Manitoba Forage Council
125 Patterson Cres.
Brandon, MB
R7A 6T7
Phone: (204) 726-9393
mfc@mbforagecouncil.mb.ca

FORAGE TECHNICAL BULLETIN

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Impact of alfalfa and fertilizer on pastures: The importance of including and maintaining alfafa

Introduction

Legumes, particularly alfalfa, are a valuable tool to improve the yield and nutritional quality of grass-based pastures. By fixing nitrogen, legumes add valuable nitrogen to the soil. This produces economic benefits, especially with the rising cost of commercial fertilizer. Maintaining alfalfa in pastures also promotes environmental sustainability.

Unfortunately, alfalfa content in pastures declines over time; maintaining its presence is a constant challenge. It's important to know how quickly the alfalfa content declines and the steps you can take to reverse or minimize the process.

Research Study

A ten-year grazing study was conducted at the Agriculture and Agri-Food Canada Brandon Research Centre from 1994-2004. The goal was to study how grass-based pastures can be improved by adding alfalfa or fertilizer. In the spring of 1994, pastures were established on a Souris fine sandy loam. The study used rotational grazing on four combinations of pasture type and fertilizer management. There were two different pasture types (100% grass or mixed alfalfa-grass) and two different fertilizer treatments (no fertilizer, or spring fertilization to full soil test recommendation levels). This resulted in a total of four treatments, shown in Table 1.

Table 1. Pasture Types and Fertilizer Treatments used in the Study

1) Meadow bromegrass No added fertilizer	3) Meadow bromegrass + Alfalfa No added fertilizer
2) Meadow bromegrass + Fertilizer	4) Meadow bromegrass + Alfalfa + Fertilizer

The grass only pastures were seeded with 10 lb/acre 'Paddock' meadow bromegrass. The mixed alfalfa-grass pastures were seeded with 7 lb/acre 'Paddock' meadow bromegrass and 3 lb/acre 'Spredor II' alfalfa. Starting in 1995, fertilizer was surface-applied as dry blend prior to grazing each spring. The concentration of each nutrient in the blend was based on soil samples collected the previous fall.

Each pasture was 9.1 acres and divided into five paddocks. Four tester animals were assigned to each pasture and these animals remained in their designated pasture for the entire grazing season. Additional animals were used to adjust stocking rates so that the amount of forage remaining after the grazing period was equal in each pasture. All the animals in all the treatments were rotated at the same time.

Information was collected on forage production, animal performance, and carrying capacity. In each pasture, forage samples were clipped and separated by hand to determine what percentage of the stand dry matter was accounted for by alfalfa and what percentage was accounted for by meadow bromegrass.

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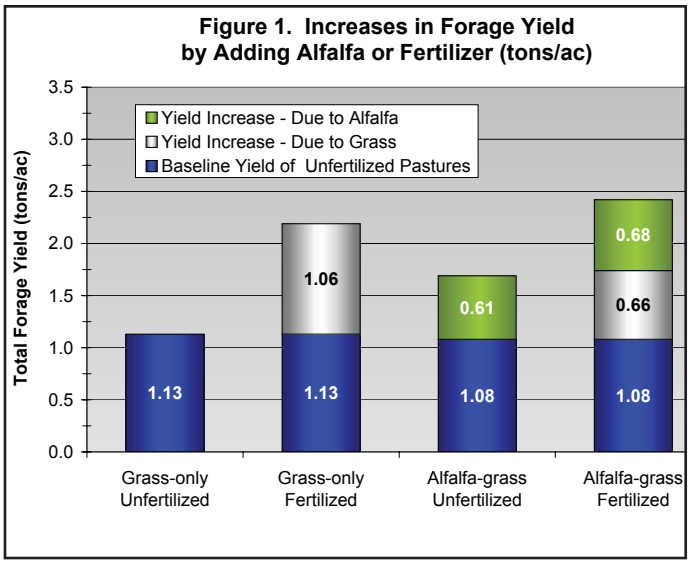
The Importance of Including and Maintaining Alfafa

Study Results

Effect of Alfalfa or Fertilization on Forage Yield

The effect of adding alfalfa and/or fertilizer on forage yield is shown in Figure 1. The blue bars (*black if printed in black and white)* show the baseline unfertilized grass yield for each pasture type. For the unfertilized grass only pasture, the baseline yield was 1.13 tons/ac. For the unfertilized alfalfa-grass pasture, the baseline yield of the grass component was 1.08 tons/ac. The slightly lower grass yield in the unfertilized alfalfa-grass pasture is likely due to the lower seeding rate of meadow bromegrass (7 lb/acre) compared to the pure grass pasture (10 lb/acre).



