Producing forage finished beef

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Quality: The challenge of grass-fed beef

Finishing cattle on pasture to the degree most consumers prefer is not always easy. At the heart of the challenge is the fact that growing a beef animal from weaning to slaughter takes a long time (a year or more). This means a high forage quality must be provided during all (or nearly all) seasons of the year.

Unlike a feedlot where the feed quality and energy level can be constant, in pasture situation it is ever changing. This requires not only a high level of grazing management, but a forward planning process to schedule not just one pasture but a whole sequence of forages, that should also overlap.

Defining factors	
1: Location **Year round** a) Temperate climate b) Near neutral pH and deep soils c) Above 25 inches in rainfall or irrigation **Seasonal Opportunity windows**	**2: Proper Genetics** a) Yield, tenderness, marbling, color b) Environmental adaptability c) Homogeneity of product – straight bred or cross-breeding
3: Forage Chain **Bound to high quality forages** a) Weight gains for steady growth and finishing gains (above 1.7 lbs/day) b) Reliable c) Cost Effective	

The number one constraint we deal with is the limitation in metabolizable energy content of forages. Different from concentrates (grains), forages offer a limited amount of energy which will set a limit to weight gains. A 3-lb-per-day target is common in a pen-fed finishing diet, but it is nearly impossible to achieve on grass. However, we may not need that performance to produce well finished grass-fed beef. Depending on the program, we may be able to use some supplements and complementary resources to help in the process. Supplementing on pasture with energy supplements during winter is common in many parts of the World.

Growing and finishing cattle on pasture is a time race. And the market we target dictates many of the rules of the race. A 100% grass, from weaning to slaughter is a big constraint. Likewise, marbling (grade), tenderness, flavor and color are conditioning factors. The older the animal at processing, the greater the chances for undesirable colors and flavors. Tenderness tends to worsen with age, more so if nutritional stress has taken place during part of the animal's life.

Meat quality and consistency can be affected by periods of low gains (less than 1 lb/day), struggle for grass, uneasiness and animal stress factors, all work against performance. We find these issues common among the programs that produce poor quality. Grass-finished beef is going to be leaner and will have less cover fat than feedlot beef. But, these are some of the attributes we like with grass-fed beef. We want the tenderness, the juiciness and the color

to be there for a good eating experience. Putting enough marbling lipids (intramuscular fat) in grass-fed beef is a challenge that involves genetics and nutrition and starts before birth.

Having genetics for marbling ease also correlates with early maturing, medium frame cattle (frame 4 in our part or the World). Cross breeding is a good tool to put together a good set of beef attributes with out having to wait to change the attire cow herd. The old terminal cross concept can be easily adapted to produce beefy calves. Black or red baldy (Hereford x Angus) steers are the preferred steer in Argentina and Uruguay for pasture finishing. Likewise, low-frame Shorthorn x Angus is another desirable cross. Searching for the adequate biotype within breeds that fits our program is the key. To accomplish this, we need to develop a program, with our resources and constraints.

Producing a steer or heifer that will marble with ease and yield well is easier if we start with a good nutritional management of the cow during the last half of gestation and during the first 4 months after calving. Starvation or malnutrition reduces the proliferation of adipose tissues (future fat cells in the animal tissues). Well nursed calves, will have the opportunity to express their potential for marbling and tenderness. This fat cell proliferation and development process seems to be sensitive to nutrition until 10 months of age in domestic cattle. Therefore, we need to be careful about our management not only before, but after weaning. Quality of grass is very important in weaned calves.

Creating reliable tender beef with attractive flavor and color from lean muscle on grass has to start early. Research has shown that marbling (or intramuscular fat) increases linearly with age under a good nutrition regime or nearly constant gain. Cover and organ fat shows an exponential increase with the energy concentration of feed and age. We also know that older animals tend to lay more fat than muscle than younger ones. But, we also know that muscle growth and fat deposition are not separate compartments. Calves lay fat of all kinds if the daily energy status they are offered is high enough. This means that we can start the process of producing desirable meat from weaning (and before) if we have the adequate feed. In other words, our product would be more consistent if we can rely on a forage base that has finishing quality at nearly all times in the life of the animal. This, however, does not mean a 3-lb-per-day forage. We find that steady gains of 1.8 lb/day can produce the beef we are looking for.

In addition, it is not necessary for an animal to gain at this high rate for its whole life. In Argentina, we have found that to produce a consistently tender beef an animal can gain 1.2 lb/day for the first half of its life as long as it gains over 2.0 lb/day during the second half. A low gain period, however, should not be pushed too far (for too long) and gains should not drop below 1 lb/day. Compensatory growth will be a partial help to us in a second phase, but marbling and overall fattening may be compromised, particularly for the large and lean biotypes.

A short growing-finishing period is a good indicator of high performance of a finishing program. Length of the growing-finishing period (which in a grass-fed program starts when the calf is purchased or weaned until it is sold as finished steer or heifer) should be kept as short as possible. Periods of 12 to 15 months (from purchase to sale) produce some of the best grass-fed beef that Argentina is able to generate. Longer periods generally mean lower overall gains, periods of hardship, more than one summer or one winter in the program (higher costs per pound gained) and less chances of tender beef.

Consider forages capable of producing high weight gains

So, what is the definition of beef finishing quality forage? For our purposes, high quality would be defined as the power of a grass to sustain a rate of gain (ADG) of at least 1.8

lb/day during its vegetative stage. Forage that will do this has an adequate energy supply to produce marbling fat on a steer.

Table 1 shows the chemical composition of the ideal forage to accomplish the highest weight gains in a grass-fed beef program. The closer our forage is to this ideal, the greater the gain potential. Dry matter content (DM) is the first limiting factor of intake in quality forages. Low dry matter (below 20%) reduces forage intake. Effects are more severe as we reach dry matter below 15%. It is not uncommon to find winter annual species with 11 to 14% DM in late fall or early winter at first grazing. These forages have high digestibility (above 70%) but excessive water and low effective fiber.

Table 1. Desired composition of green forages for high individual production

Nutritional components	Values
Dry matter, %	above 20
Crude protein,%	range from 14 to 18
Soluble carbohydrates,%	above 18
CP/SCH	similar or below 1
NDF, %	below 40
ADF, %	below 25
In vitro digestibility, %	above 65
DM intake, %LW	above 2.5
ME concentration, Mcal/kg DM	above 2.4

In forage base diets, fiber content should be of concern when offered in excess. Neutral detergent fiber (NDF) and acid deter gent fiber (ADF) are chemical indicators of the cell wall and cellulose fractions of for- age, respectively. Although grazing ruminants digest fiber in the rumen and obtain most of their energy from it, the process is slow, keeps the animal full, and could restrict intake. The greater the amount of fiber, the lower the rate and daily intake. As plants mature, fiber increases along with indigestible lignified components of the cell wall. Compiled research has shown that forages considered of high quality should have ADF content below 25% and NDF below 40%, which implies an “in vitro” digestibility (IVDMD) greater than 65%. This correlates with a metabolizable energy (ME) concentration of 2.4 Mcal/kg DM or intake greater than 2.5% of body weight. Two additional components are crucial to describe fattening potential of forages: a) crude protein (CP) and b) soluble carbohydrates (SCH). The first is estimated from nitrogen content of the forage and -the second is direct measured by sugar presence in the cell soluble fraction.

Targets for high-quality beef

- Annual ADG greater than 1.6 lb/d
- Daily gain during last 90 days greater than 1.8 lb/day
- Growing-finishing period less than 15 months
- Age at slaughter not far from 2.5 year old, (below if possible)
- Eliminate restrictions (less than 0,60 lb/d of weight gain)
- Reduced size of “restriction (stocker) group”

Designing the system for high-quality beef

- 1. Locate the high-gain window or windows (60 to 90 days of reliable finishing gains)
- 2. Work back the gains possible for stocker phase
- 3. Look for proper calve size/weight at the desired time
- 4. Have some control on the genetics with deal with

Protein is required to develop animal protein and it is generated in the rumen (major fraction) by the rumen microbes from dietary nitrogen and de-amination of forage proteins during rumen fermentation. (A minor fraction is provided as such for the diet.) Nitrogen release in the rumen after a meal is quite fast, therefore the presence of an easily degraded carbohydrate is useful to capture nitrogen in microbial mass. Most winter annuals have crude protein levels in excess of the animal requirements and are marginal in soluble carbohydrates, more so if soils are heavily fertilized with nitrogen.

The greater the soluble carbohydrate content, the better the match with protein supply and greater the chances of capturing nitrogen in microbial protein. The best ratios between crude protein and soluble carbohydrates are the ones closer to 1:1. (Soluble protein content and the ratio soluble protein to soluble carbohydrate would be a more direct estimator. Laboratories are less prepared to run soluble protein analysis, however.). Winter annuals differ in the con tent of soluble carbohydrates. These carbohydrates are low in the early stages of growth and increase over time as growth slows down in winter or later in the growing season. The first grazing is always the one with chances of low values. Generally, the faster the initial growth, the more unbalanced the forage is likely to be for beef finishing purposes. Dry matter and soluble carbohydrate contents tend to be lower in fast growing annual forages. Nitrogen fertilization can speed initial growth but it could worsen the unbalance. However, some species seem less sensitive and are genetically more unbalanced than others.

Pastures that have forage with composition and digestibility within the range above have been shown to produce daily weight gains of 2.2 to 2.65 lb/day. This rate of gain is 100 to 200 percent higher than pastures that offered high digestibility, but too low SCH (less than 8%).

For example, in our part of the World, new alfalfa pastures in the spring and fall, and fertilized small grain pastures in the late fall at first grazing, offer very lush and digestible grazing but disappointing weight gains that are often less than a pound a day. These types of pastures have low dry matter content and are high in protein but low in SCH. Feeding of high quality hays can help to overcome these poor gain bottlenecks in 100% grass-fed beef programs.

The most common perennial pasture used for finishing in Argentina's temperate zone is a mixture of alfalfa and perennial cool-season grasses such as orchard grass, fescue, brome and perennial ryegrass. These pastures provide grazing from mid-spring through fall.

Winter annuals such as rye, oats, triticale and annual ryegrass planted in early fall provide the winter and early spring forage. The forage quality of the perennial pastures is reinforced during the late summer and early fall period with summer annual forages, mainly corn (grazed before seed formation), but some Sudan- type grasses.

The production dependability of these forages is highly influenced by the reliability of the region's rainfall and the quality of its soil (primarily phosphate and organic matter). In some areas, alfalfa-based perennial pastures cover the forage supply for most of year and small grain pastures play a minor role. In other areas, alfalfa pastures supply forage for only six to seven months and winter annuals must supply the forage the remaining months. Also, spring and summer species produce more forage than winter ones. Therefore, the adjustment of supply has to be carefully planned considering the following three factors.

1. Acreage assignment
2. Pasture production distribution and use.
3. Cattle demands according to production program.

Potential of a pasture-based production system in central Argentina

Pordomingo et al., 2004; INTA Anguil Experiment Station

Phase 1. Winter annuals

First 2 months	ADG = 1.6 lb/day	96 lb	1 month of Fall, 3 months of Winter
Last 3 months	ADG = 2.7 lb/day	243 lb	1 month of Spring

Phase 2. Alfalfa pasture

First 3 months	ADG = 2 lb/day	180 lb	Last 2 months of Spring, 3 months of Summer 2 months of Fall
Next 2 months	ADG = 1.5 lb/day	90 lb	
Last 2months	ADG = 1.5 lb/day	90 lb	

LV initial		152 kg – **332** lb
LV final		467 kg – **1032** lb
ADG	12 m	866 g/d – **1.91** lb/d
Production	12 m	317 kg – **699** lb
Stock eff.		103 %

Mixed forage diets

This concept is based on the idea that a mixture of well picked species can provide a better balanced, more stable diet composition than a single species. Approaches vary and more than one are implemented in most farms. We can classify them in: a) **Grass and legume** mixed pastures, b) **Complemented pasture** with specialist forages, or c) **complementary pastures programs.**

Grass and legume mixtures offer the possibility of better balanced diets with higher intake potential than grass monocultures. New Zealand experience has shown the advantages on animal performance of including clover or alfalfa in ryegrass based pastures. Additionally, chicory, lotus species and sulla (Hedysarum coronarium) are suggested by New Zealand research as good complements in a mixture with ryegrass. Argentinean and Uruguayan finishing programs use mixed pastures as the basic forage source. Among them, the most common mixtures are alfalfa, red clover or white clover with ryegrass, fescue or orchard grass.

