Pasture management and animal production in Quebec: A review

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Petit, H. V. 1993. **Pasture management and animal production in Quebec**. Can. J. Anim. Sci. **73**: 000--000. Twenty percent of forage farmland was devoted to seeded and native pastures in 1991. Common white clover is widely found in native pastures but ladino clover is the main legume recommended. Timothy is the most popular grass for seeded pasture and its yield is increased by N fertilization. More than 30% ladino in pasture decreases the N fertilizer requirement. High fertilization of pasture where beef steers are kept at high stocking rates and moderately fertilized pasture where beef steers are kept at low stocking rates result in similar average daily gains. Excessive steer stocking rates can result in decreased herbage production at the end of the growing season which results in decreased weight gain.

However, feeding concentrate can compensate for herbage shortage and maintain weight gain of steers with a high stocking rate similar to that of unsupplemented animals on pasture with a low stocking rate. The difference in total beef production per hectare between heavily and moderately fertilized pastures is only 10% higher for the former when herbage surpluses conserved as silage and hay are fed to steers during winter. When herbage allowance is not limiting, there appears to be no advantage in supplementing grazing cattle with concentrate or protein.
Key words: Pasture, grazing, dairy cattle, beef cattle, sheep

Petit, H.V. 1993. **Régie du pâturage et production animale au Québec**. Can. J. Anim. Sci. 73: 000-000. Au Québec, environ 20% de la terre agricole cultivée en fourrage était en pâturage amélioré et non-amélioré en 1991. Le trèfle blanc commun est la plante la plus trouvée dans les pâturages non-améliorés, mais le trèfle ladino est la légumineuse recommandée. La fléole est la graminée la plus populaire pour le pâturage amélioré et son rendement en matière sèche est augmenté avec une fertilisation azotée. Avec 30% et plus de trèfle ladino dans la composition du pâturage, on peut économiser des coûts de fertilisation azotée. Un niveau élevé de chargement de bouvillons au pâturage peut être compensé par une fertilisation accrue, ce qui donne des gains de poids semblables pour les animaux à faible taux de chargement sur un pâturage peu fertilisé, et pour ceux ayant un taux élevé de chargement sur pâturage très fertilisé. Un taux de chargement trop élevé peut diminuer la disponibilité du pâturage à la fin de

la saison de végétation et diminuer les gains de poids des bouvillons. Cet effet négatif peut être surmonté en donnant du concentré aux animaux à taux de chargement élevé qui ont alors des gains de poids semblables à ceux ayant eu un faible taux de chargement. La différence de production de viande bovine (gain total par ha) entre les pâturages hautement et moyennement fertilisés n`est que de 10% lorsqu`on considère la transformation par les bouvillons des surplus d`herbe conservés en foin ou en ensilage. Lorsque la disponibilité de l`herbe n`est pas limitée, il ne semble y avoir aucun avantage à supplémenter les bovins au pâturage avec du concentré ou des protéines.
Mots clés: Pâturage, bovin laitier, bovin de boucherie, mouton

It is universally accepted that pasture grazing systems provide the most economical means of producing the quantity and quality of feeds required for ruminant maintenance and production (Table 1). This is an important consideration for two reasons. First, the price per kilogram of dry matter (DM) of feed grain relative to forages is high, and second, ruminant animals generally are not very efficient in converting DM of feedstuff (Walton 1983). Competitive beef, dairy and sheep production can only be realized with cheap feedstocks. Since feed constitutes an important fraction of the costs of meat and milk production, it is essential that the expense related to this component be minimized wherever possible. These considerations determine the importance of the role which can be played by pasture. In 1991, the province of Quebec ranked first in Canada in the number of milking cows,

Table 1. Economic efficiency of forage production[z]

Production system used to maintain livestock	Percentage cost		
	Netherlands	Canada	United States
Grazed pasture	100	100	100
Hay (all kinds)	140	152	160
Alfalfa hay	138	139	152
Timothy hay	143	167	161
Silage	187	193	195
Dehydrated forages	294	281	320
Grain and concentrates	314	457	425

[z] From Walton (1983).

fourth in number of sheep, fifth in number of steers and sixth in number of beef cows (Statistics Canada 1991). With these high numbers it is clear that forage should play an important role.