The white bars in Figure 1 show the increase in grass yield when fertilizer was added. In the grass only pasture, adding fertilizer increased grass yield by 1.06 tons/ac, almost doubling the yield. In the mixed alfalfa-grass pasture, adding fertilizer increased grass yield by 0.66 tons/ac, an increase of 61% over the unfertilized alfalfa-grass pasture.

The green bars *(grey if printed in black and white)* in Figure 1 show the increase in forage yield resulting from alfalfa in the mixed alfalfa-grass pastures. In the unfertilized alfalfa-grass pasture, alfalfa yield contributed an additional 0.61 tons/acre (a 54% increase) over the unfertilized grass only pasture. In the fertilized alfalfa-grass pasture, alfalfa added an additional 0.68 tons/acre to the forage yield, a 60% increase over the unfertilized grass-only pasture. Adding both alfalfa and fertilizer resulted in an increase in forage production of 1.34 tons/ac, more than doubling the yield of the unfertilized grass only pasture.

Persistence of Alfalfa in Mixed Pastures

In the mixed pastures, alfalfa accounted for 80% of the forage dry matter at the beginning of the study, but declined to less than 10% of the stand after 10 years. Averaged over the 10 years of the study, the unfertilized alfalfa-grass pastures maintained a higher percentage of alfalfa in the stand (36%) compared to the fertilized alfalfa-grass pastures (28%).

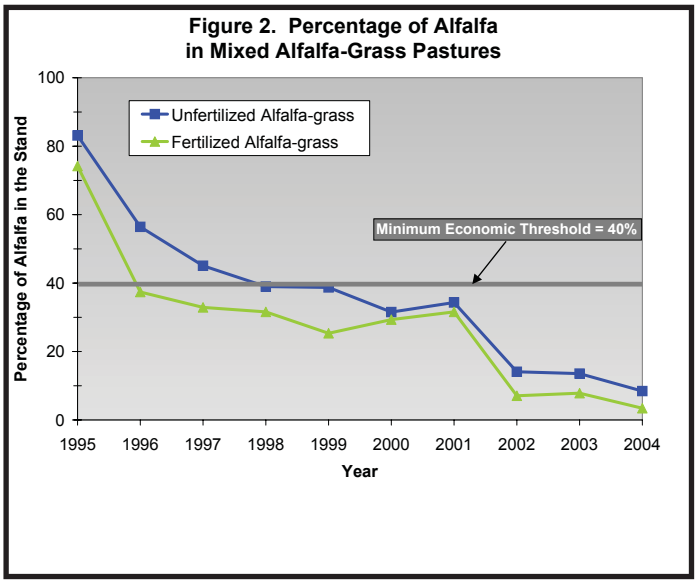


Figure 2 shows the percentage of alfalfa in the mixed alfalfa-grass pastures over the ten years of the study. Over this time period, there is a very clear and steady decline in the alfalfa component. The fertilized pastures had a slightly faster rate of decline compared to the unfertilized pastures. Grasses are able to use applied N fertilizer more effectively than legumes. As a result, grasses in a mixed alfalfa-grass pasture become

more competitive against the legume when too much N fertilizer is applied. Applying too much N fertilizer results in a decline of the legume component compared to unfertilized mixed pastures.

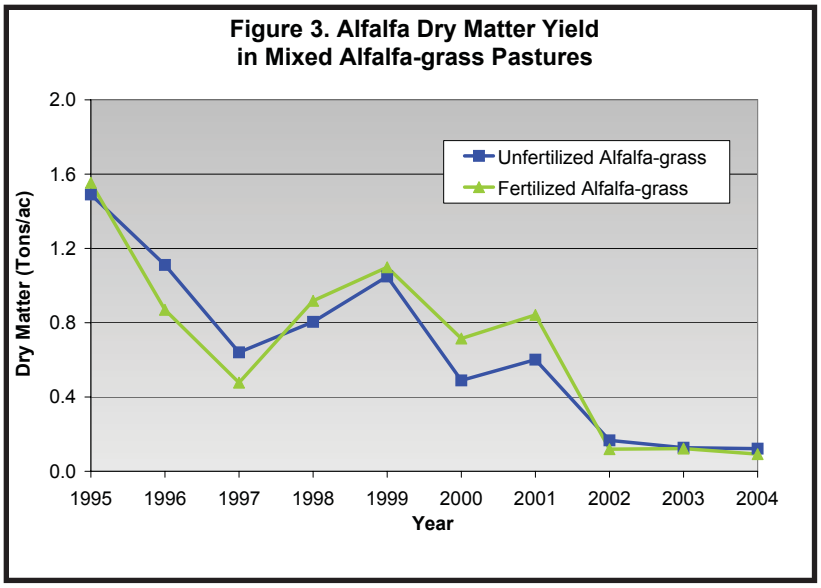
Previous research conducted at the Brandon Research Centre showed that alfalfa should make up a minimum of 40% of the dry matter yield in a mixed alfalfa-grass pasture to be economically and environmentally sustainable. This is shown in Figure 2 by the horizontal line. The alfalfa content in the mixed pastures dropped below that threshold very early in the study, within 4 years of seeding the unfertilized alfalfa-grass pastures and within 2 years of seeding the fertilized alfalfa-grass pastures.