It is well known that legumes result in higher digestibility diets and greater intake than grasses. However, pure legume stands are not recommended because of increased incidence of bloat and the metabolic costs of high protein diets. Persistence of components in the mixture is often cited as a drawback in mixed pastures. Perennial ryegrass tends to displace and dominate New Zealand swards, and alfalfa or the grasses tend to leave the mixture in Argentinean pastures after four to six years. If the soil allows, however, the need for establishing new pastures on a five-year frequency may not be a disadvantage. It gives the opportunity of incorporating genetic improvements and the possibility of land rotation with annuals (winter annual pastures or annual crops).

Complementary forage programs

When mixtures are not an option, an alternative to supplementing hays or silages, is to plant annual or perennial pastures in strips or to develop designs that allow an hourly, fraction-of-day or daily grazings of forages of the different quality. These schemes could become complicated if they are not carefully designed in advance, but they have a good potential to maintain a stable high-quality diet.

Our local experience in Argentina suggests that shifts between materials should not exceed the 2-day basis and about a one-half-a-day switch would be adequate. Size of herd is a constraint. Groups should not exceed the 250 animals to maintain a low stress level in the animals and the people.

The number of hours in each paddock will depend on the availability of grass. Residuals need to be carefully watched to avoid over grazing or elicit reduced intake. If legumes participate in the multiple-paddock multiple-species program, one-half-a-day switches would be best. We should enter the legume paddock with no hungry animals, after the morning feed and water intake took place. Entering the legume pasture in the afternoon, the content of soluble carbohydrates in alfalfa should be greater and the animal's grazing drive lower, which should promote a more balanced use of nutrients and prevent bloat.

Nutrient balanced species

Use of nutritionally balanced grasses simplifies nutrition and management in finishing programs. Some summer annuals (e.g corn) or other warm season perennials can offer high-quality nutrient-balanced diets. In most instances, however, these species are limited and economics or soil and climate restrictions prevent us from using them as the backbone of finishing programs. Forage from corn is commonly used to overcome the summer slump and drop in finishing potential of legume-based pastures during fall in Argentina. Strip, high intensive grazing is a "must" for these species to minimize wastage.

Depending on soils and climate, small-grain winter annuals can yield nutritionally balanced diets, and become the best forage there is. In Argentina we find a large variation in nutrient balances of winter annuals from the humid to the sub-humid and semi-arid areas. Humid areas can produce twice as much forage compared with the other areas but nutrient balances frequently follow the opposite trend. Differences are found between varieties too. The higher the soil nitrogen and moisture contents, the greater the chances of nutrient imbalances in these species.

Easiness of grazing and forage on offer are related to finishing ease

Forage allocation is another major contributor to beef tenderness and consistency. The easiness of grazing and the amount of forage on offer are highly related to beef tenderness. Grazing requires more effort on the part of the animal than standing at the feed bunk in a feedlot. This effort favors muscle development and increases protein turnover. Excessive grazing effort increases energy requirements for maintenance, increases muscle toughness and lengthens the time required to finish the animal for slaughter.

Guidelines for forage allocation suggest assigning forage bases on two factors: A. Estimates of unrestricted daily intake; B. Estimates for grass harvesting efficiency.

The first is calculated as a proportion of live body weight on a dry matter basis after assuming a diet metabolization rate. Commonly used values range; from 2.8% to 3.2% for most beef cattle types. The higher number roughly corresponds to younger, growing cattle and the lower number to older finishing cattle. Three percent of body weight is a good estimate for budgeting unrestricted intake (on dry matter basis).

The second depends upon grazing pressure and remaining forage (residual) desired. In a cattle program geared toward high quality tender beef, harvest efficiency greater than 60 percent has been shown to be detrimental to the rate of gain and should be avoided (or

realized). Using half of the forage (50%) on offer has not been found to be detrimental to average daily gain. Here is a simple estimation. If a 900-pound steer has an intake potential of 27 lb of dry matter (900 x 3%), forage assigned daily should be 54 lb of dry matter (27 x 2 for the 50%).

Information of probable forage production (lb of dry matter per acre) allows us to budget supply, define carrying capacity, and plan the grazing rotation program. This estimated allocation is a way to start and a tool to help us think, but it does not replace the everyday art of walking the pastures, reading the remaining pasture and watching the animals fatten.

Rotational grazing helps to allocate forage

Continuous-grazing in a finishing program requires a tremendous amount of knowledge on the pasture behavior and climate to do it right. For most tamed, improved pastures, continuous grazing does not allow for proper matching of grazing and pasture dynamics. But, above all, short-duration, rest-rotation rotational grazing is our most economic tool for continuous budgeting and allocating quantity and quality of forage. Each grazing should harvest accumulated growth but not the newly coming re-growth. Entering a pasture too early frequently results in unbalanced quality and reduced overall forage yield. Grazing late results in reduced quality and lowered intake. Finding the optimum grazing moment depends on the species and the species mixture. (Sometimes, undesired nutritional syndromes such as pasture bloat could become additional conditioning factors too.)

Setting the adequate grazing pressure should take into account the grass species and the production target. As grazing pressure increases, so does grazing efficiency but selection opportunities decrease, bites get closer to the ground and fiber content of the diet increases to the detriment of forage quality.

For most improved pastures of central Argentina (temperate sub-humid region similar to Central Oklahoma), paddock size and stocking rate are set on the basis of a daily dry matter intake of 3% of the animals body weight (for growing-finishing beef cattle), so that the resulting grazing pressure will remove the 50 to 60% of available forage in 1 to 7 days and pastures will rest for 30 to 45 days, period that depends on re-growth rate).

Daily and even day-fraction rotations are used. Proper adjustment of paddock size to requirements is more difficult as grazing period becomes shorter than 3 days. Programs that are set on fraction-of-the- day rotations yield highest grazing efficiency but often the lowest weight gains. Underestimated demands or overestimated supply are the common mistakes we should avoid. At the end of the day, all efforts should be directed for us to be in control of the program and not the opposite. If the process gets away from us, most likely intake will suffer, undesired shifts, stress will increase, the finishing process will lengthen and inconsistency will be the end product.

Developing the program

Finishing programs tend to develop year-around schemes to supply beef at all times. This is obviously appealing and we have to explore within our resources the possible opportunities. Setting a program that produces grass-fed beef year around is easier in temperate sub-humid climates than in cold or arid ones. But, even in the more moderate environments there are tradeoffs to assume. Planting pastures (perennials and annuals) is required. Even long perennials need periodic replacement or over seeding. There is opportunity for use of winter and summer annuals as specialty forages to help the finishing process. Tenderness and consistency of meat colors and flavors were not evolution for survival

targets. Nature's beef was not intended to be tender, marbled at all times. In the past, quality beef was a consequence of opportunistic than systematic harvesting. Frost, heavy snow, drought, high temperatures are some constraints that shape our programs and place boundaries. Cultural and mental boundaries are also others group of constraints we deal with all the time. Carcass size, weight and grade at processing are also some of these boundaries.

Developing seasonal programs for producing pasture-fed beef is a start and may be the only option for many places or type of products. As an example, I discuss the analysis of seasonal finishing of heifers as an example of the concept of finding "finishing windows" in our environment.

Heifers for beef

Heifers are easier to finish than steers and it takes less time. But, quality of forage is essential and feed restrictions must be avoided. Compared to steers, heifers mature earlier and marble easier. As a guideline, a heifer mature weight is 80% of the steer weight. Although depending on the market, heifers fed on high-quality grass can reach fat cover and marbling targets as early as 70% of the steer slaughter weight. Therefore, if a steer's target weight at slaughter is 1,000 lbs, a heifer of similar genetics would reach the same fattening target for harvest at 700 lb. If the market does not take such a light animal, 800 to 900 lb would be good target weights. Actually, waiting for the heifer to reach 900 or 1000 lb may result in over fatten cattle.

A 200-lb difference in target weights between heifers and steers could be the opportunity of a grass-fed beef program. This difference means 100 days of quality feed. Finishing programs that have problems with high gain in late summer or fall need to consider this. Finishing heifers in spring and summer could be the opportunity to reduce the risk loading fall with unfinished cattle.

Table 2 shows the live weight evolution of heifers and steers under a similar weight gain expectation. For comparison, if both categories enter the growing-finishing program in October with similar weights (steer calves are a little heavier) after weaning, and follow a similar rate of gain as suggested in the chart (average daily gain = ADG), it will take 8 months to finish the heifers at above 800 lb live weight, and about 12 months to finish the steers on the 1000 to 1100-lb range (without feed quality restrictions.)

Steers may even take longer if fall gains are lower than those established in this table, and if winter is rough and quality is limiting, they will end being finished during the following spring.

Therefore, heifers could become an interesting option for seasonally finish beef in spring and early summer, or to increase capital turnover if cost of money is a constraint. A combination of heifers and steers in a grass-fed beef year around production

Table 2. Simulated weight evolution and gain (ADG) of heifers and steers under a similar daily gain scheme

Month	ADG	Heifers	Steers
	lb/day	Live weight, lb	
October	-	450	480
November	1.0	481	511
December	1.0	511	541
January	1.0	542	572
February	1.5	589	619
March	1.5	634	664
April	2.0	696	726
May	2.0	756	786
June	2.0	818	848
July	1.5	-	894
August	1.5	-	936
September	1.5	-	983
October	1.5	-	1029

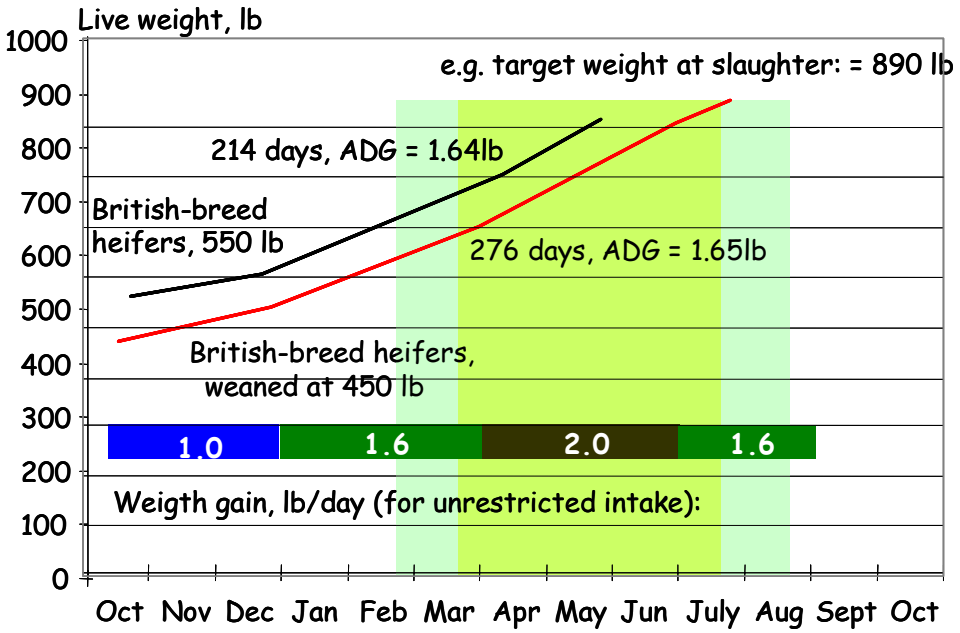
program can be the opportunity of optimizing use of financial and physical resources. Most likely, spring is the time of the year with greatest quality and amount of grass produced. Selling finished heifers in late spring and early summer gives the opportunity of making a good use of spring grass and de-stocking early before entering fall or facing winter with a large number of unfinished but heavy cattle. Steers can make the backbone of the year-around program and heifers can fit in as seasonal product to maximize forage use.

