 4.

Table 4. Summary of Costs per Unit per Entry

Activity	Cost per Hectare ($)	Cost per Tree ($)
Planting stock	542.83	0.34
Site prep, chemical	105.32	0.07
Site prep, mechanical	98.83	0.06
Plot layout	181.48	0.11
Mechanical marking	122.20	0.08
Planting	561.11	0.35
Plastic mulch	1,359.07	0.85
Application of mulch	1,251.67	0.78
Fertilization	98.59	0.06
Mowing	343.06	0.21
Pre-emergent herbicide	no data	no data
In-row chemical herbicide	274.31	0.17
Decapitation, singling (pruning)	219.17	0.14
Establishment of PSPs for tree data	70.65	0.04
Data collection*	1,200.00	0.81

* Unit costs of data collection calculated using PSP area and number of trees measured

COMPARISON OF ACTUAL COSTS TO ORIGINAL ESTIMATES

There were significant variances from the original cost estimates to the actual costs. This comparison is summarized in Table 5. Some of the key causes of the variances include:

1. Material and labor costs rose substantially between the time the project was initiated to actual establishment. This resulted in a negative variance for the erection of the fence.

2. Use of a replicated design, rather than a simple demonstration, resulted in several negative variances. Replication adds to the cost of both establishment and maintenance activities because of the increased level of complexity and the shorter rows for manipulating equipment. In particular, the cost of the mulch application is about seven times the original estimate. This is probably due to a combination of factors including inclement weather, weekend interference, coordinating labor from three organizations, as well as an original underestimation of cost, but the most significant impact was the amount of time spent turning and aligning equipment.

3. Fewer entries in the unmulched trees for vegetation control resulted in a positive variance, but also compromised the demonstration by exacerbating the poorer performance of the unmulched trees compared to the mulched trees.

4. Need for innovative responses to unplanned events resulted in unplanned expenses. The impact of voles on the trees the winter following planting required immediate action or the tree mortality would have been close to 100%. The cost to decapitate and

subsequently single almost every tree planted was not included in the original proposal, but was necessary to save the project.

Costs pertaining specifically to the grass component of the demonstration have not been included.

Table 5. Comparison of Actual Cost with Original Estimate

Item	Actual Cost ($'s)	Original Estimate ($'s)	Variance ($'s)	Explanation of Variance
Fence	35,392.97	26,000.00	(9,392.97)	Cost of fencing materials and labor increased significantly from the first quote obtained for the proposal to the initiation of the project.
Seedlings (17,362)	5,862.60	5,631.00	(231.60)	The number of trees required increased from 16,500 to 17,352 due to going from1100 to 1600 stems per hectare. Purpose of change was to obtain crown closure earlier, plus the trees are intended as pulp wood.
Site prep for trees, chemical	1,137.50	840.00	(297.50)	Initial underestimate of cost. Efficiencies gained by working the whole field.
Site prep for trees, mechanical	1,067.32	2,592.00	1,524.68	Initial overestimate of cost. Efficiencies gained by working the whole field.
Tree planting	9,339.75	6,930.00	(2,409.75)	Increased due to the increased number of trees, as well as underestimating the time involved to lay out the treatment areas and mark the planting spots accordingly.
Plastic mulch (41 rolls)	7,339.00	3,060.00	(4,279.00)	Original estimate was 17; actual purchase was 41. Used a total of 52 rolls of mulch; remainder provided by PFRA and NPARA.
Application of mulch	6,759.00	960.00	(5,799.00)	Original 6 days was an underestimate. Time was spent turning and aligning the machine. In addition, weather was rainy so application was inefficient.
Tree fertilization	1,064.75	6,270.00	5,205.25	Fertilization occurred in the first year only.
Turf grass seed (5 bags)	437.00	437.00	0.00	No variance.
Mow/cultivate between tree rows	3,705.00	12,000.00	8,295.00	Mowing and cultivation did not occur as frequently as it should have; some entries are not documented here because the work was completed by NPARA, or DMI in conjunction with test site maintenance.
Pre-emergent herbicide	0.00	504.00	504.00	Weather and time did not provide the opportunity to apply a pre-emergent herbicide.
In-row herbicide	5,925.00	4,500.00	(1,425.00)	Underestimate of cost of applications of glyphosate with shrouded sprayer, and clopyralid over the top of the trees.
Decapitation and singling	7,101.00		(7,101.00)	Not in the original estimate, but was necessary in order to save the trees, and therefore the whole project, from certain death by vole girdling.
Monitoring	2,401.00	1,500.00	(901.00)	Time required to measure the trees was underestimated.
Sub-Total	87,531.89	71,224.00	(16,307.89)	
Project Administration	3,561.00	3,561.00	0.00	No variance. Calculated as 5% of the total estimated cost of $71,224
Total	91,092.89	74,785.00	(16,307.89)	

FUTURE BENEFIT OF THE MURDOCH LAKE DEMONSTRATION

The Murdoch Lake Agroforestry Demonstration will continue to be used as a demonstration of one option of how trees can be incorporated into "normal" agricultural practices. The project collaborators will continue to work together to encourage opportunities for technology transfer, and make decisions regarding the on-going maintenance of the site. A plan is being developed for the introduction of grazing during the summer of 2009.

Additional future benefit will be gained from the site, as the success of the demo to date has encouraged others to come forward with suggestions of research questions that could be linked to the base demonstration. Currently PFRA is preparing a proposal to include other studies which would incorporate a better understanding of the science behind the demonstration. They propose looking at site utilization criteria such as root distribution, soil moisture gradients, hay yield relative to distance from trees, and others. PFRA also brought forward suggestions for expanding the extension role of the demonstration including the use of video.