What are some factors that could account for this rapid drop in alfalfa content? The rapid decline between 1995 and 1996 can be partly explained by the different growth patterns of alfalfa and grass plants over time. In 1995, the second growing season following seeding, the alfalfa plants were more vigorous than the meadow bromegrass plants. However, the vigour of alfalfa plants declined in later years, while the meadow bromegrass continued to produce larger crowns and higher yields. In addition, plant injury from grazing likely contributed to increased alfalfa winterkill. Taken together over time, these factors resulted in a decline in the percentage of alfalfa compared to that of grass.

Other research studies at the Brandon Research Centre have shown that alfalfa persistence under grazing is closely related to cultivar winter-hardiness. Spredor-type alfalfa cultivars used in pastures have greater persistence and suffer less winterkill than hay-type cultivars. Alfalfa winterkill and stand reduction are higher in mixed alfalfa-meadow bromegrass pastures compared to pure alfalfa stands, especially under rotational grazing. The vigorous meadow bromegrass plants are very competitive with alfalfa. The rate of decline of alfalfa in this study is typical of grazing-type alfalfas in mixed pastures, and management of these systems needs to be improved to either reverse or halt this deterioration.

Figure 3 shows the alfalfa dry matter yield in tons/acre over the 10 years of the study. This figure shows that the dry matter yield is closely related to the percentage of alfalfa in the stand. However, it is interesting to note the spike in alfalfa dry matter yield in 1998 and 1999, even though the percentage of alfalfa in the stand had either remained constant or had declined slightly during this time (see Figure 2). The 1998 and 1999 growing seasons had higher total growing-season precipitation than other years in the study. The spike in alfalfa yield relative to the percentage of the stand shows that alfalfa has more potential to respond to improvements in moisture conditions than meadow bromegrass.

Figure 3. Alfalfa Dry Matter Yield in Mixed Alfalfa-grass Pastures



Nitrogen Fixation by Alfalfa in Mixed Pastures

Previous research at the Brandon Research Centre showed that alfalfa could fix approximately 54 pounds of N for every ton of above-ground alfalfa dry matter production. Based on this, Figure 4 (next page) shows the estimated N fixed by alfalfa in the fertilized and

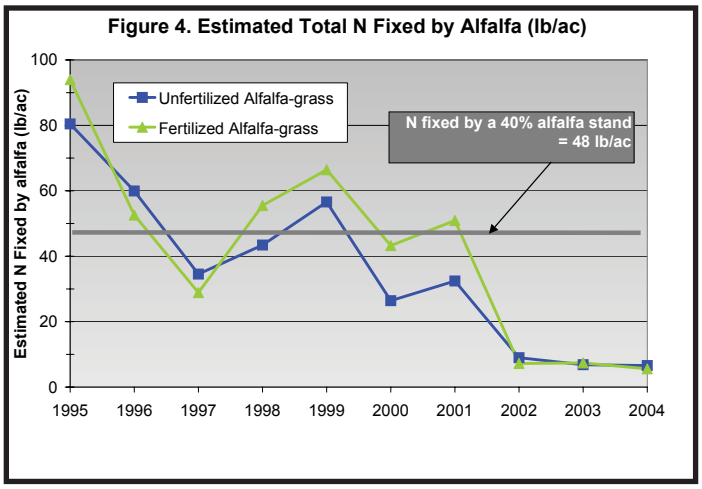
unfertilized mixed alfalfa-grass pastures. The horizontal line shows the amount of N fixed by a mixed alfalfa-grass pasture containing 40% alfalfa (48 lb/ac).