We must remember, however, that a heifer grass-fed beef program would be less tolerant to restriction phases, and more so if heifers are not spayed after puberty. Heifers in heat reduce intake and increase activity, which affect weight gain and marbling rates. Therefore, fattening heifers that cycle regularly becomes a harder task and could take 30 to 45 days longer. Fat cows are good beef too, but consistency for gourmet beef could to be at risk.

If possible, a safe heifer program should plan on selling as many fat heifers as possible at the end of spring. If we are unfamiliar with the finishing process, it would be wise to chart the growth curve on paper. The most relevant information we need then is: a) the forage chain heifers will be on from weaning to harvest, and b) the expected weight gains, at least on a monthly basis. We need to have an estimate of weaning weight, a desired final live weight, and a target harvest month. The forage chain will tell us about possible weight gains, which will in turn define the length of the growing-finishing process and the feasibility of fat laying gains during the last 60 to 90 days before harvest.

However, the harvest month is very important too. A fair forage chain can take the heifers to the slaughter weight, but it could be too early or too late in the year. Therefore, we need to equate the month(s) too. This may lead us to review: a) the forage chain (to improve gains), b) the weight and time at weaning (or purchase) in the short term and, c) genetics in the longer term.

As an exercise, let us say we plan on a weaning weight of 450 lb, and a final weight of 800 lb to happen in June. If the forage chain gives as an average daily gain of 1.5 lb/day, then we could reach the 800-lb weight in 8 months. If we wean in October with 450 lb, the heifers will have reached the targets in June. And, if at least the last 60 days produce 2 lb/day, most likely the gain will have reached the minimum fat cover and marbling needed.



Weight curves from weaning to harvest of grass-fed heifers weaned with a 100-lb difference

Weaning weight plays a central role in the success of grass finishing. While light calves at weaning reach the target in 8 months, 100 lb heavier would reach the final weight a month and a half earlier. These are observations that fit best medium frame British-like genetics, if larger frame genetics are our resource, a larger period of high gains will be needed for proper fat deposition and the growing-finishing period will extend.

Working with genetics that are on the large and lean side, will require a special effort in planning the harvest time and the last 60 to 90-day finishing period. Under that circumstance, we need to define the harvest time and slaughter weight first, work back the desired rate of gain to accomplish the minimum fattening requirements, and estimate the length of the growing-finishing period. It may lead us to adjusting purchases or weaning weights, which in turn may imply adjusting the breeding season.

Weaning early would be discouraged in that situation, actually the advice would be to wean as late as possible and graze the cows in good pastures to promote calf growth to its potential. Creep grazing of calves into a high-quality pasture during the last two months before weaning would help to sustain high gains. And, it would be best if calves had access to the same type of pasture they will be weaned on. Early fall-planted winter annuals work best in most cases.

The forage base

Actually, winter annuals will be the best winter forage source for weaned calves to be grazed on. A sequence of winter annual species (and varieties) could be planted to construct a forage chain until spring comes. Varieties of cereal rye, triticale, oats, barley, wheat and annual ryegrass could be combined in a forage chain (not mixed together). Where temperatures and fertility allows, annual ryegrass is very good forage and it has the advantage of a long production season (with a longer season than all other winter annuals, depending on locations and latitude, ryegrass can produce quality grass until late spring.) The potential for animal growth winter annuals have during winter and early spring excels any other resource. So, the longer we keep the cattle on that kind of forage, the greater the overall average daily gain is going to be.

Weaning on high quality alfalfa hay for late-weaned calves is another option for operations that have little standing quality grass in winter. Calves that are weaned late and know how to eat hays or a mix of hay and silage can easily be weaned on these resources and continue until winter annuals resume growth in spring. Grazing winter annuals during early spring (annual rye, triticale, annual ryegrass) allows for transitions of the animals to perennial pastures.

Legume based pastures (legume & grass mixtures) are appropriate forage resource for finishing gains during spring and early summer. In continuing the chain, early-planted corn or soybeans can be the forage of choice in mid and late summer if pasture quality is bound to drop and animals remained to be finished. In some cases, some native ranges offer finishing quality during spring and should not be over looked (we need however to judge the length of the quality period.)

Good quality alfalfa hay fits well with winter annuals (other pasture hays need quality characterization with laboratory analysis to be included in the diet.) It would be recommended, however, the hay component of the daily diet (hay + grass) not to exceed 1.5% (on dry matter basis) of the animal's body weight, which means no more that ½ of the daily intake. (If a 700-lb heifer can eat about 21 lb of high-quality forage -dry matter basis- a day, hay should not exceed 10 lb/day to affect the least rate of gain). Legume & grass silages could play a similar

role, yet, silages could be energy-limited and laboratory information would be required to properly assess their complementary potential.

Every ranch or farm is a particular case, and need to study its options, but, if quality grass can be grown for a period longer than 6 months, it may have potential for grass finishing heifers. The key points are to count on top quality grass during the last 3 months of the process. Well fitted heifer finishing programs can not only improve cash flow and flexibility of year-around beef production, but also make an excellent platform for a 100%-grass raised replacement heifer program.

The forage chain

The first step - Finding the right forages

Finding the right plant species for our grass-fed program is critical. The first step in defining a forage sequence is to explore in depth the available species and varieties for your region. Strengths and weaknesses of each plant material regarding quality distribution over time and behavior under climate extremes must be studied. Digestibility of forages at grazing time must become our main concern. A few points extra in digestibility could mean everything in critical periods for sustaining acceptable weight gains. Three points, from 62 to 65% digestibility in summer for example could imply that we can finish steers on 2 lb/day vs 1.5 lb/day.

We must ask the question - have we explored enough high quality plant materials? Exploring for new plant materials should be an endless task.

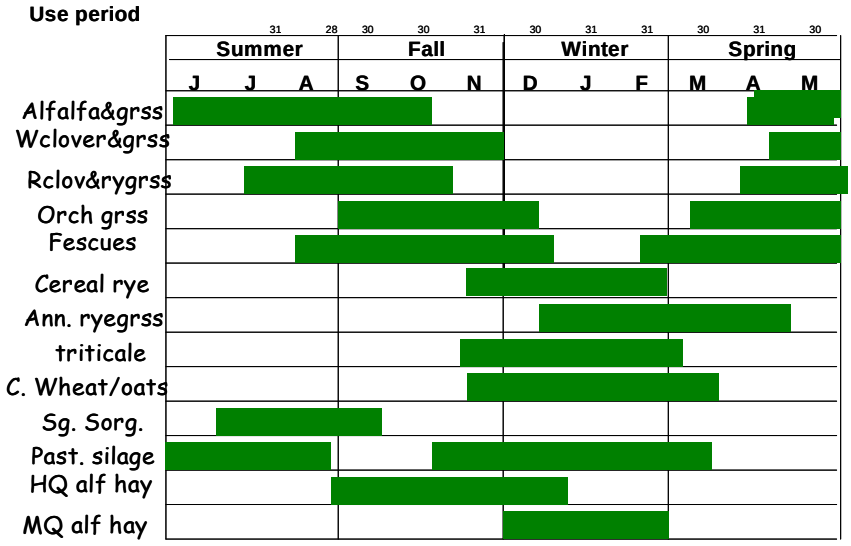
For a better view of the distribution of the forage supply, it is a useful exercise to plot every 15 days along the year, each forage species - the use period and finishing potential (high, medium or low). The chart would give us a quick look at bottlenecks in quantity and even quality. In finishing programs of the Argentinean central pampas, early and late winters are bottleneck periods where the forage chain requires permanent improvement. Mid-summer is another period where quality becomes limiting sometimes and programs struggle to sustain good rates of gain. From this analysis we should be able to discern between what we have and what we should have. After selecting the grass species, a monthly forage budget should be prepared. Monthly quantity and quality of forage supply should emerge from this budget.

Development of a growing-finishing program requires of some background knowledge about the species that we could grow. The information needed has to do with the period of the year the grasses are to be grazed, the forage yield, the quality and the weight gain potential during the grazing period. Quality is highly associated with expected weight gain. The greater the forage quality, the greater the potential gain. But, it is necessary to clarify our concept of quality for the relationship to hold true in all cases. Quality implies highly digestible feeds, which are rich in crude protein and low in lignified fiber. Fibrous forages (species bound and season or drought triggered) have low digestibility. Stemy plants, low in leaf content and frequently lignified are slowly digested in the rumen, voluntary intake is restricted and performance declines. It is common to find 20% drops in weight gains in early summer and 50% in mid summer, compared with spring gains.

We should add to our definition of quality, however the implication of a “balanced feed”. A well balanced high quality grass has not only a high digestibility, but it has no excess crude protein (below 18%), a soluble carbohydrate content above 15% (on dry matter basis) and a dry matter content above 20%. All this attributes make of it a highly nutritious grass, which will also have a good vitamin and mineral content. Forages in this category have gain

potential above 2 lb/day and can easily reach 3 lb/day in growing grass-fed beef steers. Although highly digestible and low in fiber, washy feeds are most likely unbalanced forages (too high in protein, low in soluble carbohydrates and high in water content) and yield low gains (1 lb/day or less) in beef cattle. We must remember that gain below 1.8 lb/day are not finishing gains (very low back fat and intramuscular fat deposition) and limit the finishing capabilities of the program.

The more humid the environment is, the greater the risk of the low gain syndrome on 100% grass-fed programs and climate conditions favour this to take place in Fall. Shortening of day light and dropping temperatures slow energy capture in aerial biomass growth and promote a shift of the energy flux to reserves in roots in Fall. If no mechanisms of adjustment to low-temperature are triggered, there is plenty of moisture, and then the plant most likely will become washy. Falls are frequently a difficult season for finishing cattle on forages. White clover or alfalfa and cool-season-grass pastures, that express their highest potential in Spring, frequently run into a low digestibility scenario in summer to resume growth and potential in early Fall. But the expected gains drop in mid and late fall again, this time as consequence of the unbalance described above as the "fall syndrome".