Importance of Pasture

In Quebec, more than 62% of the 3.43 million ha of farmland was assigned to forage production in 1991 (Statistics Canada 1992a). Of this area about 0.67 million ha (20%) were devoted to various types of pasture. These numbers were different in 1981 with 62% of 3.78 million ha of farmland in forage production, and pasture constituting only 11% of this area (Statistics Canada 1992a). Therefore, in 10 yr, farm area, and area of seeded land and pasture decreased; however, the percentage of farmland used as pasture increased from 1981 to 1991. This was paralled by a decrease in the number of cattle and calves whereas the sheep and lamb population increased by 8% (Statistics Canada 1992a).

Dry matter yield of pasture is quite variable and is in the following ranges: native, from 500 to 3000 kg ha^{-1} and seeded, from 3000 to 8000 kg ha^{-1}, depending on the management practiced (Rohweder and Thompson, quoted by Perron and Germain (1986)). The DM yield of supplementary pasture depends on the crop. The principal legume found in native pasture is common white clover (Trifolium repens). However, its yield is low and irregular throughout the growing season compared with the higher and more uniform growth of ladino white clover (Trifolium repens 'Ladino', Fig. 1). Ladino white clover is the main pasture legume recommended in Quebec. The grazing season is usually from the end of May to the middle of October (Dionne et al. 1972, 1981; Lalande et al. 1974).

In Quebec, there is more native than seeded pasture (Table 2). The Eastern Townships region has the highest area under pasture. The Agriculture Canada Research Station, Lennoxville, is located in the Eastern Townships and has played a key role in pasture research in Quebec (Cameron 1965, 1966; Gervais 1969; Dionne et al. 1972, 1975, 1981; Lalande et al. 1974).

Grazing System

The number of paddocks used for rotational grazing depends on yield and number of grazing days, generally one to seven. Many dairy farmers have intensified their rotational grazing by using electric fences to limit grazing to 1 d, but there has been no research in Quebec to determine the effectiveness of this strategy. Moreover, no comparison has been made between continuous and rotational grazing in Quebec. It has been shown at Lennoxville (Gervais 1969) that a system where pasture is cut four times during the season results in higher grass yields (mixture of timothy and bromegrass) and clover yields than a system where pasture is cut six times (Table 3). Moreover, cutting only two times resulted in a lower DM yield of clover but higher DM yield of grass. In this experiment (Gervais 1969), the pasture was hand clipped and no animals were used.

Forage Species

Cutting height depends on plant species. The most popular species

Table 2. Number of livestock on Canadian farms in 1988 by province (thousands)[z]

	Nfld.	P.E.I.	N.S.	N.B.	Qué.	Ont.	Man.	Sask.	Alta.	B.C.	Canada
Milking cows	4.2	20.9	33.6	26.8	568.0	465.0	66.0	53.0	124.0	75.0	1436.5
Sheep and lambs	7.1	6.1	38.0	9.0	111.0	201.0	22.0	51.0	198.0	53.5	696.7
Steers	0.2	19.2	8.8	8.4	58.0	350.0	95.0	210.0	490.0	46.0	1285.6
Beef cows	1.0	11.3	22.6	19.2	170.0	350.0	380.0	810.0	1365.0	223.0	3352.1

[z] From Agriculture Canada (1989).

