GRAZING ALFALFA SYSTEMS IN THE ARGENTINEAN PAMPAS

D. H. Basigalup and E. Ustarroz[1]

ABSTRACT

Alfalfa is the most important forage crop in Argentina, where about 4.7 million hectares are grown. In the Pampa Region, more than 90% of the area devoted to alfalfa is utilized under direct grazing for both beef and dairy production. In this paper we discuss the main concepts necessary to implement adequate and practical rotational grazing systems. Particular attention is given to issues such as grazing frequency, grazing period, pasture use efficiency, and alfalfa quality variation by canopy strata and time of year. Specific management requirements for beef and dairy operations are also discussed. Direct grazing can play an important role in reducing operative costs and decreasing quality loss due to forage conservation (hay or silage). Argentine experience indicates that is possible to reach high animal response under direct grazing, provided appropriate management practices.

Key Words: alfalfa, grazing systems, grazing pressure, forage quality, beef, dairy.

INTRODUCTION

Argentina, with nearly 4.7 million hectares grown in 2006/07, is the second largest alfalfa producer in the world. The total area devoted to alfalfa is mostly concentrated in the Pampa Region (Central Argentina) and is planted 50% as pure stands and 50% associated with temperate grasses (mainly *Festuca arundinacea, Bromus catharticus, Lolium spp.* and *Dactylis glomerata*). While pure stands are primarily used for dairy and hay, mixtures with grasses are primarily used for beef production.

During the 2006/07 season, the total size of the Argentine alfalfa seed market was about 9,000 tn (9 million kg), including both raw and coated seeds. From that amount, approximately 20% is national production and the remaining 80% is imported, mainly from USA and Australia. The latter also includes seed increases for domestic cultivars that are carried out overseas. Regarding fall dormancy groups, those 9,000 tn are divided as follows: FD 3-5: 3%, FD 6: 9%, FD 7: 14%, FD 8: 35%, FD 9: 37%, and FD 10: 2%. The trend for the near future is a significant increase in the use of non-dormant varieties. According to INTA's National Alfalfa Cultivar Evaluation Network [(23)], average 4-year accumulated forage yields for a high number of commercial cultivars included in the trials conducted between 1994 and 2002 throughout the Pampa Region ranged from 21.85 tn DM ha^{-1} (5.46 tn DM ha^{-1} $year^{-1}$) at Anguil (La Pampa Province) to 80.05 tn DM ha^{-1} (20.01 tn DM ha^{-1} $year^{-1}$) at Marcos Juarez (Cordoba Province). It is important to mention that these trials were conducted under no irrigation and no fertilization conditions.

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More than 90% of the alfalfa grown in Argentina is utilized under direct grazing for both beef and dairy production. Compared to confined systems, direct grazing has the following advantages: i) lower operational costs; ii) better use of alfalfa quality relative to conserved forage (hay or silage); and iii) healthier animal products for human consumption (for instance: compared to feed lot operations, beef produced on pastures has lower total cholesterol content, less intramuscular fat content, and higher unsaturated fatty acids omega-3/omega-6 relationship). On the other hand, the disadvantages of direct grazing are: a) risk of bloat; b) longer fattening period; and c) lower milk production on an individual cow basis [(1)].

Correct alfalfa grazing management, in order to complement high animal production with high levels of pasture yield and persistence, must be based upon the particular growing pattern of the plant. New stems in alfalfa arise in series or lots that come from axillary as well as crown buds. When a lot of stems are actively growing, the buds responsible for the next lot are dormant. Right before blooming, when stems are sufficiently elongated, growth rate is at its maximum and buds responsible for the next lot become active. If the alfalfa were grazed before that moment, removing the apical meristems, stem growth would be stopped; as a result, forage yield would be diminished and regrowth delayed. From grazing viewpoint, alfalfa has two important features: i) it can reach values of foliar area index (IAF) close to 10 or 11 without losing photosynthetic capacity in the lower leaves; and ii) speed regrowth after grazing depends primarily on reserve carbohydrate content on crown and root rather than on remnant leaves. Based on the previous remarks, the best way to use alfalfa is under rotational grazing in which the main objective must be to combine adequate levels of grazing intensity with appropriate resting time. Alfalfa can tolerate intensive grazing periods as long as they are not frequent. Repeated interruption of the carbohydrate reserves cycle leads to loss of stand and the subsequent decrease in beef or dairy production.