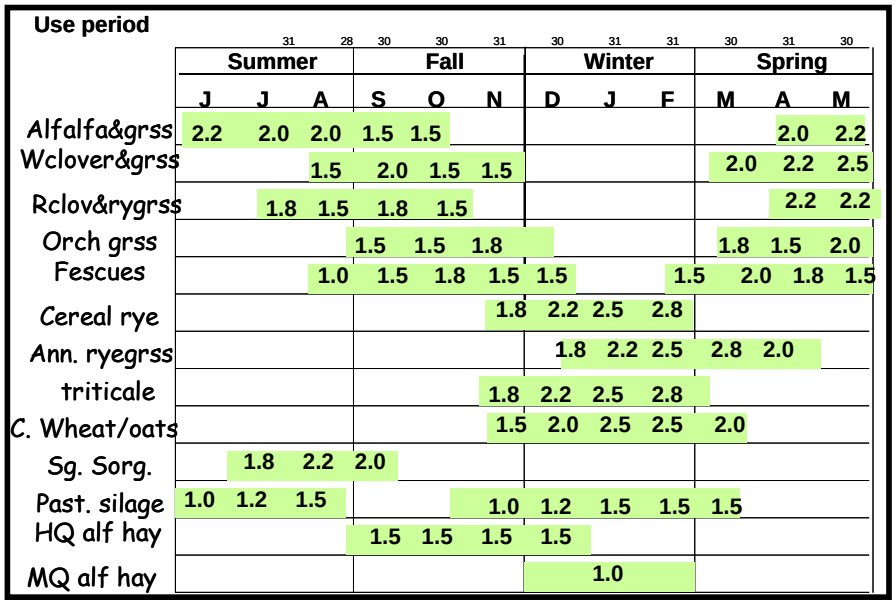
Winter annuals are frequently lush and washy in the first grazing (late fall in temperate climates) and become stronger as winter progresses. This effect is more pronounced when fast growing species such as cereal rye and barley are chosen. Cereal oats, wheat and annual ryegrass follow in the list. Planted early in the fall, cereal wheat and annual ryegrass are the most balanced ones. Ryegrass shows the longest season for balanced quality in most environments. Chemical analysis, including dry matter, crude protein, cellulose (acid detergent fibre) and soluble carbohydrate contents, provides a good base to define the possibilities if our forage species. If no performance information is available, chemical data would be a good way to start the assessment of potential for weight gain of our forage base. If performance data is available for at least one category of animals, however, the degree of confidence would be much greater.

Expected gains on pastures

Expected gains are not well documented for all forages in most places. We must know that performance on the different forages is bound to vary with soil, season, climate and animal

characteristics. Season and climate can greatly affect growth potential of forages. Hot and dry summers can drop in more than half the growth potential of pastures compared to mild summers. Likewise, pastures can yield less than half the growth potential in rainy and foggy fall, compared with drier ones. Likewise, lush legume pastures or winter annuals can result in "washy" feed in mild winter, compared with frost endured (winter hardened) grass.

Animal age, size, genetics, origin and background also affect the animal response to given forage. It is easier to accomplish high gains with young cattle than with near-to-finish ones. Weight gain composition and maintenance requirements are different in these two categories. Grown steers lay more fat than growing ones; therefore, the energy content of such a gain is greater. Likewise, the amount of energy required for maintenance is higher in heavy steers compared with lighter ones. On the other hand, young growing cattle have greater requirements of vitamins, minerals and quality protein.



All the previous considerations suggest that any absolute value to define expected gains needs to be used with caution. However, it is a needed tool to assess the potential of the program for beef production in the season, and more important to produce finished beef. It is easy to grow a steer, but it could become very difficult to achieve a rate of gain that will lay the sufficient amount of fat to consider it in a finishing stage. And, only knowing the possible gains achievable for each of our forage sources during the use period, we can plan the proper "growth route" of cattle within targets for age, finishing degree and time at slaughter. It is necessary to adjust the "finishing phase" of cattle to the potential of pastures and forages, and make all possible adjustments in the forage chain to enlarge the finishing phase and avoid bottle necks on demand of quality forage for heavy cattle.

A very first step is to size the possibilities of our forage base. Although in some areas of the world, this step is overlooked because the potential and limits of grass or legume species is well known, new areas or new comers in the business need to do the exercise. For many it should up front the advantages and constraints grass-fed program would phase. A monthly chart of possible gains for each forage source we have (or could have) would be of great use. Along with information on the area of land we can devote to those pastures, we could estimate the amount of grass of different potentials we are capable of having each month. This tells us about the possibilities of our farm to grow and finish beef each month. In some circumstances, it could be a year around program with more finishing potential in certain times of the year. In

other circumstances, we may realize we have limited potential for finishing or that the growing-finishing program has to be reviewed and re-planned.

Table 1. Expected live weight gains (lb/day) for grass-fed medium frame beef steers in temperate sub-humid environments*

	Summer			Fall			Winter			Spring		
	J	J	A	S	O	N	D	J	F	M	A	M
Perennial pastures												
Alfalfa + orchard grass	2.2	1.5	1.8	2.0	1.5						2.0	2.4
Alfalfa + fescue	2.0	1.8	1.5	2.0	1.5	1.5				2.0	2.2	2.0
Alfalfa + crested wheatgrass	2.0	1.5	1.5	1.8	1.2	1.4				2.0	2.2	2.2
White clover + ryegrass		2.0	2.2	2.0	1.5	1.5				2.0	2.4	2.4
White clover + orchardgrass	2.0	1.8	2.0	1.5	1.5	1.5				2.0	2.4	2.3
Red clover + ryegrass		1.8	1.8	1.8	1.6	1.5				2.0	2.2	2.3
Red clover + fescue		1.5	1.5	1.8	1.5	1.4						
Red clover + orchard grass	2.2	2.0	1.6	1.8	1.6	1.3				2.0	2.4	2.4
Gamma grass	2.4	2.0	2.4	2.0	1.2						2.8	2.8
Johnson grass	1.5	1.0	1.2	1.2	1.0	0.5				1.5	1.8	1.8
Annual winter pastures												
Cereal rye						1.5	2.0	2.4	2.0	1.8	1.5	
Annual ryegrass	2.0	1.8						2.0	2.4	2.5	2.5	2.2
Wheat						1.5	2.0	2.0	2.5	2.2	1.8	
Triticale							2.0	2.2	2.5	2.5	2.0	1.5
Cereal oats						1.8	2.2		2.0	2.4	2.0	1.6
Barley						1.6	2.2	2.2	2.0	2.4	1.8	
Annual winter legume + grasss												
Wheat + vetch						1.5	2.0	2.2	2.2	2.4	2.2	2.0
Oats + vetch							1.8	2.0	2.4	2.4	2.2	2.0
Triticale + yellow trefoil						1.5	2.0	2.2	2.3	2.5	2.2	2.0
Cereal rye + trefoils						1.5	2.0	2.5	2.2	2.0	1.8	1.8
Annual summer pastures												
Soghum sudan	1.8	2.0	2.0	1.8								1.8
Forage corn	2.2	2.5	2.8	2.8								
Pearl millet	1.5	1.8	1.5	1.0								
Forage soybeans	2.2	2.0	2.2									2.0

Compiled form research trials and commercial operations throughout central Argentina. Rates of gain reported assume a normal grown, non nutrient restricted plant.

Table 1 depicts the possible weight gains for grass-fed British blood steers in temperate sub-humid areas with bimodal Spring-early Fall rainfall distribution, and cold dry winters. By no means this chart is universal. Every area and operation should develop its own chart using as much local information as possible, even based on the best guess-estimates from experienced people.

The first finding we may derive from the analysis will be the season or period of the year where recourses with finishing potential are scarcest, or in other words, when finishing would be most difficult.

Fall in this exercise would be such a time, and more so when no early winter annuals are a possibility. In that scenario, native ranges could become the only winter option and most likely quality will be not good enough to reach finishing gains. Spring is almost always plentiful of quality forage. Even native ranges and warm season perennials offer quality good enough to support high gains.

Summer quality could be limiting at times, which is highly depending on soil moisture and temperatures. Hot dry summers could trigger summer slumps and gains may drop to half of those of spring and jeopardize the finishing phase. If a hot dry summer is followed by an above normal humid fall, finishing gains may not be accomplished in either season. In this scenario, supplemental forages would be needed to counteract effects.

Finishing program and beef cattle performance

Anguil, La Pampa, Argentina. 1999/2000

		ADG, lb/head			
		J-A-S Winter	O-N-D Spring	J-F-M Summer	A-M-J Fall
Forage grazing (100%)		2.08	2.18	0.79	1.79
Grass + supplement (1.2 to 1.5% LW)		2.43	2.29	2.30	2.09
Forage grazing 100%					
Angus	1.52	1.66	1.92	0.91	1.58
British crosses	1.56	1.78	2.05	0.73	1.69
Holstein	1.98	2.57	2.51	0.74	2.11
Grass + supplement (1.2 % LW – 6 mo)					
Angus		1.76	1.94	2.18	1.98
British crosses		1.88	2.04	2.31	2.12
Holstein		2.67	2.54	2.29	2.18

Pushing the limits with conserved forages

Hay or silage is commonly used to meet shortfalls in feed supply rather than to complement pasture quality. Supplemental forages are, however, a great tool to complementing diets. Well produced hays from pure legume stands or cereal oats are good resources to complement grass monocultures (annual or perennial ryegrass, annual winter forages). Argentinean research has pointed out that high quality alfalfa or oats-pasture hay can complement (and substitute) high- quality winter annuals up to 50% of the diet, improving dry matter content and nutrient balances. Results were similar or greater, overall intakes more stable and consistently high weight gains showed in beef steers.

Silages fit different purposes depending on protein and soluble carbohydrate contents and digestibility. Legume silages are commonly low in readily available carbohydrates and high in crude protein. Most frequently these silages are produced to transfer quantity to meet shortages. But, high-quality silages complement well with summer pastures or winter annuals reaching maturity (last grazing). Offering high-protein low-carbohydrate silages on lush high-protein fall or spring forages should be avoided. It will worsen the protein/energy imbalance of the diet and will not improve energy intake.

Silages or hays could be included systematically or strategically in a program. On the other hand, if they were introduced strategically to balance supply and quality, limited quantities could stabilize stocking rates, and more important sustain weight gains. Strategic more than systematic use of conserved forages is generally more economically efficient in grass-fed beef operations. If these conserved forages are needed as part of foundation of the production program, they are to be used systematically and in large quantities, we need to know their quality for gain. Relative feed value (RFV), protein (CP), NDF and ADF analysis

help to efficiently use them. Low quality hays could rapidly become a liability and have the system collapse. .

The highest quality hay is produced from spring alfalfa-rich pastures that are cut before ten percent blooming. Frequently, this cutting stage produces less quantity than at mid-blooming, but the quality will match well with the winter annual forages. These high quality hays are the way we can maintain animal performance in mid-winter. Even, on 100%-hay diets we can sustain good gains if intake is not restricted.

Table 2. Expected gains on 100% based conserved forages and nature of interaction effects on gains when supplemented with green pastures.

	100%	Alf/clvr past			Wntr annual			Smr annual	
	lb/day	Sprg	Smr	Fall	Fall	Wntr	Sprg	Smr	Fall
Hays									
Good alfalfa hay	1.7	=	++	++	++	=	+	+	++
Alfalfa + grass hay	1.5	=	+	+++	+++	=	=	+	+
White clover + grass hay	1.7	=	+	+++	+++	=	=	+	+
Millet hay	1.0	-	-	+	+	=	-	=	-
Mid quality pasture hay	0.9	-	-	+	+	=	-	-	=
Low quality pasture hay	0.5	-	--	-	-	--	--	--	--
Winter annual grass hay (cereal triticale, oats, wheat)	1.5	+	+	+++	+++	=	+	-	+
Winter annual+ annual leg. hay (cereal oats + vetch)	1.5	=	++	++	+	=	+	-	+
Silages									
Alfalfa silage	1.1	--	+++	---	---	=	+	++	+++
Alfalfa+ grass silage	1.3	-	++	--	--	=	=	++	++
Unwilted direct cut leg. silage	1.3	+	+++	-	---	+	++	+++	+++
Mid qual. Leg. pasture silage	0.8	+	++	--	--	=	=	+	++
Winter annual + vetch silage	1.4		++	---	---	=	+		
Millet silage	1.1	=	+	+	+	=	=	=	-
Sugar sorghum silage (no grain)	1.2	=	+	+	+	=	=	=	-
Corn plant (earless) silage	1.4	+	++	++	++	+	+	+	=

+ Possible positive interactive effects. Improvements would be noted compared to grass alone
++ Positive interactions will be evident
+++ Positive interactions will maximize
- Possible negative effects on gains compared to grass alone
-- Negative interactions will take place depressing gains
= No interactions expected. Response will be similar in gain. Under no grass shortage, effect will be substitutive.