Table 3. Area of pasture in Quebec classified by agricultural region[z]

	Thousands of acres		Thousands of heads	
	Improved pasture[Y]	Unimproved pasture[X]	Cattle and calves	Sheep and lambs
Beauce	93.5	97.3	176.9	6.6
Eastern Townships	90.9	123.6	177.7	14.5
Lower St.Lawrence and Gaspé	95.5	68.7	158.3	26.6
Mauricie Region	27.8	25.6	65.5	3.8
Nicolet Region	73.6	55.8	170.1	8.8
North-West Québec	47.1	70.4	65.6	7.2
Outaouais Region	70.9	106.3	107.1	10.8
Québec Region	83.4	66.4	182.7	11.6
Region North of Mtl	31.1	34.8	84.1	5.2
Region South-West of Mtl	26.8	37.3	103.1	7.1
Richelieu Region	37.6	34.3	150.2	5.7
Saguenay-Lac-St-Jean	65.8	42.5	84.7	8.1
Total	744	763	1526	116

[z] From Statistics Canada (1987).
[Y] Improved pasture = all land which is being used for pasture or grazing and which has had some improvements (cultivation, drainage, irrigation, fertilization, seeding or spraying for brush and weed control).
[X] Unimproved pasture = native pasture used for the grazing of livestock.

in Quebec are bird`s-foot trefoil (Lotus corniculatus), ladino white clover, orchard grass (Dactylis glomerata), timothy (Phleum pratense), bromegrass (Bromus inermis) and reed canary grass (Phalaris arundinacea) all of which, according to Perron and Germain (1986) can be grazed as close as 5 cm. In a simulated pasture system, Gervais (1969) observed that raising the height of cutting from 3.75 cm to 7.50 cm depressed the yield of clover without changing the yield of a mixture of timothy and bromegrass (Table 4). Therefore, total production of DM was affected only by clover yield with higher DM production when pasture was cut at 3.75 compared with 7.50 cm.

Animal and Plant Production

Timothy is the most popular grass for pasture and stored forages in Quebec due to its winter hardiness and ease of establishment. Although most experiments conducted in Quebec have involved timothy as the principal species, others used a mixture of ladino white clover and timothy; it has been demonstrated that a pasture containing ladino white clover requires less N fertilization than one with only grasses for similar total DM yields throughout the growing season (Dionne et al. 1972). Once the proportion of ladino white clover decreases, an application of 200 kg of N ha^{-1} increased DM yield. St-Pierre and Pelletier (1977) reported an increased DM yield of 16 kg for each kg of N applied to timothy up to 112 kg N ha^{-1}.

Pasture Exploitation

Nitrogen fertilization is known to increase DM and CP yields of timothy without any difference being observed between cultivars (St-Pierre and Pelletier 1977). The beneficial effect of N fertilization also is reflected in animal production. Cameron (1965) reported that total gain of lambs (kg ha^{-1}) grazing timothy increased linearly with N fertilizer rates from 0, 56, to 112 kg of N ha^{-1}. The larger mean increase per kilogram of N applied was obtained at the highest level of application (1.4 and 1.7 kg for the 56- and 112-kg N rates, respectively).

In an experiment conducted at the Lennoxville Research Station, Lalande et al. (1974) determined beef production from pastures based either on ladino white clover and timothy or on grass. The grass pasture was a blend of timothy, Kentucky blue grass (Poa pratensis) and bent grass (Agrostis spp.). Pastures were fertilized either moderately or heavily (Table 5). Animals on moderately fertilized pasture were at a relatively low stocking rate of 1.85 steer ha^{-1}, and animals on heavily fertilized pasture were at a stocking rate of 3.70 steers ha^{-1}. The grazing season was from 22 May to 20 October. During the 3-yr experiment, the average daily gains (ADG) were similar for steers on heavily (792 g) and moderately (821 g) fertilized pastures, indicating that the increased DM yield of heavily fertilized pasture met the requirements of the higher stocking rate. Weight gains per hectare were 423 kg and 228 kg for steers on heavily and moderately fertilized pastures, respectively. Dressed carcass produced per steer (233 kg) was not influenced by treatments. The only significant difference ($P<0.05$) between the two swards was the decreased dressing percentage for steers fed mixed grasses (51.92%) compared with those fed the white clover and timothy pasture (53.09%). Fertilization had no effect on weight of beef carcasses. However, carcass weight per hectare was twice as high for steers on heavily fertilized pasture (858 kg) than on moderately (433 kg) fertilized pasture, which would have an economic impact for beef production. The ADG obtained in this experiment ranged from 700 to 900 g which is similar or even higher than that obtained with unsupplemented silage (Veira et al. 1985) and hay (Petit and Flipot 1992).

