The Benefits of Including Forages in Your Crop Rotation

Why Should You Consider Forages?

Forages can be a simple answer to soil erosion and decline in organic matter and fertility, a problem caused by modern cultivation and fallowing practices on much of the farmland in Western Canada. Forages can also help you reduce nitrogen fertilizer costs and the energy costs associated with applying nutrients.

Many farmers are using forages for positive results on any land, but particularly, on marginal crop land. The numerous benefits in any situation include:

- increased soil fertility when legumes are used
- increased soil quality
- better water filtration and internal drainage
- less disease in subsequent cereal crops
- reduced weed populations
- increased yields in subsequent crops
- better economics in subsequent crops
- greater and deeper carbon sequestering for greenhouse gas reduction

Forages require less cash investment than most grain crops. Although you will need special harvesting equipment, there are now many more options for harvesting forage crops than in the past. These include sharing equipment with other producers or using custom harvesters.

Increased Soil Fertility

Legume forages such as alfalfa are usually inoculated with rhizobia bacteria at the time of seeding to force the development of tiny nodules on the plant root hairs. These nodules capture nitrogen (N) from the atmosphere and make it available for plant growth and development, a process called nitrogen fixation. Because inoculated legumes are very efficient at nitrogen fixation, they are able to return their stored nitrogen to the soil through root decay for subsequent grain crops to use.

Research has shown that nitrogen produced as a result of rhizobia is the most cost-efficient way to supply the nitrogen needs of a legume crop, and to provide additional nitrogen benefits to the soil. If a legume/grass forage crop is fertilized commercially with nitrogen rather than being inoculated, a portion of the commercial fertilizer may be lost to volatilization or leaching and will not be available to the plant. Additionally, the legumes will not support nodulation when nitrogen fertilizer is available.

When a legume/grass stand is terminated, there will be high amounts of nitrogen for subsequent crops at the beginning of the following season, but it will be lost if it is not used. On the other hand, studies show that in a no-till system when herbicide is used for crop termination, nitrogen becomes mineralized and is released more slowly at rates that can be better used by plants. This type of nitrogen is released slowly throughout one growing season and into the next, and can improve protein levels in spring wheat.

Improved Soil Quality

Forages improve soil quality, a benefit that is especially important given that Manitoba soils have undergone serious degradation since the early part of the 20th century.

Did You Know?

- Average annual contribution of nitrogen by alfalfa is approximately 3% of the yield produced per acre or about 45 pounds per acre under a one-cut system, but can be as high as 107 pounds per acre during optimum growing conditions.
- Research trials show that soil N levels increased by a total of 130 pounds per acre after two years of alfalfa, when two cuts were taken each year.
- A five year alfalfa stand can provide considerable nitrogen for two following crops, and nitrogen benefits can last for up to seven years. A recent survey showed that cereal crops immediately following alfalfa require little added nitrogen and one-third of the average amount in the second year.
- Forages improve soil quality, a benefit that is especially important given that Manitoba soils have undergone serious degradation since the early part of the 20th century.

Greenhouse Gas Mitigation Program for Canadian Agriculture

Reducing greenhouse gas through healthy pastures, efficient feed practices and better manure management

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More Organic Matter

The extensive root systems of perennial forages add significant amounts of soil organic matter. A three-year perennial forage crop has been shown to return more than twice the soil organic matter as annual crops, such as cereals or pulse crops. Soil organic matter is the energy which fuels decomposer organisms, which in turn improve soil structure, water-holding capacity, and resistance to both compaction and erosion.

Less Crusting

Soils higher in organic matter have fewer tendencies to crust, which can be a problem when you are establishing many small-seeded crops and large-seeded pulses.

Better Water Infiltration and Drainage

Forage roots improve water infiltration, especially on clay soils. This results in improved soil drainage and water use by subsequent crops. It can also help producers get on the land earlier in spring when excess moisture is often an issue. Improved drainage is especially evident when alfalfa is terminated with herbicide, rather than tillage, because soil pores and root channels remain intact.

Subsoil Advantages

Studies have shown that a perennial legume's drainage effect on subsoil lasts for at least two years after stand termination, particularly with alfalfa. On clay soil, because of this improved drainage, alfalfa-based rotations produce higher wheat yields than those of annual grain-based rotations.

Less Tillage in Subsequent Crops

Because of increased organic matter and better internal drainage, soil becomes more workable and requires less tillage.