Forage quality also plays a very important role in animal performance. If alfalfa pastures were grazed at full blooming (stage in which forage yield and carbohydrate reserves are very high), digestible DM content would be very low. As a compromise, grazing alfalfa at 10% blooming integrates acceptably high forage yield with adequate levels of forage quality and root and crown carbohydrate reserves. For those months in which temperatures and day length are not high enough to allow blooming, alfalfa should be grazed when the regrowth from the crown is about 5-cm tall. From the physiological viewpoint, the latter is equivalent to 10% blooming.

When implementing a rotational grazing system, three fundamental issues must be defined: 1) **Grazing Frequency (GF)**, or pasture resting period. GF depends on environmental conditions (season, temperature, moisture, etc.) and fall dormancy (the more non-dormant the shorter the resting period). In general terms, across the Pampa Region, GF ranges from 23 days (FD 7-10 in spring/summer) to 42 days (FD 4-6 in middle-fall/winter); 2) **Grazing Period (GP)**, or number of days in which animals graze on a particular strip of pasture. GP depends on the type of operation (dairy or beef) and fall dormancy (the more non-dormant the cultivar the shorter GP in order to avoid consuming regrowth from crown buds). For the Pampa Region GP goes from 1 day (dairy production) to 7 days (beef production on FD 4-6 cultivars); and 3) **Degree of Pasture Utilization (PU)**, a concept related to grazing pressure that results from the interaction between forage availability and stocking rate, which –in turn- produces different levels of animal intake. In determining PU, variation of alfalfa forage quality by canopy strata (Table 1) or by days of grazing (Table 2), also plays an important role. The combination of all of these factors impacts on beef or dairy production both on an individual and an area-unit basis.

Table 1 – *In vitro* Digestibility (IVDig) and Crude Protein (CP) content (expressed as % of DM) of green alfalfa leaves and stems discriminated by 10-cm canopy strata. Adapted from Ustarroz *et al.* [24] and Romero *et al.* [21].

Strata	Composition (% DM)		Green Leaves		Green Stems	
(cm)	Leaf	Stem	IVDig	CP	IVDig	CP
> 30	65.3	34.7	70.0	28.5	70.0	16.0
30-20	36.7	63.3	70.7	28.5	62.5	13.0
20-10	14.2	85.8	67.0	30.0	55.5	11.0
< 10	6.0	94.0	67.0	31.0	48.0	10.0

Table 2 – Variation of forage quality (whole plant) of alfalfa cultivar CUF 101 in day 1 and day 7 of the grazing period. Values are expressed as % on a DM basis.

Variable	Día 1	Día 7
In Vitro Digestibility	63.2	45.1
Crude Protein	19.7	11.7
Cell Wall	23.0	29.1

GRAZING SYSTEMS

Beef production. As mentioned before, the most important parameters that define a rotational grazing system are GF and GP. For the FD types of alfalfa cultivars presently used in the Pampa Region (temperate climate and no irrigation), many studies conducted by INTA for beef production stated an average GF from 35 to 42 days and an average GP of 5 to 7 days. Obviously, these figures are indicated as a general rule; it should not be overlooked that the environmental factors (location, weather conditions, FD, season, etc.) can have a dramatic impact on both parameters.

In alfalfa, significant differences in beef production among grazing systems are more related to the capacity of reaching higher yields (DM ha^{-1}) than any other variable. The negative effect of continuous grazing on pasture productivity and persistence were pointed out by several authors [21]. However, variations among grazing systems *per se* only could explain a small proportion of beef production increases if it is assumed that other management components remain stable [14]. When the appropriate GF for each time of the year is respected, the number of paddocks (grazing strips) or the duration of GP (assuming a maximum of 7 days) do not impact on the alfalfa yield.

In this context, the use of an optimal stocking rate is by far more important in determining individual live weight gains and/or beef production per unit area.

In the Pampa Region the most popular alfalfa grazing system for beef production is the so called "**7x35**" because it results from a combination of an average of 7 days of grazing (GP) and 35 days of resting (GF), which means a total grazing cycle of 42 days. The 7x35 system is simple, effective and cheaper than others that are based on higher number of paddocks. To organize the system, the pasture is divided into 6 grazing strips o paddocks, which are grazed in turns, following a regular schedule. During spring and the beginning of summer, when alfalfa is growing very rapidly, succession of paddocks can be altered in order to maintain forage quality sufficiently high. The escaped paddocks are generally used for hay production. On the other extreme of the systems scale is the so-called "**1x35**", that combines 1 day of GP and 35 days of GF, and gives a total grazing cycle of 36 days. This system, which divides the pasture into 36 1-day grazing paddocks, is more intensive than the 7x35 system and offers more flexibility for escaping strips so as to keep highly enough forage quality; on the other hand, it requires more infrastructure (mainly fences) and personnel attention. Due to the latter, the 1x35 system is only exceptionally used in the Pampas for beef operations.