In the experiment by Lalande et al. (1974), the effects of fertilization and stocking rate were confounded. Dionne et al. (1975) conducted another experiment over a 3-yr period to study the influence of fertilization and stocking rate on herbage and beef production. Stocking rates of 2.47 and 4.94 steers ha^{-1} were compared and the fertilizer rates were 1121, 2242 and 3363 kg ha^{-1} of 10--10--10. There was no unfertilized pasture. At the higher stocking rate, half the steers were fed 7.7 kg $head^{-1}$ d^{-1} of concentrate from the end of August to the end of October. Supplemented and unsupplemented steers were kept in different paddocks throughout the grazing season. The experimental design was a 3 x 3 factorial. All steers were slaughtered at the end of the experiment. The sward was seeded with a mixture of timothy (6.73 kg ha^{-1}), bromegrass (11.21 kg ha^{-1}) and Kentucky blue grass (5.60 kg ha^{-1}).

An increase in fertilizer rate from 1121 to 2242 kg ha^{-1} increased total DM production of herbage by 28%. High amounts of

P and K were used to maintain soil fertility. However, Dionne (1974) observed in a companion experiment that fertilizing with 3363 kg ha^{-1} of 10--10--10 increased the amounts of N, P and K found in underground water, suggesting that the maximum amount of fertilizer should not exceed 200 kg ha^{-1} of N, P_2O_5 and K_2O. The ADG (802 g) of steers was similar among treatments during the first half of the pasture season (until the end of August). At the stocking rate of 4.94 steers ha^{-1}, it was impossible to maintain pasture DM production to meet the feed requirements of the grazing steers during the complete pasture season, even at the highest fertilizer rate. In the second half of the season (after the end of August), weight gains of unsupplemented steers at the high stocking rate decreased by 50% due to decreased DM intake resulting from decreased herbage availability. Feeding concentrate to half of the steers from the end of August compensated for the herbage shortage but had no effect on DM intake of herbage. Dressing percentage was higher ($\underline{P}<0.05$) for steers at high stocking rate and fed concentrate (53.3%), intermediate for those at a low stocking rate (52.2%), and lower for unsupplemented steers at high stocking rate (50.8%). Fertilization increased dressing percentage. Fat cover was increased by fertilization and concentrate feeding, and decreased by a high stocking rate. Carcass grades of steers at a low stocking rate, unsupplemented at a high stocking rate and supplemented at a high stocking rate were 3, 4 and 2, respectively, which would correspond approximately to A3, B3 and A3 of the current grading system. The best carcasses were obtained with supplemented steers at a high stocking rate. The loin eye was increased by concentrate feeding. There was no fertilizer by stocking rate ($\underline{P}>0.05$) interaction. Finishing steers exclusively on grass pastures was possible only at the stocking rate of 2.47 head ha^{-1}. The lack of a significant effect of fertilization on weight gain in this experiment might be due to the high nitrate content of herbage (0.08% of $N\text{-}NO_3$), which is known to be deleterious to ruminants (Marty 1970). In this experiment (Dionne et al. 1975), a stocking rate of 2.47 steers ha^{-1} was optimum to maximize performance of steers fed only pasture since above this concentrate supplementation was necessary at the end of the pasture season. Weight gains per hectare were significantly ($\underline{P}<0.05$) higher for supplemented steers at the high stocking rate (733 kg), intermediate for unsupplemented steers at the high stocking rate (441 kg) and lower for unsupplemented steers at the low stocking rate (299 kg).