Less Root Disease

Studies on cereal crops following three year forage hay stands have shown that there are reduced occurrences of common root rot. Perennial forage crops break disease cycles by removing host plants from the rotation for a longer term, thus reducing the level of pathogens in the soil.

Reduced Salinity

Soil salinity is caused when high water tables bring salts to the soil surface. Through deep roots that improve drainage, forages help lower the water table level and thus reduce soil salinity. Alfalfa's extremely deep roots can also lower salinity levels in the rooting zone of subsequent crops.

Less Erosion

Crop rotations that include forages provide more soil cover. Soil has higher levels of organic matter and a more stable structure to reduce the potential for wind and water erosion.

Anti-Leaching Effects

Perennial legume forages can extract nutrients such as nitrogen and phosphorus (P) from up to a 10-foot depth due to their deeper and more permanent root system as compared to annual crops. In particular, the deep taproot of alfalfa can use nitrogen that has leached past the rooting zone of annual crops – up to a depth of three feet the first year to nine feet in the fourth year, according to recent research based on a four year alfalfa stand.

Reduced Weed Populations

The use of forages in crop rotations will reduce weed infestations in your subsequent crops, thereby reducing your need for additional herbicide inputs. This in turn may reduce the problem of herbicide resistant weeds. Following are the results of recent studies that show the benefits of forages in controlling weeds.

- 83% of producers in a University of Manitoba survey indicated fewer weeds in annual crops after alfalfa compared to rotations with annual crops only. Good control of wild oat, green foxtail and Canada thistle was observed for up to three years after alfalfa, although the alfalfa stands did have higher dandelion and shepherd's purse populations.
- In long-term crop rotation trials at Brandon using a 3-year alfalfa hay crop in a 6-year crop rotation, wild oat densities were substantially reduced compared to rotations with only annual crops.
- Herbicide-resistant wild oats and green foxtail can be controlled when forages are included in the rotation.
- One year of forage harvested as a hay or silage will remove weeds and their seeds with the forage, and therefore can reduce some weed populations to the same extent as herbicides in subsequent cereal grain crops.
- When forages are used in a no-till system, benefits include reduced annual weed density and longer suppression of weeds in following crops.
- In one study, no-till forages reduced populations of green foxtail by 98% and lamb's quarters by 17% compared to conventionally tilled forage.

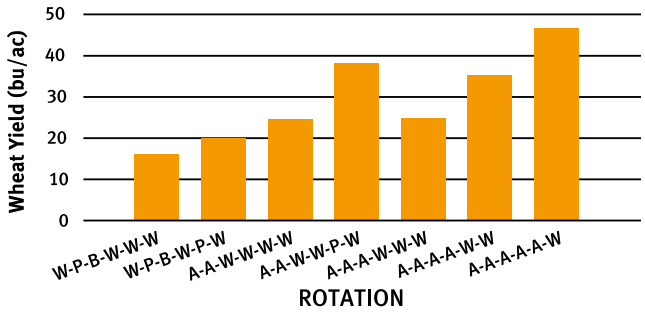
Increased Yield and Quality in Following Grain Crops

Forages can produce increased yields in your subsequent grain crops, and improve quality, too. Following are the results of research illustrating this.

- Seventy-one per cent of forage producers surveyed reported yield benefits in cereals after forage crops, with the greatest increases in higher rainfall areas of the black soil zones and lowest increases in the brown soil zones.
- No-till removal of alfalfa produced better yields in subsequent crops grown, especially in dry years.
- An eight-year study in the Red River Valley compared a three-year-alfalfa / five-year-consecutive-wheat rotation with eight years of consecutive wheat. The nitrogen benefits of the alfalfa-wheat rotation contributed an additional 18 bu/ac of wheat the first year and an additional 9 bu/ac per year when averaged over the five years.
- In the same alfalfa-wheat versus wheat study, there was a two per cent increase in wheat protein the first year after alfalfa, with increases ranging from 0.5 to one per cent for up to five years after alfalfa termination.

- Another Manitoba study comparing various rotations using wheat, peas and barley with wheat and alfalfa rotations showed predictably higher yields with alfalfa in the rotation. However, including peas in a wheat-wheat rotation also produced excellent yield benefits. (See chart, below for details.)

Various Six-Year Rotations and Yields in Manitoba



W=wheat; **P**= field peas; **B**= Barley; **A**= alfalfa.
No nitrogen fertilizer was added to any rotations.
Source: University of Manitoba, Entz et al. 2001 Agon J. 93-:495-503.