Using slightly different combinations of GF and GP, some other grazing systems ranging in between the two previously described have been proposed. For example, Kloster *et al.* [15] compared a **2x34** system (18 paddocks) with the traditional 7x35 system in an experiment carried out at INTA Marcos Juarez. Using the same grazing pressure for both systems, they found that the 2x34 system produced 11.2% ($p<0.05$) more kg of beef ha^{-1} than the other. According to the authors, the total grazing cycle of 36 days (2+34) in the first system produced 12.3% ($p<0.01$) more forage yield than the 7x35 system (total cycle of 42 days), allowing a 12.9% ($p<0.01$) increase in the stocking rate and thus producing a higher amount of beef per unit area.

An alternative grazing system is the so called "**leaders**" (L) and "**followers**" (F), in which two groups of animals are formed in order to alternatively graze the same paddock: group L enters first and consumes the upper half of the canopy, after which enters group F and grazes the remaining forage in the paddock. Each group of animals is conformed based on nutritional requirements relating to category, developmental stage, productivity level or species. A key point in the use of the LF system is to manage forage allowance in order to avoid important feed restrictions in the F group. In that sense, Redmon [19] suggested that the L group should consume no more than 1/3 of the initially available forage and Blaser [2] took that level up to 50%. In Argentina, Kloster *et al.* [16] did not find any difference in beef production per hectare between a 6x35 and a LF (3 days for each group) system. Nevertheless, the use of LF could be useful in helping to handle the excess of forage in spring/summer, and provided there is a possibility of forming groups of animals with different nutritional requirements.

Whatever the chosen combination between GF and GP, the main goal for any grazing system must be to reach a high degree of forage utilization through an adequate grazing pressure. In doing so, it is important to take into account that the effect of pasture use intensity on individual live weight gains is different throughout the year (Table 3). In this context, when planning increases in stocking rates not only differences of alfalfa quality by strata of canopy should be considered (Table 1) but also the time of the year. As a general rule, systems that include high stocking rates produce more beef per unit area, and very often justify some decrease on individual live weight gains. However, losing some degree of individual gains may delay the fattening process and negatively influence the profitability of the operation and/or the returning speed of investment. Therefore, the grazing system to be used for beef production must be in total agreement with the productive objectives of the whole operation and integrate every single factor that contributes to the final equation.

Table 3 – Relationship among forage allowance (FA), forage harvesting efficiency (FHE) by the animals and individual live weight gains (ILWG) on steers in two seasons along the year. Adapted from Ustarroz *et al*. [24].

Season	FA (% DM lw^{-1})	FHE (%)	ILWG (g day^{-1})
Spring	3.3	75	1002
	4.4	64	1032
	7.9	39	1097
Summer	2.4	84	565
	2.8	78	595
	4.9	61	699

Dairy production. When formulating diets for dairy cows, especially for those with high milk potential, the first criteria to be considered should be animal intake (AI). Total amount of consumed DM depends upon animal characteristics (weight, age, level of production, lactation time, etc.) as well as forage nutritional value. Under grazing conditions, three other components must be included: i) pasture structure (height, stand density, etc.); ii) environmental conditions; and iii) grazing management (forage allowance, grazing system, level of supplementation, etc.).

In dairy operations solely under direct grazing, forage allowance (FA) has a direct effect on milk production. In operations in which pasture is just one of the diet components, like in the vast majority of dairy farms in the Pampa Region, FA also has incidence on addition and substitution effects among feeds in the diet. Even though FA can be expressed as g DM kg live $weight^{-1}$ or as % or live weight, Comeron and Romero [12] suggested that in the case of dairy cows it is probably better to express it as kg DM cow^{-1}. FA is asymptotically related to AI and milk production. Comeron *et al.* [7] concluded that the minimum level of FA in order to obtain maximum values of AI and milk production is equivalent to 1.75*MEI, where MEI is the maximum expected intake and is expressed as kg DM cow^{-1} day^{-1}. The value of MEI can be calculated from the equation proposed by Neal *et al.* [17]:

$$MEI\ (kg\ DM\ cow^{-1}\ day^{-1}) = (0.025 * live\ weight) + (0.2 * liters\ of\ milk\ cow^{-1})$$

Using this equation, a cow of 550 kg of live weight that produces 25 liters of milk day^{-1}, would have a MEI value of 18.75 kg DM day^{-1} (or 3.4% of its live weight). So, FA for that particular cow should be 1.75*18.75 = 33 kg DM day^{-1} (or 60 g DM kg of live $weight^{-1}$). This value is consistent with the report of Castro *et al.* [3], who did not observed any milk increase over a FA = 30.25 kg DM day^{-1} (or 55 g DM kg of live weight^{-1}).