Pasture stocking rate should be calculated to match herbage productivity. One lactating dairy cow can consume an average of 15 kg DM d^{-1} of forage on pasture (Dionne et al. 1981), concentrate being supplied to meet the animal's total requirements for milk production. One spring-calving beef cow with her calf during the first 3 to 4 mo postpartum and producing 5 kg of milk d^{-1} will consume 13 kg DM d^{-1} of forage on pasture (National Research Council 1984). One gestating ewe averaging 70 kg of body weight will consume 1.75 kg DM d^{-1} of forage on pasture (National Research Council 1985). For a pasture season of 150 d, one dairy cow, one beef cow with her calf and one ewe will need, respectively, 2250 kg, 1950 kg and 262 kg of DM. To reach this goal, pasture management should be very intensive. For a DM yield of 4500 kg ha^{-1} throughout the growing season, 1 ha therefore could support 2 dairy cows, 2.3 beef cows or 17 ewes (Perron and Germain 1986). However, in these calculations, no considerations were made for pasture spoilage from treading, feces and urine, which would underestimate pasture requirements and lead to overestimation of carrying capacity. Under intensive pasture systems in temperate areas, up to 45% of the area may be covered with herbage rejected by cattle by the end of the grazing season (Arnold and Dudzinski 1978). In another study (Simpson and Stobbs 1981), 2--3% of the surface area had feces dropped on it by the end of the grazing season, which caused incomplete consumption over 15--29% of the area. Such losses must be considered as well as dry matter intake when calculating stocking rate in order to meet adequately requirements of grazing animals. In fact, data from France have shown that excessively high stocking rates for ewes and lambs decrease herbage availability enough to decrease weight gain of lambs. However, this deleterious effect can be overcome by supplementation with concentrates (Prache et al. 1990) but has no effect on weight gain of lambs when herbage allowance is adequate.

Nitrogen fertilization maintains higher DM production of herbage throughout the pasture season. Dionne et al. (1972) reported that the DM yield of heavily fertilized pasture (560 kg ha^{-1} of 0--15--30 twice throughout the growing season for ladino and timothy pasture, and 1120 kg ha^{-1} of 0--15--30 once and 224 kg ha^{-1} of 33--0--0 four times throughout the growing season for grass pasture) was 1744 kg ha^{-1} in mid-September compared with 710 kg ha^{-1} on moderately fertilized pasture (560 kg ha^{-1} of 0--15--30 for all pastures, and 224 kg ha^{-1} of 33--0--0 twice for grass pasture only). The response to N fertilization depends however of the type of species in the pasture. Dionne et al. (1972) observed that N fertilization had no effect on DM yield of a ladino and timothy mixture which would decrease fertilizer N requirements. However, DM yield of a pure grass (mixture of timothy, Kentucky blue grass and bent grass) sward was increased by 9% when fertilizing twice throughout the growing season rather than once with 224 kg ha^{-1} of 33--0--0.