- In long-term studies in North Dakota, Manitoba, Saskatchewan and Alberta, wheat yields were 50 per cent higher from land previously cropped to alfalfa for three years than from land previously cropped to non-legumes such as corn, wheat, or flax.

Forage Production Tips

The following production suggestions can help you get an edge on establishment and, when appropriate, to terminate the stand in the most efficient manner. Stands should be terminated sooner rather than later for maximum nitrogen benefits. After two to three years of production is usually optimum.

Consider No-Till Seeding

Forage establishment in a no-till situation is usually better than in a conventional system, especially in drier years. Forage seeds are small and vulnerable to dry seedbeds and erosion that often occur with conventional techniques. Some residue on the soil surface can provide some of the same benefits (shading, lower soil temperatures and reduced blowing soil) as companion crops. Excessive residue from the previous crops should be removed for better establishment. The relative firmness of no-till soils also provides firm seedbeds for excellent seed-to-soil contact.

Choose Less Competitive Companion Crops

Although companion crops can often reduce forage yields in the second year by hindering stand establishment, they can also provide much needed shade and moisture conservation for new forage seedlings. There are situations where you may find a cover crop more economical than none at all, especially if you harvest the cover crop early for silage. In these cases, it is important to reduce the seeding rate of the companion crop to minimize the amount of competition for the forage stand being established. Ideally cover crops should be harvested earlier rather than later.

Consider No-Till Stand Termination

You can often get more efficient stand termination by substituting herbicides for tillage. Tilling is expensive, uses fossil fuel energy, dries the soil and, in wet years, may not kill the stand completely. However, depending on the forage species, herbicides use may be less costly and more effective. Because nitrogen release is slower, herbicides can improve the availability of nitrogen for uptake into subsequent crops.

Use an Effective Herbicide Combination

Glyphosate/2,4-D Amine, Lontrel™/2,4-D or glyphosate/Banvel™ are all highly effective combinations for stand termination, although higher rates of glyphosate are required for mixtures with higher grass content. Apply to at least eight inches of growth for greatest kill efficiency. Most glyphosate products can be used as a pre-harvest treatment, but allow a minimum of three to four days after spraying before harvesting to ensure a good kill. All glyphosate products are more effective when grasses have three to four or more leaves per stem, and when legumes are in the bud or a later stage of maturity. Always check herbicide labels for feeding restrictions harvesting to ensure a good kill.

Evaluate When to Terminate

Although maximum agronomic benefits from forages can be obtained after two or three years of production, the cost of establishment may dictate that a stand be left longer. Costs of production should be considered, so that both agronomic and economic benefits are balanced. Weed and pocket gopher encroachment may also determine the useful life of the forage stand. See the factsheet *Northern Pocket Gopher - Biology and Management* for details on their control.

Marketing Your Forage

In recent years, forage markets have opened up dramatically in the mid-west U.S. dairy and horse industries. Our cooler nights and longer day growing seasons produce forage that has a higher digestibility than the forages grown in the hotter, shorter days of the southern climates, and U.S. demand is increasing as our reputation grows.

You can market your own hay (See factsheet *The Basics of Marketing Cash Hay*) or you can use the services of professional marketers who have experience in this market. You may also want to list your hay for sale on the Manitoba Agriculture, Food and Rural Initiatives' free Hay Listing website. Contact the Manitoba Forage Council for more information on hay marketing.

Interest in the use of high-quality forage for backgrounding (increasing the value of Manitoba beef calves) has also created a local market for high-quality forage such as hay or silage. Manitoba studies have indicated feed efficiencies in the range of six to eight pounds of feed per pound of gain from high-quality, forage-only rations, compared to gains of three to four pounds of feed per pound of gain with more costly grain rations. As a result, forages have provided more opportunities for adding value in the beef and cow/calf industry.

Forage seed crops such as alfalfa, birds foot trefoil, tall fescue and perennial ryegrass can also produce good economic returns, and the residues from these crops are also a viable feed source for low-producing animals.

Another new opportunity in forages exists because of the health benefits that have been found in forage finished red meats, including the presence of healthy Omega-3 fatty acids and conjugated linoleic acids (CLAs).

Economic Considerations

To capitalize on the benefits of putting alfalfa into your rotation, it is critical to reduce nitrogen fertilizer applications on following crops. Do not rely on the soil nitrate-N test to measure nitrogen. Gauge nitrogen contribution through assessment of the legume stand and time of termination. (See Manitoba Agriculture's *Soil Fertility Guide*)

Because of reduced inputs and fuel costs, the cost of production for rotations that include forages have proven to be lower than those for rotations based on continuous grain crops. Net returns tend to be more stable across a range of crop prices for rotations that include forages. Studies continually show that including two to three years of forage crops in six-year rotations significantly reduce income variability, even more than crop insurance.