If the goal is to maximize animal response under grazing conditions alone, the best way to achieve it -based on the previous remarks- is to use high levels of FA, or in other words utilize low stocking rates. In such a context, pasture use efficiency (PUE = AI/FA) will be low, with values no larger than 50-55% [18]. However, using these levels of PUE would imply wasting a large amount of forage and, consequently, obtaining low milk production per unit area. On the contrary, increasing alfalfa PUE to a significant degree would negatively affect AI and milk production due to quality losses from the top to the basis of the alfalfa plants (Figure 1). Thus, if the objective is to increase individual cow productivity under high PUE, some level of supplementation with conserved forages and/or concentrates must be used. Additionally, the latter would allow offering better-balanced diets to cows.

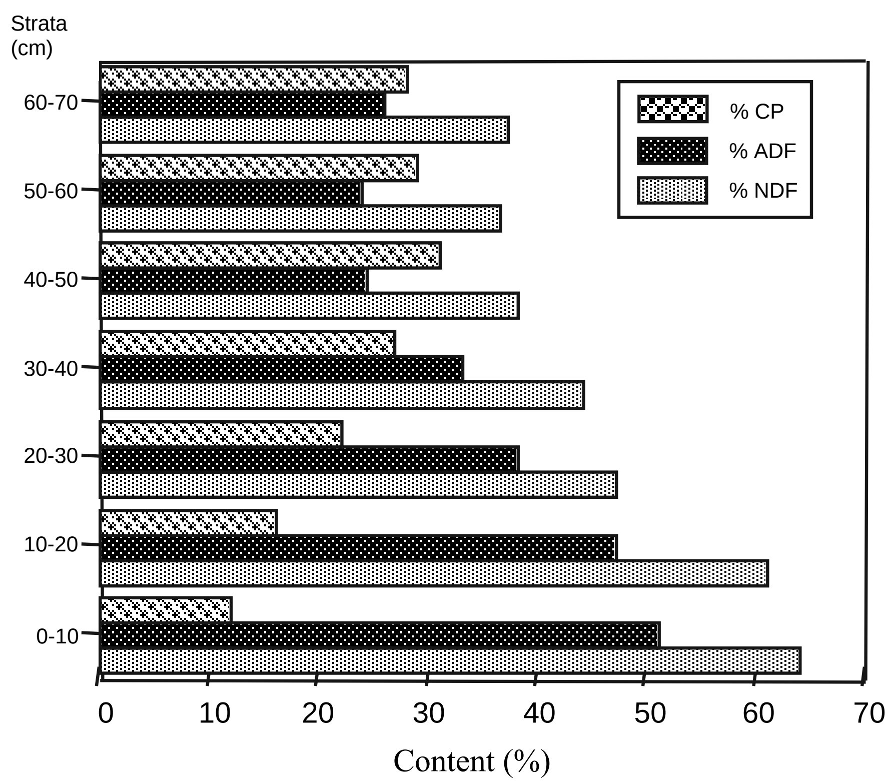

Figure 1 – Alfalfa quality distribution by 10-cm strata in the canopy. CP = crude protein; ADF = acid detergent fiber; and NDF = neutral detergent fiber Adapted from Romero *et al.* [20].

Results from many studies on alfalfa pastures conducted in Argentina indicate that in order to obtain a compromise between milk production per cow and milk production per unit area, FA should be around 20 to 22 kg DM cow^{-1} day^{-1} (or about 4% of the live weight) with an average PUE ≥ 70% [20]. Obviously, PUE varies along the year, going from >80% in winter to 55% in spring or <50% in summer. Some researchers have suggested that PUE should be defined in terms of quantity and quality of the remaining (after grazing) forage in the paddock rather than

FA. In this sense, Comeron [4] conducted at INTA Rafaela an organic milk production unit under rotational grazing with variable GP (0.5 to 2 days in every paddock), in which the criteria for changing paddocks was defined by alfalfa stem height and presence of leaves in the pasture not consumed by the cows. After 5 years of the trial, the average PUE was ≥70%, the mean production was 10,000 liters ha^{-1} $year^{-1}$ and the stocking rate was up to 1.7 cows ha^{-1} $year^{-1}$. It is also important to consider that animal response to a certain value of FA varies with herd characteristics, environment (mainly heat stress) and type of pasture (structure, quality, stage of maturity, etc.).