In the same experiment, Dionne et al. (1972) compared weight gains of steers grazing pasture based on grass or on a ladino and timothy mixture, with steers kept either at a low stocking rate (1.85 steer ha^{-1}) on moderately fertilized pasture or at a high stocking rate (3.70 steers ha^{-1}) on heavily fertilized pasture. Steers grazing heavily and moderately fertilized pastures produced for the growing season total gains of 413 and 230 kg per ha^{-1}, respectively, this being a 79% increase in favour of the highest fertilization and high stocking rate (Table 6). With the low stocking rate, there was a surplus of herbage that had to be harvested and stored as hay or silage. The difference in total gains for the growing season between the two fertilizer treatments (295 kg ha^{-1} and 169 kg ha^{-1} for the moderately and heavily fertilized pasture, respectively) was decreased to 10% when the herbage surpluses conserved as silage and hay were taken into account. Dionne et al. (1972) calculated under Quebec conditions the total beef production obtained from heavily and moderately fertilized pastures taking into account DM production from both pastures and the surplus of herbage harvested and stored. Values of DM intake observed for each treatment were used in these calculations and they were similar to those reported by Cameron (1966). Total gain per ha on pasture was 16% higher ($P<0.01$) for a pure grass sward (594 kg) compared with a ladino and timothy mixture (512 kg) and it was 10% higher ($P<0.01$) for heavily (582 kg) compared with moderately fertilized (525 kg) pastures.

Animal Production on Pasture and Supplementation

A 12-wk experiment was conducted at the Lennoxville Research Station and showed that dairy heifers averaging 325 kg had an ADG of 0.97 kg when kept on pastures based on quack grass (Agropyron repens). In this experiment, each group of six heifers was kept on a 0.15-ha paddock and the animals were rotated when the sward was reduced to the 8 cm height (Petit, H.V. unpublished data). The pasture was fertilized with 150 kg ha^{-1} of N each time the animals were rotated. Another experiment at the same location (Petit and Yu 1993) with zero grazing showed that younger dairy heifers (152 kg) fed a mixture of 70% timothy and 30% red clover had an ADG of 0.73 kg which is close to the optimal weight gain of 0.7 kg expected from such animals (Petitclerc et al. 1984). These results show the potential of well managed pastures.

Another experiment with sheep showed that ADG of weaned lambs fed only pasture at a low stocking rate (25 head ha^{-1}) was equivalent to those at a high stocking rate (50 head ha^{-1})

supplemented with either barley or hay (Boucher and Grégoire 1989). Similarly, in Great Britain, no effect on weight gain of lambs was found when availability of high quality ryegrass (Lolium perenne) pasture was not limiting and when pasture was supplemented with silage (Martin et al. 1991a). The only beneficial effect of concentrate or forage supplementation on pasture was to reduce liveweight loss of lactating ewes without changing stocking rate (Martin et al. 1991b). This practice, however, is unlikely to be economic since weight loss by the ewe during lactation can be restored at less cost with grazed herbage later in the season.

The effect of protein supplementation on weight gain of grazing animals is more controversial. An experiment conducted at the Lennoxville Research Station showed that a daily intake of 260 g of fish meal $head^{-1}$ did not change the ADG of dairy heifers averaging 325 kg and grazing ad libitum a pasture based on quack grass (Petit, H.V. unpublished data). The lack of protein supplementation effect in this experiment was thought to be a result of the low fish meal intake or the low degradability of protein of fresh grass though this was not determined. In fact, beef steers of similar weight fed a highly rumen-degradable forage such as high-moisture timothy silage supplemented with 400 g fish meal daily showed an increased ADG compared with those fed unsupplemented forage (Petit and Flipot 1992) and it has been shown that protein degradability of fresh timothy is lower than that of timothy silage (Petit and Tremblay 1992) probably due to proteolysis occuring during the fermentation process of silage.

Another experiment using grazing dairy heifers weighing between 100 and 200 kg showed that weight gain of heifers supplemented with low or high rumen-degradable protein was significantly higher than that of unsupplemented heifers (Petit and Yu 1993). However the ADG was similar for grazing heifers fed with low and high rumen-degradable protein supplements suggesting that the amount of total N ingested rather than protein degradability was one limiting factor for growth of heifers fed fresh grass; this is corroborated by the high correlation ($\underline{r}$=0.85, $\underline{P}$=0.0001) observed between weight gain and total N intake in this experiment. Protein of low degradability may, therefore, be required only for growing cattle fed silage and not for those on pasture. On the other hand, low rumen-degradable protein such as fish meal increases milk yield of ewes fed fresh forage and growth rate of their suckling lambs (Penning et al. 1988). Barry (1981) concluded that protein absorption from the small intestine was limiting for growth of weaned lambs on ryegrass spring pasture.