The value of the nitrogen fixed by alfalfa is shown in Figure 5. Values are in 2007 dollars, using a nitrogen cost of $0.50/lb. A mixed pasture with 40% alfalfa content could contribute approximately 48 lb/acre of nitrogen to the soil each year. This translates to a value of about $24/acre of nitrogen that is potentially available for uptake by the grass component of the pasture.

If there is less than a 40% stand of alfalfa in a mixed pasture, the addition of commercial fertilizer equal to the reduction in N fixation is needed in order to achieve a similar yield potential. Figure 5 shows that the need for supplemental N fertilizer occurs only a few years after establishment of a mixed alfalfa-grass pasture.

Effect of Alfalfa on Productivity of Mixed Pastures

Table 2 summarizes the benefits of adding alfalfa, especially to unfertilized pastures. By adding alfalfa to the pasture at the time of seeding, there were significant increases in pasture performance and economic productivity, even six to ten years after establishment (2000-2004). Between 2000 and 2004, the average alfalfa content was only 20% of the unfertilized alfalfa-grass pasture and only 16% of the fertilized alfalfa-grass pasture. In 2004 (the 10th year of the study), alfalfa content in both fertilized and unfertilized pastures was less than 10%. Although these levels are well below the optimum alfalfa content of 40%, they still provide an economic benefit.



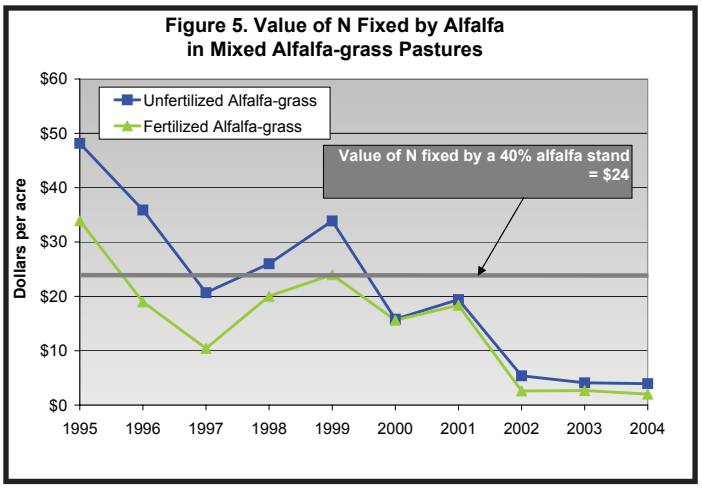


Table 2. Productivity of Grasser Steers – Average of 2000-2004 Grazing Seasons

	Unfertilized Pastures		Fertilized Pastures	
	Grass-only	Alfalfa-grass	Grass-only	Alfalfa-grass
Carrying Capacity ***Animal Unit Days (AUD)/ac***	41	67	97	104
Total Gain ***(lb/ac)***	82	146	221	229
Total Gain ***(lb/steer)***	163	179	185	185
Average Daily Gain (ADG) ***(lb/steer/day)***	2.2	2.5	2.6	2.6

The Importance of Including and Maintaining Alfafa

Conclusion and Recommendations

During the 10 years of the study, adding alfalfa improved pasture and animal productivity and economic gain while providing environmental benefits. Adding alfalfa at the time of seeding, with no added fertilizer, was economically the best management strategy (see the publication "Impact of Alfalfa and Fertilizer on Pastures: Economics"). Although it is important to include alfalfa at pasture establishment, it is even more critical to adopt practices that limit or prevent its decline in the stand.

Grazing management strategies to promote alfalfa persistence in pastures:

- Limiting grazing time in each paddock to less than 7 days;
- Leaving higher levels of residual forage at paddock exit;
- Providing longer rest periods between grazing events, with 45 or more days of rest when growing conditions are stressful;
- Avoiding adding excessive amounts of nutrients (fertilizer, manure, supplemental feed, etc.) to avoid giving a competitive advantage to the grass component in the pasture;
- Limiting or eliminating grazing of legume-containing stands through the critical period (5-6 weeks prior to a killing frost) to reduce winterkill (for example, using other forage sources during this time).

Researchers: Dr. Shannon Scott, Dr. Hushton Block, and Clayton Robins, Agriculture and Agri-Food Canada, Brandon Research Centre.
Writer: Orla Nazarko, Greenstem Communications.
Editor, Design: Corie Arbuckle, Corie Communications.

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For more information contact: Dr. Shannon Scott
Agriculture and Agri-Food Canada/Agriculture et Agroalimentaire Canada
Brandon Research Centre
Telephone (204) 578-3605
E-mail: sscott@agr.gc.ca

This technical bulletin is part of a series that have been developed as a result of this collaborative study.