Alfalfa in a crop rotation provides overall higher returns due to additional hay revenue, as well as a reduction in N requirements and herbicide use after the alfalfa is terminated.

Revenue Increase Using 2 Years of Alfalfa in a Rotation

Year of Rotation	1	2	3	4	5	6	7	8	Net Return $/ac/yr averaged over 8 year rotation	Additional Income $/ac/yr averaged over 8 year rotation
Rotation 1 – Coarse Loam	Wheat	Navy Beans	Corn	Canola	Wheat	Navy Beans	Oats	Canola		
Net Income ($/ac)	**(37.20)**	**28.42**	**49.31**	**15.04**	**(37.20)**	**19.67**	**3.51**	**15.04**	**7.07**	
Rotation 1 – Coarse Loam	Wheat	Navy Beans	Corn	Canola*	1st Year Alfalfa**	2nd Year Alfalfa	Wheat***	Navy Beans		
Net Income ($/ac)	**(37.20)**	**28.42**	**49.31**	**(39.62)**	**42.16**	**26.74**	**42.40**	**19.67**	**16.49**	**9.41**
Rotation 2 – Coarse Loam	Wheat	Conven. Soybeans	Oats	Canola	Wheat	Conven. Soybeans	Corn	Canola		
Net Income ($/ac)	**(37.20)**	**22.46**	**14.76**	**15.04**	**(37.20)**	**22.46**	**49.31**	**15.04**	**8.08**	
Rotation 2 – Coarse Loam	Wheat	Conven. Soybeans	Oats	Canola*	1st Year Alfalfa**	2nd Year Alfalfa	Wheat***	Conven. Soybeans		
Net Income ($/ac)	**(37.20)**	**22.46**	**14.76**	**(39.62)**	**42.16**	**26.74**	**42.40**	**22.46**	**11.77**	**3.69**

Land value =$500/acre. Average costs of production and prices are 5-year averages taken from the 2002 Manitoba Agriculture Yearbook; average yields are 5-year averages taken from MASC data. Hay was cut twice annually, with a yield of 2.27 MT/ac on a dry matter basis, and sold at an average price of $0.015/lb standing crop. Not accounted for are the increased wheat protein content from the slow release of mineralized N in year 1, the second and third crop-year benefits in reduced nitrogen requirements, nor the improved soil quality characteristics.

* Cost include: Canola operating costs of $217.46 + Alfalfa operating costs ($5/ac custom spring broadcasting of alfalfa and $5/ac fall broadcasting of fertilizer, seed and fertilizer costs).

** Alfalfa value based on selling the standing crop at $0.015/lb to the hay harvester/buyer. Cost of production 1st year includes $7.50/ac land tax, $5/ac misc. Cost of production 2nd year includes $7.50/ac land tax, $5/ac fall custom spraying, $10/ac herbicide, $5/ac misc.

*** Less $20.10 for N fertilizer, $21.00 for herbicides, and $5.00 for fewer field passes. (Apply 30 lb/ac starter N, 33 lb/ac P, and fungicide.)

You Can Help Reduce Greenhouse Gas

When you grow perennial forages, you are also doing your part to reduce carbon, one of the components of greenhouse gas. The large root systems of perennial forages can store up to 2.7 times more carbon than annual crops, and place (sequester) it deeper into the ground for better longer-term storage. As well, the lack of annual tillage slows the breakdown and release of carbon from the plants' roots.

For more information on greenhouse gas, and what else livestock producers can do to help reduce it, visit the following websites:

- Canadian Cattleman's Association: **www.cattle.ca**
- Greenhouse Gas Mitigation Program: **www.agr.gc.ca/progser/ghgm_e.html**

For More Information

- Your local Manitoba Agriculture, Food and Rural Initiatives Growing Opportunities Centre.
- Manitoba Agriculture regional forage specialists.
- Manitoba Agriculture, Food and Rural Initiatives website: **www.manitoba.ca/agriculture.**
- Manitoba Agriculture, Food and Rural Initiatives' Soil Fertility Guide.
- Manitoba Forage Council website: **www.mbforagecouncil.mb.ca.**
- Glenlea Long-Term Rotation Study website: **www.umanitoba.ca/faculties/afs/plant_science/glenlea/glenlea.html**

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