Pasture and Silage

A 3-yr study was conducted by Dionne et al. (1981) to compare milk production from different systems based on pasture or silage. Three groups of 10 Holstein cows were used over three summers and fed either timothy pasture, ladino--timothy pasture, or a mixture of corn and alfalfa-timothy silages. All pastures were fertilized with 120 kg of K_2O, and timothy pasture was also fertilized with 168 kg ha^{-1} of N. The different pastures were compared to determine if milk production would be similar for N-fertilized grass pasture and grass and legume pasture not fertilized with N in order to save on cost of N fertilizer. The grazing season extended from 29 May to 7 October, and the stocking rate was 3.09 cows ha^{-1}. Forage DM yield was similar for all species. Milk production per hectare was highest from fields harvested for silage: 11 891 kg from silage compared with 8147 kg from pasture. The forage-producing area required per cow was 50% less for the silage crop (0.15 ha) than for the pastures (0.28 ha). Considering milk production per hectare and the area required for feeding, silage was more efficient than pasture. However, daily milk production was higher for cows on pasture (21.7 kg) than for those fed silage (18.2 kg). Milk protein percentage was high for cows on timothy pasture, intermediate for cows on ladino--timothy pasture and lower for those receiving silage. Feed efficiency was better for cows fed silage compared with those on pasture (0.88 vs. 1.16 kg DM kg^{-1} of milk) probably as a result of lower DM intake for the former. The lowest feed efficiency for cows on pasture could have been avoided by increasing the stocking rate per hectare which would have increased milk production per hectare but decreased milk yield per cow as reported by Gordon (1973) in Ireland and by McMeekan and Walshe (1963) in New Zealand. Milk production was similar for timothy and ladino--timothy pastures. Nitrogen fertilization was applied to timothy pasture while the ladino--timothy pasture was not fertilized, with both having similar DM yield. These results again suggest that a grass--legume association allows for an economy of N fertilizer. Moreover, the pasture system would have resulted in a potential saving in fossil fuel compared with the silage system.

Future Needs for Pasture Research

Research on pasture was conducted many years ago. At that time, the herbage was usually grazed at the bloom and head emergence stages as suggested by values of chemical composition of pasture available in published experiments. However, the present popular practice on farms is to allow the animals to graze vegetative herbage and to move them many times a week. Many dairy farmers intensify their rotational grazing by using electric fences to limit grazing to 1 d but there has been no research to determine the effectiveness of this strategy. Dairy farmers often report that it is possible to decrease the daily amount of concentrate fed to dairy cows grazing immature pasture, but no scientific data are available in Quebec on cost savings of concentrate in such situations. Moreover, no comparison has been made between continuous and rotational grazing in Quebec. Research is also required to identify plant species other than timothy and ladino white clover that are more persistant under grazing pressure. More emphasis should be put on pasture research as it is an important aspect in animal production and is of considerable economic importance to farmers.

CONCLUSION

Pasture in Quebec constitutes an excellent feeding system for cattle and sheep. A system in which pasture is cut four times during the season gives higher grass and clover yields than one in which pasture is cut six times. Timothy is the most popular grass for pasture due to its winter hardiness and ease of establishment. Dry matter yield of timothy is increased by N fertilization but more than 30% legume in pasture allows a saving in N fertilizer without any effect on DM yield. Supplementation of pasture generally has no effect on animal performance when herbage availability is not limiting. In areas where land is very expensive, a silage-feeding system might be preferable due to the higher DM yield per hectare. However, the effect of forage system on soil degradation in Quebec is unknown.

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Fig. 1. Dry matter yield of ladino white clover (▯) and common white clover (▯) throughout the growing season. From Gervais (1978).