Table 2 summarizes average expected responses on medium frame beef steers to some of the most common conserved forages (variability within in each material could be high and animal effects ever greater) and interaction effects when offered as supplemental feed on perennial cool-season pastures, winter annuals or summer annuals. Gains shown assume normal quality for the cited resource and the numbers must be taken for gross budgeting and planning only. As it could be noted, the most common conserved forages cited here do not

have potential for high gains if offered as the only forage source. Therefore, a 100% grass-based operation should not base its program on these resources only and plan on finishing gains. Most of these would be better used if they are considered tools to transfer feed and strategically balance diets. More so if the interactions with the grass base are well understood.

It can be noted that the hays yield positive interactions (match better and improve gains) of lush and washy pastures (perennial pastures and winter annuals during fall). In all cases the best results will be obtained with good quality hays. Hays of medium or low quality do not interact well with lush pastures because rates of ruminal degradation are very different. Hay fibre breakdown will be too slow to sustain high overall intake.

Alfalfa or grass silages (high in moisture and low in sugars) would not be recommended for the fall situation, but would have a place in summer on perennial pastures or summer annuals. Dry summers result in lignified and stemy forage, short in protein in many cases. Supply of high moisture, highly digestible silage, rich in crude protein would help to speed pasture fermentation in the rumen. High quality alfalfa silages would be the choice supplement for summer pastures.

Interactive responses would be minimum when pastures are well balanced (winter annuals in winter and spring, summer annuals in spring, cool-season perennial pastures in Spring). During this time of the year, added supplemental hay or silage will increase carrying capacity but it will not significantly affect rates of weight gain. However, gains will not be affected if the supplemental feed is of good quality. Low quality hays or silages will decrease rates of gain because well balanced forage will be substituted by one of lower quality.

Lastly, the amount of supplemental hay or silage offered is key to this discussion. Low quantities (below 0.5% of the animal's body weight on dry matter basis) do not significantly impact the gains and may have little overall effects. For interactive and substitution effects to occur, it would be necessary to supply 0.75 to 1.5% of the animal's body weight (dry matter basis), which means about 1/3 to half of the animal's voluntary daily intake in conserved forage. Research data has shown that up to ½ of the animal's intake could be provided in high quality legume-based hay or silage without significantly depressing gains in winter annuals during winter. It has been also shown that high quality hay supplied at the 1% body weight level would improve fall gain in 50 to 70%. Moreover, high RFV alfalfa hay can even yield finishing gains. Experimental data has shown alfalfa hays to produce up to 2 lb of gain in stocker cattle (which could yield 1.6 to 1.8 lb/day). A key factor here is consistency of hay quality. Stand composition (mix) affects the quality of hay substantially. Compared to pure alfalfa hays, grass and legume mixed hay is always lower in quality and weed infestation decreases quality even further. Haylage is another interesting option to sustain gains on conserved forages and allows a wider haying window, given that the moisture content at baling does not become such a critical issue.

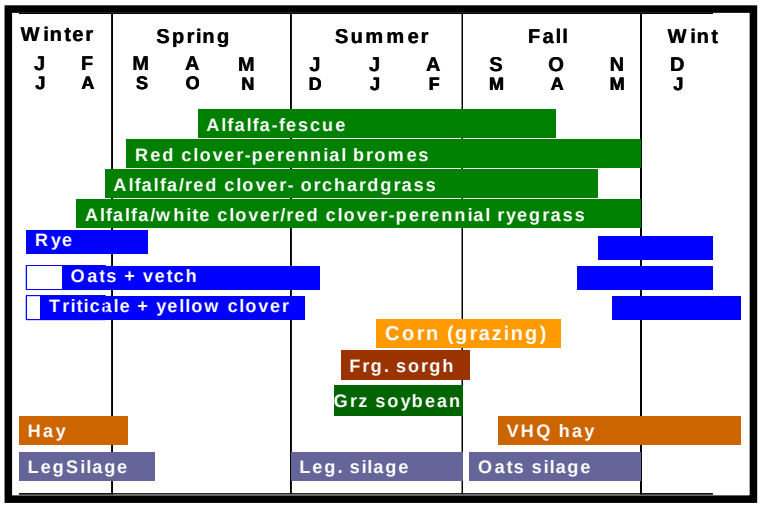
The second step - Putting together a forage sequence

The forage sequence does not need to be complicated but making it simple requires the use of intelligent choices based on knowledge. We need to know the forage resources for grazing or harvesting (hay or silage) that we can use. Sequencing them is a second step and an easy one, once we understand their possibilities and limits. Each operation will have different constraints and alternatives.

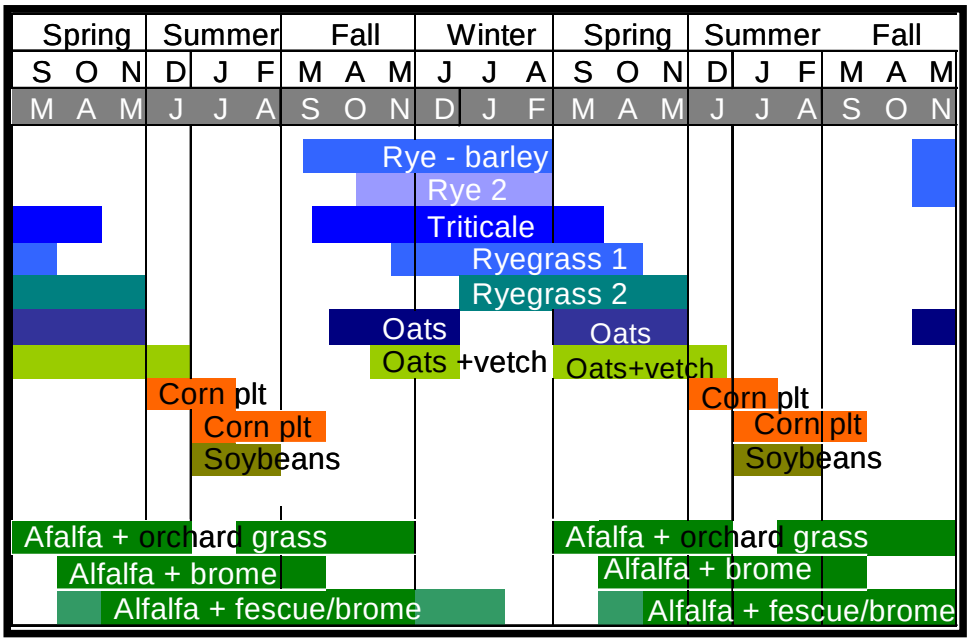
Some programs can be based on year-around grazing and rely on perennial leguminous pastures as the backbone, complementing with winter and summer annuals and the strategic use of hay and silage to help to balance quality and supply. Other operations run stockers on stockpiled perennials and hay and exploit to the maximum the spring and summer forages in a more seasonal program. Summer annuals are included in systems where summer slump is common or fall rains are scarce. Likewise, early-planted winter annuals (cereal rye) improves forage supply in fall on year-around grazing or white clover and perennial ryegrass as in New Zealand.

It is important to have more than one forage option at all times. Let's say, winter annuals and hay or silage are used in quantity to take over if no grass is left out there. For many in cold or snowy areas this is the case for most winters. Leguminous perennial pastures are the preferred forage base, but the option of summer annuals brings an alternative to unpredicted events such as heavy rains, drought, etc. Alternatives give the opportunity of complementary grazing and balancing the diet for better results. Likewise, when using winter annuals, a combination of several options planted separated provides the opportunity of a supply of even quality (see discussion on winter annuals).

The second piece of information needed is the size and distribution of requirements the program will demand along the year. The shape of the curve of nutrient demands will have to be followed by the nutrient supply curve. In particular, moments of the year of highest demands need to be identified. Nearly finished animals are a heavy burden due to their heavy weight and high body maintenance and need to be closely matched with forages of high finishing potential. Stocker calf purchases should be adjusted so that finishing times will match periods of high finishing possibilities.



The shape and magnitude of forage demand charted on a monthly basis and the expected forage production helps us to define the acreage to allocate to each forage resource. The following charts are examples of perennial and annual pastures used in two different forage chains in year-around programs. Seasonal programs are likely based mostly on leguminous perennial pastures, with overlapping of summer annuals and limited acreage of winter annuals to be use in late winter and early spring. Systematic use of large quantities of hay, haylage and silages are included to feed during winter months.



Overview of resources

Alfalfa and grass mixtures offer a long period of high quality grazing

In most temperate areas of the world where pasture finishing and dairying takes place (Argentina, New Zealand), improved perennial pastures are at the core of the programs and alfalfa, or clovers are always the main forage producer in the pasture mixtures (60 to 80% of total dry matter). They are the species of greatest quality. But, they are also the species that impose the most restrictions to management.

Why a legume based finishing system is necessary for pasture finishing??

1. ***Is the source of high-quality, low in-put forage***
   a. Has the longest production period
   b. Has the longest high-quality window
   c. Has the largest production of low-cost forage
   d. Is required for low-input nutrition of mixed pastures
   e. Produces the best high-quality non-starch conserved forage
2. ***In low-input systems it:***
   a. Increases soil fertility
   b. Modulates soil water dynamics
   c. Increases soil aeration
   d. Increases soil biological activity
   e. Increases soil organic matter reserves
   f. Decreases soil erosion
   g. Improves system physical resilience
   h. Increases system economic resilience

Rotational grazing is imperative for alfalfa survival in the stand. If alfalfa is a part of a forage mixture, 3 to 7-day grazing and 30 to 40 resting periods are the preferred strategies during the growing season for maximum alfalfa survival. Frequent or continuous grazing will progressively reduce the alfalfa stand and the grasses will take over the field. Letting alfalfa rest is essential to recuperate biomass and energy reserves. As days become shorter and temperature decreases, resting periods should be longer. Alfalfa paddocks that were heavily used in late fall should be managed to allow at least a 30-day period of re-growth before entering winter dormancy. After 30 days the reserves are likely to be replenished. Standing forage can then be grazed intensively with no detrimental effects on subsequent stand survival.

Forage production of a pasture based growing finishing program of beef cattle in Western pampas of Argentina (ton/acre)

	Alfalfa pasture	Winter annuals	Summer annuals
1981-85	2.17	1.27	1.86
1985-89	3.21	1.21	2.09
1989-93	3.80	1.62	1.89
Min	1.84	1.09	1.28
Max	5.53	1.94	2.53
Avg.	3.06	1.36	1.94

Romero et al., 2000. INTA Anguil, La Pampa, Arg.

Grazing consistent quality forage in alfalfa based pastures requires a compromising management between quality, which in practical terms implies grazing mostly leaves (large leaf/stem ratio), and an acceptable level of accumulated biomass without affecting the alfalfa stand. The suggested management for alfalfa-grass mixtures in Argentina is to follow the guidelines for pure alfalfa fields. This management maintains a fairly constant participation of legumes and grasses in the mixture reaches the maximum amount of harvestable digestible energy per unit of land (quality and quantity combined). More precisely, this occurs when 10 to 15% of the alfalfa flower buds have flowered. Happily, flowering takes place in a similar pattern as the desired management for alfalfa stand survival or every 30 to 40 days during the growing season. The highest overall quality is obtained at alfalfa bud stage, but incidence of alfalfa bloat is greater.