All previous considerations are the basis on which Argentine milk production operations under rotational grazing systems are founded. The most popular system is the use of **daily grazing strips** (daily paddocks) with a resting period (GF) of 35 days. An alternative is the utilization of **paddocks with variable time of grazing**, where the main objective is to improve alfalfa persistence through the reduction of the instantaneous stocking rate but without reducing the average stocking rate. Based on this, Comeron *et al.* [5, 6] compared daily strips with paddocks having 3 and 5 days of grazing. For each of the three systems (1, 3 and 5 days of grazing), FA and total number of cows remained the same (Table 4). The experiment did not detect any difference in average milk production per day but instead there was a difference in the daily evolution of milk production: cows grazing on the daily strips exhibited a more stable production (liters of milk cow^{-1}) than cows grazing on 3- and 5-day paddocks. The authors concluded that this more stable production was a consequence of the higher alfalfa quality the cows had access to on the 1-day system.

Table 4 – Milk production of cows evaluated under three rotational grazing systems using variable time (1, 3 and 5 days) of grazing on the same paddock and keeping the same forage allowance (FA) and very similar pasture use efficiency (PUE). From Comeron *et al.* [5, 6]

Variable	---------Grazing paddocks of----------		
	1 day	3 days	5 days
FA (kg DM cow^{-1})	26	78	130
Milk production (lt cow^{-1} day^{-1})	23.2 [1]	23.5 [2]	23.9 [3]
PUE	62	62	60
Instant stocking rate (cows ha^{-1})	127	37	18

[1] and [3] : average for 5-day production cycles; [2]: average for 3-day production cycles.

Another alternative is the use of **daily strips with sectors of restricted access**, which basically consists in subdividing the daily strips into sectors so that cows can have access to a new one throughout the day. Comeron *et al.* [8] did not find any difference in milk production and AI between two groups of cows grazing on daily strip (complete access) and on daily strips subdivided into two sectors (half-day each); however, cows on the 2-sector strip spent more time grazing than cows on the strips with complete access. In another experiment, Comeron *et al.* [9, 10] compared animal response to daily strips (complete access) and to daily strips with hourlyrestricted access (5 periods) and did not detect any difference in milk production and AI. Despite this evidence, Jahn and Soto [13] suggested subdividing daily strips in order to decrease alfalfa losses due to trampling.

Romero *et al.* [22] compared animal response of alfalfa under three utilization systems: a) **direct grazing of standing plants**; b) **cut + pre-dried in rows + grazing rows**; and c) **cut + chopped + distributed in** feed troughs. The authors concluded that the first system (grazing standing plants) produced higher milk production cow^{-1} because it allowed selection (higher quality) by the animals. Jahn and Soto [13] also compared direct grazing of standing plants vs. **soiling** (distribution of freshly-cut alfalfa), and found differences ($p<0.05$) favoring direct grazing because of the selection by the cows.

As with beef production, there has also been some research on adapting the **leaders and followers** (LF) system to dairy production. In one experiment conducted at INTA Rafaela a "traditional" type of management (mixture of cows of different lactating period grazing daily strips) was compared to the LF system. In this case, group L was formed by cows in the first third (40 days) of their lactating period and the F group was composed by cows in the second third (160 days) [12]. There were no differences in average milk production between both groups because the decrease in the F group could not be compensated by the increase in the L group. Implementing a LF system implies a series of practical problems that usually discourage its use in commercial dairy farms. As an option, Comeron *et al.* [11] proposed a type of LF system in which the L group was composed by milking cows and the F group was composed by dry cows; both groups sequentially accessed for 2 days the same grazing strip. When compared to a system that included two lots of cows (milking and dry) that separately accessed to new grazing trip every day, the L group produced more milk ($p<0.05$) than the latter as a consequence of a higher PUE and AI.

All the information generated in the Pampa Region, coming not only from INTA but also from commercial dairy farms, indicate the feasibility of using a combination of direct alfalfa grazing and strategic supplementation. By doing so, it is possible to obtain > 10,000 liters of milk ha^{-1} $year^{-1}$ as a consequence of individual production levels of 7,000 to 7,500 liters cow^{-1} $lactation^{-1}$ and stocking rates of over 1.7 cow ha^{-1}. Direct grazing of alfalfa allows a reduction of operative costs and contributes to decrease losses of quality due to forage conservation. However, to harmonize direct grazing with adequate nutritional level of the herd, in order to obtain appropriate animal response and good stand persistence, is not always an easy task. In addition, changes in alfalfa forage quality -by canopy strata or time of the year- may complicate formulation of well-balanced rations, particularly working with high potential cows.

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