Quality of alfalfa pasture under grazing across dormancy and variety

Cut	Month	NSC	ADF	DMD	ME	CP	CP/NSC
1	E. Spring	5,7	28,7	66,6	2,39	23,5	4,2
2	M. Spring	6,6	31,5	64,4	2,32	21,7	3,8
3	E. Summer	4,8	31,0	65,9	2,34	23,7	5,0
4	M. Summer	10,1	27,2	67,6	2,45	20,7	2,1
5	Fall	5,7	26,8	69,2	2,45	22,7	4,1
6	Winter	7,8	38,1	58,6	2,28	19,5	2,4
	SE**	0,44	1,08	1,09	0,031	0,82	0,29

Pordomingo et al., 2004

Effects of forage allowance and use efficiency on weight gain (ADG) and beef production of steers grazing alfalfa pasture under a 7:35 rotational grazing y season over a production cycle

Steers/ acre	Allow %BW	Use %	ADG lb/head	Production lb/acre
		Spring		
5.1	3.3	75	2.21	656
4.3	4.4	64	2.27	592
2.0	7.9	39	2.42	298
		Summer		
5.1	2.4	84	1.25	569
4.3	2.8	78	1.31	557
2.0	4.9	60.5	1.54	319
		Fall		
5.1	0.73	100	0.16	169
4.3	1	100	0.46	292
2.0	2.2	70.5	1.24	250

Ustarroz, 1997. Producción intensiva de carnes. Forrajes y Granos J. Report. pg. 181-204

Effects of forage allowance and use efficiency on weight gain (ADG) and beef production of steers grazing alfalfa pasture under a 7:35 rotational grazing (8-month cycle)

Steers/ acre	Allow %BW	Use %	ADG lb/head	Production lb/acre
5.1	2.4	82.5	1.30	1280
4.3	3.3	74.5	1.41	1254
2.0	6.3	55.0	1.80	724

Ustarroz, 1997. Producción intensiva de carnes. Forrajes y Granos J. Report. pg. 181-204

Winter management

The quality of legume - grass mixtures generally decreases in winter. After temperature decreases and growth ceases, the removal strategy of standing biomass becomes less relevant for the plant, but more relevant for the animal performance. As alfalfa goes dormant and leaves start to die, the quality of cool-season grasses compensate in part, but not fully, and quality drops. Use of low dormancy alfalfas and fall fertilization with nitrogen helps to mitigate this problem.

However, most improvements in animal gain have taken place through the selection of high-quality grass species, which not only increase winter quality but year- around pasture quality. In Argentina, perennial ryegrass, orchardgrass, bromegrass and phalaris (reed canary) have provided greater year-around quality than tall fescues and wheatgrass. Each country and region should select the germplasm that will better equate adaptability, productivity and quality

for the production purpose. The more palatable and tender (high digestibility) the grass over the growing season, the greater the potential of the pasture for finishing programs. If pasture mixtures are uncommon, picking species and. varieties becomes an easier task.

Perennial legume & grass mixed pastures

•**Including cool-season perennial grasses** lengthens the grazing period (6 to 8 months).
•Reduces bloat risk (dilutes alfalfa or clover and generates a higher-NDF (fiber) diet; higher in soluble carbohydrates; higher in DM)
•Improves soil structure (more superficial root system).
•Uses nitrogen fixed by the legume and nutrients pumped from deeper soil strata
* Does not provide more than 20 to 30% of the total DM.

• Use the highest-quality grass species and varieties possible
• Manage pasture as a pure legume field
•If too dry, leave more standing residual. Grasses are more sensitive to heavy grazing than alfalfa or clover
• Plant in separate rows. Every two of legume or every other (depends on environment quality)
• Protect establishment of grasses by cutting or grazing light the first spring (for early fall planted pasture)

How short to graze alfalfa?

Leaving sufficient biomass in most pastures to protect crowns is usually recommended. Alfalfa is highly tolerant to heavy grazing. (Crowns are well buried in the ground). Grasses, on the other hand are more sensitive (crowns are on the surface) to heavy grazing pressure. Therefore, leaving 1 to 1.5 inch- tall standing biomass would avoid eroding the crowns of grasses, plus increase the surface roughness which reduces wind speed on the ground and protects against wind erosion.

Leaving a taller biomass, however, should be avoided in alfalfa based pastures. Remaining stems with branches promote axial re-growth rather than basal. (crown re-growth of alfalfa.). Sprouting from crowns is desired to maintain quality in the stand and more important, maintain control over the waves of re-growth. In addition, alfalfa stems are highly lignified which reduces diet quality. On the other hand, bud activation requires removal of apical dominance and sunlight access to crown level.

Bud activation happens uneven, if biomass removal is partial which creates a mosaic of plants with different stages of re-growth. In this situation, we lose control of the field's re-growth and mature stems alongside lush re-growth would co-exist and increase the chance of bloat. Under these circumstances, the mechanical harvesting of hay could be a useful tool to homogenize the field re-growth which would promote an even re-growth.

Effects of mechanic harvest of forage

Removal of almost all available biomass by mechanical harvesting or by highly intensive grazing in a few hours or within a day has become a strategy in the Argentinean pampas to maximize forage harvesting efficiency, and some intensive grass-fed programs have implemented it. However, research conducted in New. Zealand and Argentina has shown that this management may reduce the stand persistence potential of alfalfa fields.

Grazing in a less intensive manner, yet highly efficient (removing 60 to 65% of available forage over a 5 to 7-day, period) seems to favor crown bud activation for re-growth (after apical dominance is removed) with a greater proportion of carbohydrates synthesized in the remaining foliage. This exerts a sparing effect on energy reserves. If foliage removal happens rapidly re-growth has to be subsidized 100% from crown and root energy reserves, therefore reducing the size of these energy reserves which are highly associated with, persistence.

Additionally, we should not forget that associated with grazing is the positive effect of nutrient recycling through the manure. Although often unevenly distributed, grazing returns to the field a significant amount of plant nutrients whereas haying does not. Under low-input programs in Argentina, case studies of fields systematically harvested for hay compared with fields systematically exposed to grazing, have shown that the soil fertility decline trajectories are very different. Hay harvesting and removal from the pasture invariably lead to the increasing use of fertilizer and lower soil organic matter content.

Other pastures, such as small grain annuals (wheat, rye, oats, barley and triticale), are more suited for strategies of fast and light grazing to increase and maintain diet quality. Under common management (grazed down to about 2 inches above ground), small grain winter annual forages allow typically for three grazings (first growth and two re growths). However, lighter grazings, removing about one third of the plant, have provided an overall higher quality diet. If temperature and water allow, leaving 2/3 of the plant promotes photosynthesis of the remaining foliage and helps resume re-growth.

Small-grain winter annuals in the forage chain - A tool for reliability

For most grass-fed beef finishing operations in the world, winter annuals are needed. Even under seasonal programs, winter annuals can ensure proper finish (winter or early spring finished beef sales) or proper stocking for later summer sales (off perennial pastures). Proper finish means gains greater than 1.8 lb/day in a 900-lb steer.

Although, the protein-energy unbalances are frequently present with winter annuals at first grazing (washy feed), we must realize that winter annuals are a major energy resource (second to green corn plant). Depending on the temperatures, rain fall distribution and soils, the forage chain can vary greatly. But in most cases, winter annuals comprise from 4 to 7 months of the year-around forage supply, with quality for high gains during most of the growing season. The shorter the frost-free period, it is possible to use a larger proportion of winter annuals in the forage chain.

Within the winter annual group, we include a number of grasses, e.g. cereal rye, cereal oats, wheat, triticale, and annual ryegrass. And, within each species we can find a number of varieties and hybrids that can best fit our programs and environments. There are differences among them in rate of growth, tolerance to low temperatures and soil properties (fertility and acidity). Depending on the environmental constraints, winter annuals could yield one to four grazings. Three grazings are common in many temperate areas of the world where snow is not a big issue or fall drought is not severe.

Yield per grazing is uneven in most dry-`land circumstances. It decreases considerably with the drop in temperatures and late planting. In temperate latitudes of sub-humid areas in

the world, about 20% of total production is lost for every 10-day delay in planting time, starting the last third of the second summer month. Increasing plant density helps to cover the soil a bit faster but does not counteract the loss of production. Research in Argentina has shown that 50 to 70% of the total forage production takes place in the first growth (first grazing). The earlier the planting, the greater the forage yield at first grazing, and also the greater the chance for developing a good second grazing. Response to fertilizer or actual soil fertility (legume rotation or green manure) will be significant if seeding takes place early (temperatures allow for important growth), otherwise, nitrogen mineralized from fertilizers or soil organic matter will be poorly captured and mostly lost to leaching and runoff. This point is very relevant to organic farming (retaining organic nitrogen is central to organic programs.)

Major differences among materials

Cereal rye is considered the most tolerant to low temperatures and the fastest growing species. It produces well in early winter and stockpiles (or grows) into mid winter. However, it goes into the reproductive stage sooner than the other species (late winter). Some leafy and long-season varieties exist, which (depending on the region) could extend the production of good quality 15 to 20 days.

Cereal oats is a highly productive and long-season type of winter annual, but less tolerant to cold than cereal rye. It follows cereal rye in rate of growth and could be as productive. It produces in a bimodal phase with no growth in mid winter. After winter lethargy it resumes growth in late winter or early spring. If winter frosts are severe or persistent, we must avoid heavy grazings, otherwise, winter kill could be extensive and plants lost. Some varieties of oats are more winter tolerant than others. This has been a trait selected for in many countries.

Wheat is an alternative preferred by many. It stands low temperatures better than oats and produces over a longer period than cereal rye. Initial growth would not be as fast as in cereal rye and requires more soil fertility, but it produces a more balanced forage (it could be considered second to ryegrass regarding balanced quality over the production period) and highly palatable. The leafy, low-grain durum varieties are usually the best suited. However, the location defines the type of material to select.

Trititcale is a well known, widely used winter annual. It follows cereal rye in production and has a wider forage production window. Its production period can be as wide as the oats period, with greater yields and more winter production than oats. It may not express a similar initial spike compared to cereal oats, but it produces more in mid and late winter. Some leafy varieties are very well adapted to many environments and soil types.

Annual ryegrass would the winter annual of choice if rainfall and fertility allow. Although other winter annuals can match its potential in certain times of the year, annual ryegrass has the best and most even quality balance over the production cycle. It is the preferred winter forage for grass-fed dairies and beef operations because of its consistent quality and length of production period. It has a slower early growth compared to cereal rye, triticale or wheat, but its production extends well into spring and even early summer with no drop in quality. Some cultivars express biannual behavior (if summers are not extremely hot and dry), which can reduce costs and increase overall quality. From all annuals, ryegrass has the largest stockpiling potential when quality and quantity are combined. It stockpiles better than the other winter annuals (which planted as early as ryegrass can prematurely go into seed). It is an excellent late winter and spring material to complete a winter annual forage chain.

Because of its slow initial growth, annual ryegrass requires early planting in fall (similar to forage oats) to allow for aerial biomass growth and root development before

temperature drops in fall. It has also high requirements of soil fertility (phosphorous and nitrogen) and it is less drought tolerant than cereal rye or wheat.

Could we mix winter annuals?

For proper use of each material seed cocktails would not be recommended. In a mix, most likely, one or two will take over and the others would be competed out (or overgrazed) and disappear. Cattle could be selective for oats, wheat and ryegrass, and against cereal rye and triticale. In a mix, cereal oats and wheat would be overgrazed and killed, and triticale and cereal rye would escape and go into seed prematurely. Single species pastures should be planted and each paddock or field used when it is best for each particular species. The grazing time and pressure will be the combined result of variety, soil fertility, temperatures and moisture. Under the proper soil, moisture and temperature situation, the species defines the grazing time.

More than one winter annual species planted would be preferred to a single choice. Paddock or field sequences of cereal oats, triticale, cereal rye and rye grass would work better than any of them by themselves. This would better ensure forage quality and supply during winter and spring under climate changing conditions. Fast growing, cold hardy materials such as cereal rye or wheat can produce well in cold winter but could grow too fast and exhaust soil moisture and fertility early, and go into the reproductive stage too soon after temperatures increase. On the other hand, relaying on annual ryegrass only could result in to low early production and low overall winter yield.

If cereal oats is our only winter annual, it could be our best option (more productive than wheat, better quality than cereal rye, earlier producing than triticale) in the mild winter (rare frosts and humid). But in a hard winter, oats forage availability in dead winter is likely to be nonexistent, which means trouble if it is our only resource in a program that needs gains and no restrictions.

Therefore, a combination of fields with several species is a good way to sustain quantity and quality under controlled risk. Chains of winter annuals need to be planned early in the summer and fields allocated to species intelligently.

A few considerations on this matter have to do with the spatial distribution of species and the adjustment of soils to the needs and tolerances of the species chosen. As an example, we do not want to have cereal rye scattered all over the property. When fields are ready for grazing, moving from one cereal rye paddock to the next could be stressful for the cattle and practically impossible. Likewise, we want to put the species with greater fertility and moisture needs (e.g. annual ryegrass or wheat) on the best soils (first in the rotation, more organic matter, lower or deeper, etc.)

Simple chains could be built around two species, let's say:

a. cereal rye and triticale.
b. cereal rye and oats.

In these two cases, triticale and oats would be planted first and cereal rye last. We may decide to graze cereal rye first, then the oats or triticale, then back to cereal rye and so on until the use period of each is over or the filed is needed for planting the next crop (eg..summer forage).

Three species chains are a common alternative which can create more flexibility and adjustments to quality requirements over winter. Let's say:

c. cereal oats, wheat and ryegrass
d. cereal oats, triticale and ryegrass
e. cereal rye, triticale and ryegrass

In cases c and d, we have not included cereal rye. This tells us about a mild climate, which can provide greater quality with more tender species than cereal rye. Although all the materials are planted at the same time in late summer, cereal oats could be planted first followed by wheat or triticale. The first grazing will start most likely on wheat, followed by oats and triticale second to last (although this will depend on soil quality and moisture.) Ryegrass will have the slowest initial growth, but will excel the others in late winter. It will be the last at first grazing but it is the preferred to defer further into winter (stockpile).

Combination (e) includes cereal rye. This chain provides a fast growing, early maturing and winter tolerant species (cereal rye), and a slow growing late maturing species (annual ryegrass), linked with a winter tolerant and intermediate growing species (triticale). Triticale will produce good quality forage after cereal rye has had its first grazing, will provide good stockpiled forage in late winter and will resume a third growth in early spring without giving up quality when cereal rye has already gone into seed. Ryegrass will have its first and second grazings in sequence after cereal rye and trtiticale, but maybe lighter and it will witness the disappearance of cereal rye and triticale after the third or fourth grazing, to remain alone. Up to six grazing can be obtained from annual ryegrass if grazed deep into spring and early summer.

Forage chains that can include ryegrass, have the advantage of overlapping with improved warm-season perennial pastures or legume based perennial pastures. Chains that include triticale and cereal oats would also overlap some with the start of leguminous pastures. However, we must keep in mind the last grazing of small-grain winter annuals can have seed heads and this could compromise a 100%forage program. Therefore, if a field is going into seed before grazing, we will need to mow it high, which will cut the reproductive stems and seed heads formed, and favor leaf growth. As an alternative to mowing prior to the final grazing, a change in herds could be the option. Cows would do very well on the last growth on winter annuals.

How to graze winter annuals?

Although more tolerant than alfalfa to continuous grazing, winter annuals should be grazed in a rotation scheme of high intensity and low frequency too. Intensity however, has to be understood as removing quickly (in a day or two) the fraction we want to harvest. This fraction is not necessarily always the same. Some systems take about 2/3 of the plant leaving about 1/3 for re-growth. If all foliage is removed, re-growth has to occur from root reserves only and it takes longer and weakens the plant. A 2-inch remnant at least should be left un-grazed. Some grass farmers would leave even up to half of the forage available to reduce the rest-recovery period if the climate is mild. Residual biomass favors speed of recovery.

Depending on temperatures and moisture, rest-recovery periods take from 30 to 60 days (or even longer). In central Argentina, after a 30 to 40 day re-growth period, the second grazing could take place. This would now most likely be mid-winter. At this grazing, oats should be grazed first, followed by cereal rye, wheat and ryegrass. In cold weather, cereal rye will make the most forage and oats will grow the least due to its low cold tolerance. Annual ryegrass should, be skipped entirely in this mid-winter period and stockpiled for later use. Deferring the grazing of the small grains is not recommended because of the risk of frost kill of the leaf tops. This is not usually as much a problem with annual ryegrass so it is the one we will continue to stockpile.

When to enter the field?

For the best use of the winter annual, the time to enter the field for the first grazing is crucial. Too early (usually less than 60 days after emergency), would result in washy (very low organic matter), nutritionally unbalanced feed. Too late could result in excessive supply at the same time and exposure to winter kill. Experience suggests late is not as harmful on gains and overall yields as early. After the first grazing availability, more than dry matter content or nutrient balances, is the major factor for making the decision on grazing time.

The overlap and transition from summer-fall pastures into winter annuals need to be planned before hand. The lack of transition planning leads to too-early grazing of winter annuals. Consequences could be devastating if we have a group of steers which are 30 days from marketing and we move it onto a lush winter annual pasture. Gains will drop from high to low in a week, dehydration may occur and condition will be quickly lost. Intramuscular fat will be quickly burnt and we will be selling a stressed, unfinished beef. Much less stressful transitions take place with more developed ("stronger") forage (more organic matter, more balanced feed.)

How to allocate winter annuals?

Deciding how many steers and days (or day fractions) per acre is not an easy task. Winter annuals can de easily overestimated in the dry matter supply. Dry matter content (the proportion of remaining dry material after removing all water from the plant in an oven) could vary greatly with time of the year, soil moisture, temperatures and species. But, most likely the first grazing is going to be always the lowest in dry matter and the last the highest. However, dry matter can range from 10 to 30% at first grazing and this big deference can be imperceptible to the eye. And, we would be looking at 3 times the amount of available organic matter on the high end (30%) compared to the low end (10%). Therefore, we need to have some sort of estimate of the dry matter content (measured by sampling would be best).

Although we offer grass as-is (fresh), we have a better control and understanding of what would be happening if we allocate grass on dry matter basis. A field with 1000 lb of dry matter/acre could have 10,000 lb of forage as-is per acre if the dry matter content is 10%, or 3,000 lb of forage as-is per acre if the dry matter content is 30%. Volumes are totally different and the forage quantity (on dry matter basis) is the same.

Allocating under the assumption that we have forage with 20% dry matter content when it has 10%, results in underfeeding and overgrazing. If these concepts are not well understood and managed, or there is no experience to rely on in the area, we may want to adjust stocking rate under a crude estimates, and plan grazing-rest rotation schemes with 3 to 4 grazing days until we get a feeling of the actual supply (including the residual desired). We can adjust later more intensive schemes (daily or half-a-day grazings). Good hay at all times on the field is another safety factor which would help to counteract an allocation error. We do not want the cattle to go hungry, and the last thing we want is the pasture destroyed.

For allocating forage we need to remember that leaving about 1/3 of the forage on the ground means a grazing efficiency of 66% (which is hard to improve without hurting the voluntary intake and restricting daily gains), and that most beef stockers eat at about 2.7 to 3% of the body weight (on dry matter basis). This means that if a steer weighs 600 lb, it could eat about 18 lb of dry matter a day, which means 90 lb of fresh as-is forage that contains 20% dry matter. Under the assumption of residual or 33%, the animal will need 136 lb of fresh grass per day. If a field has 3000 lb of available fresh forage (as-is) to the acre, it can carry 22 steers to the acre that day (instantaneous grazing pressure). Although a simple concept, it is in daily

allocation of grass where most mistakes take place in managing winter annuals for finishing programs.

Lush forage problems

Occasionally, animal performance on winter annuals could be quite low on the first grazing. Nutrient imbalances (excessive nitrogen, low soluble carbohydrates content) and excessive water content are at least partially responsible for this result. It has been suggested that on lush forages, with a dry matter of less than 18%, the addition of fibrous materials to the diet would help to reduce watery feces and improve gains. Although this will help reduce scouring, there is no evidence of true gain improvement from feeding low-quality hays. On the other hand, our research has repeatedly shown that feeding high quality hays will improve gains during wet and cold periods on lush grass. Inclusion of only 15 to 20% hay in the animal's daily diet is necessary to correct the low dry matter content and poor performance.

However, rather than relying on hay only, it would be far better to try to understand and to correct as much as possible the root causes of this problem. The high use of nitrogen fertilizer, high soil moisture, and rather high temperatures during the first 40 days after seeding favor the conditions that create such imbalances. These conditions usually occur in the late fall or early winter and at the first grazing.

Counteractive measures are: 1) to delay grazing lush forage as much as possible (at least 45 days after planting); 2) Feed good quality hay or mixed pasture silage free choice with no restrictions (no high moisture alfalfa silage); 3) Mow in windrows and graze the windrows a day or day and a half later; 4) plant species with a slower initial growth (cereal oats or wheat vs cereal rye) and as early as summer allows; 5) plant species that stockpile with good quality (annual ryegrass vs cereal rye); 6) reduce or eliminate nitrogen fertilizer use at seeding time; 7) use no-till planting if possible (this results in less soil nitrogen being available at the early stage); 8) supply high-energy, low-moisture supplements such as dried molasses or beet pulp up to 0.75%of body weight level (dry matter basis) to promote better nutrient balances; 9) once the weather finally turns chilly, these imbalances will disappear and high quality forages will express their greatest potential for gain (supplementing then will only generate substitution or gain depression).

Summer annuals for high weight gains in summer

Finishing limitations may arise in summer. Perennial species could drop quality during summer and more so in areas where a bimodal precipitation distribution creates a summer slump. Summer annuals, however, can help overcome this quality restriction. Corn plant grazed green, before cob development is the option of choice in the marginal areas of sub-humid Argentina to sustain finishing gains during the last two months of summer. Other species with potential are the Sudan and sugar sorghums, and grazing soybeans.

Corn pasture

The corn plant has highest potential because of the high proportion of soluble carbohydrates and excellent protein/carbohydrate ratios, along with highly digestible fiber. It has no re-growth of use, but the accumulated amount of forage that we can stockpile until grazing pays for the only one grazing we get. It is important to intensively graze it with a high-stocking density. In the cited area, whole plant corn yields range from 8000 to 15000 lb of dry matter/acre at grazing time. The grazing efficiency should not exceed 50% if we want gains to be not adversely affected. If stockers weigh about 750 lb at the time they enter the field, they

will eat about 25 lb of DM/day. If available forage is about 10000 lb of DM/acre, with a 50% efficiency, we would expect 5000 lb/acre to be eaten, which would require 200 heads per acre per day. The remaining forage (trampled, stems and leaves remains) can be grazed further with a follower group, preferably cows. Maintaining a homogenous diet over time will require offering a new slice or paddock every day, avoiding access to previous ones if possible.

Staggered planting

One of the limitations of grazing a species such as corn at a right stage is the speed of plant maturation. Amount of available forage will then depend also on how long after planting we wait to graze. Delaying the grazing of the first paddocks to optimum stage will accumulate forage, but most of the crop will be past the grazing stage when cattle get to it. We need to delay and to stretch maturation on a 50 to 60 day period. This will require stagger planting in a time sequence to prevent from having to graze too early or too late. Grazing too early would be of no problem other than low forage yield, but too late could imply grain formation and grazing forage with corn on the cob. If this is not a restriction, then some corn fields can be grazed beyond grain formation, while plants are still green. Gains even will maximize and the grazing windows will expand (gives extra 15 to 25 grazing days), but we must keep in mind that this circumstance creates a diet which will be about 30 to 40% grain and some of the attributes of grass-fed beef (fatty acid ratios and CLA contents) will be detrimentally affected.

Staggered planting would be recommended to increase the grazing period of corn without running into the risk of feeding grain. Planting a field from early spring to late spring, even the first week in summer in paddocks 15 to 20 days apart is an option to spread the plant maturation over a long period. Use of long-season varieties also helps. We must remember that for grazing corn we want leafy, late maturing cultivars. For most temperate environments where corn (for forage) can be grown, a scheme based on 4 to 5 planting times, spread about 15 to 20 days apart (starting in mid spring), could be adequate to distribute the supply of corn forage over mid and late summer, and early fall. Corn plants will stay green and remain so palatable until the first fall frost.

Corn has a high growth potential and high soil fertility helps to develop a leafy plant. It is important to retain the lower leaves green and functional. If nitrogen is in short supply, it will be transferred from the lower to the higher canopy and the older leaves may loose digestibility. If soils are of doubtful fertility and do not come from a legume phase, nitrogen and phosphorus fertilizer may be needed. But, not intended to produce grain, heavy fertilization may not be required. Plant density should be increased 20 to 30% above the density for a grain crop and the distance within rows is maintained to be able to cultivate weeds if necessary. Fertile soils with a winter or late winter fallow are preferred. We need to store spring rains to supply water for summer growth. In temperate environments, we should be able to start grazing as early as 45 to 50 days after planting.

A 60-day window in the forage chain for corn would be common and easy to stagger the planting to cover such a period with a rather homogenous quality feed. For the exercise discussed above, if we stagger plant over two months, 15 days apart, we would be planting corn 4 times on about 15.5 acres each time. If planting starts early, as early as late June and the first frost takes place in mid October, we may be able to graze cattle on corn forage over a 4-month period. The first planting is going to take a few days longer than the others to reach a size suited for grazing. But, in most circumstances we will have to graze the first paddock when the corn plant is about 4 feet tall, before the flowering (tussling) onset. We can enter even earlier and no problems on the quality side should arise, but forage yield will be low.

Staggered planting as discussed implies that corn planting may take place over 60 to 75 days, which also means that while we may be entering to graze the early planted paddocks,

strips or fields, while we are still planting the late ones. This also suggests that we may be able to double crop a field (accomplishing to planting and two grazings before the first frost). Most marginal areas will not have this opportunity, mainly because of limitations of rainfall. These early planted, early grazed corn fields fit nicely before a perennial pasture phase (e.g. alfalfa or clover pastures) in an annual/perennial pasture rotation program.

Grazing management

Such amount of biomass can be easily wasted if grazing is not planned properly. It is important to intensively graze it with a high gazing pressure to make a good use of the available forage. Allocation (size of paddock) should be planned such as paddocks last about a day or two (implying shifts on a daily or two-day basis). Half-a-day shifts are even more desired from the diet stand point. The diet will be more homogeneous in quality and stem-leaf ratio (cattle tend to eat the green leaves first) and plant harvesting efficiency will be maximized. Under-feeding the cattle (below voluntary intake) is a risk in half-a-day allocations. Quantity is more difficult to estimate and the risk of under allocating forage is greater. Under highly intensive approaches, a leftover of above 50% of available dry matter should be considered to allow for misjudgments in availability. Two-day paddocks are a much less risky approach.

If stockers weigh about 750 lb at the time they enter the field, they will eat 22 to 25 lb of DM/day . If available forage is about 8000 lb of dry matter/acre, with a 50 % efficiency, we would expect 4000 lb/acre to be eaten, which would require 160 heads/ acre day. The remaining forage (trampled, stems and leaf residuals) can be grazed further with a follower group, preferably cows. Maintaining a fairly homogenous diet over time will require offering a new slice or paddock every day, avoiding access to previous ones if possible.

Experimental information suggests that grazing efficiency should not exceed 50% if we want gains not adversely affected. The stem fraction is going to be the most visible fraction left on the field. The second fraction left is trampled and torn leaf fractions on the ground. In a normal situation, we should not force the animals to eat more than half of the stem. If stems are visibly eaten to about 1/3 of what they were, most likely we have increased consumption of undesirable fractions beyond the limit for high gains (this is particularly true when plants are approaching the reproductive stage, or during a drought, circumstances where lignin content increases exponentially.)

Gains to expect

Weight gains will depend on the animal's size, breed, biotype and category, and on the plant nutrition, health and maturing stage; but, under normal circumstances a green corn pasture with no intake restrictions could produce gains of 2.0 to 2.8 lb/day on medium frame British breeds during a finishing phase (fat deposition is a major component of that gain). During a stocker phase gains could be even higher because the composition of gain is lower in fat and greater in protein and water.

Other species (grazing soybeans and sorghum pastures) would have a lower potential and gains for finishing would range from 1.8 to 2.2 lb/day. The more mature the summer annuals get, the lower the rate of gain we can accomplish, but the corn forage has a very steady quality up until grain develops, and at that stage quality still remains high because grain compensates for the drop in quality on the plant stem and leaves.

Where does it fit best in the program?

Corn is excellent finishing forage but we must be aware that if we run out of it and the cattle is not finished yet, the shift to different forage (legume based pasture, other summer annual or a winter annual) will reduce the rate of gain and an adaptation period will happen. Gains will drop, even halting growth for 15 to 20days (more so if we put the cattle in a perennial alfalfa or clover based pasture or any other lush forage during fall.) Although the gain accomplished will not wash out for switching forages, we will loose efficiency and some of the advantages of including corn in the forage chain will be lost. Finishing and selling straight from the corn pasture would be best. Planning in advance will be needed to synchronize demand and supply of grass. In summary, a corn pasture would be best used and justified if it has a place in the last 60 days of the finishing period.

A less common place in the forage chain is to receive Summer weaned calves right after weaning. Calves are the most efficient category in transforming grass to gain and corn provides excellent quality and nutrient balance. The grazing strategy, however, would be a little different from the suggested for older cattle. They need to enter the pasture earlier, when corn is not taller than 3 feet. They learn to graze the leaves rather fast, but it takes them a little longer to eat part of the stem fractions. After a month, their behavior will be very similar to that of the steers. Plant height at grazing could be a factor that we did not consider before for older cattle, but that needs to be taken into account here. Short leafy corn varieties would be preferred here and crop density may need to be lower so that the plant spreads and remains green in the lower part.

Grazing corn with calves may also require a more conservative harvesting efficiency and other categories will be needed to clean up. The post-weaning growth rate calves get on corn pasture, however, is almost impossible to achieve on other grasses. They could easily make 2 lb/day. On other materials, calves will not make more than 1 lb/day (even alfalfa based pastures). Only winter annuals could yield similar results, but during winter when they can be planned to match with late fall-weaned calves.

Forage soybeans

Direct-grazed soybeans make a good forage source for summer. Although unthinkable 20 years ago, soybean use for summer for age has developed in many parts of the world during the last decade. Formerly, beef operations of central pampas in Argentina started to graze poor soybeans crops. Later, dairies began planting soybeans for grazing. Among the reasons for including soybeans in dairy and beef operations are a) improved forage quality and b) the rotation program.

The species adapts well to an ample array of soils, hot summers and moisture scarcity. Crop technology and grazing management impose no complications and no toxic effects have been reported. Soybeans are suitable for hay and silage, with recommendations similar to alfalfa hay or silage production.

Forage soybeans is quality forage

Forage soybeans offer an option of better quality summer forage than sorghums and millet. It resembles alfalfa in late spring. Crude protein contents of the plant in several laboratory analyses have ranged from 16 to 18% and “in vitro” digestibility from 55 to 68% (sampled in central and western pampas -sub-humid and semi-arid areas of central Argentina). In these areas, alfalfa suffers a summer growth halt and quality drops, circumstances under which soybeans have produced greater quantity and quality than alfalfa pastures.

Rotation opportunities for Soybeans in the northern hemisphere

Planted in the first week of May, it is ready for first grazing 45 to 50 days later, and depending on rain fall, two re-growths can be expect ed every 35 to 40 days. Most operations would not go into a fourth grazing because in mid August summer is over, fall production of alfalfa- based pastures is good; and fields with summer annuals are rotated into small-grain winter annuals.

Actually, forage soybeans and small-grain winter annuals do not overlap in time and fit very well in a two-crop annual rotation. Land preparation, nitrogen and phosphorus turnover, fertilization and weed control conducted during the soy bean phase, leaves excellent conditions for small-grains. Frequently, fertilization of the winter annuals is not required. In addition, farms with severe weed infestation have found in forage soybeans the summer annual of choice.

In Argentina, the opportunity of using Round-up-Ready genetics opens an economic window for producing good quality summer forage in fields infested with perennial graminoid weeds (such as wild Johnson-grass and Bermuda grass) and other major weeds.

Nutrient requirements

Being a leguminous plant and used prior to seeding, its own nitrogen fixation supplies most of the nitrogen the plant requires to produce 3500 to 7000 lbs of dry matter per acre. Remember to inoculate the seed and create the adequate soil environment (depth, soil pH, available sulfur and phosphorus) to favor rapid nodulation and growth.

In our rather sandy soils (with a history of erosion), forage soybean responds well to phosphorus, sulfur and magnesium fertilization. We have found low soil p in the first foot of soil frustrates good establishment and nodulation. If doubts arise, soil pH (determined in KCl) and the calcium: magnesium ratio should be determined to plan amendments if required.

Water needs

Accumulating moisture in the soil prior to planting and deep soil profiles favor rate of growth and re growth of forage soybeans. Hard pans under the surface reduce root exploration and water harvest capacity. In the areas we are using forage soybeans; we have to keep in mind that we want this species to produce a large quantity of good-quality forage during a period frequently dry and of high temperatures.

Planting keys

Planting in narrow rows (one foot between lines) and 20 to 25% higher densities than grain soybeans is recommended in most of the central pampas of Argentina. Varieties vary with regions but the long cycle ones are suggested, aiming to the largest leaf/stem ratio as possible.

Grazing keys

Grazing soybeans requires a different approach than alfalfa. Being a bushy plant with axilary re-growth, we need to prevent heavy grazing. The number of grazing vary from two to five with 2 to 3 being most common. Although research is not profuse on this matter, some trials have suggested entering the field to graze with a plant height of 20 inches in the low end and 40 in the high. Removing up to 70% of the leaves is considered high utilization and up to 40% low. Animals will prefer and select for leaves, but will remove pods and stem fractions too.

Forage soybeans combine well with corn in hourly strip grazing. Corn provides more sugars and dry matter, and soybeans complements with protein and digestible fiber. Forage soybeans combine well with energy supplements such as molasses.

Sorghums or related species

Sudan and sugar sorghums are another option. In Argentina, weight gains on most of our sorghum materials will not compare to gains we can achieve on corn pasture. Fast growth and re-growth, and a greater drought tolerance, however, are the advantages of sorghums. If high gains are a must because steers need to be finished and sold in 40 to 60 days, and we are in mid summer, combining sorghums with other species on fraction-of-the-day grazing gives us the chance to partially overcome the quality restriction. Although in many cases the two pasture shifts are not possible. We must explore to the extent the varieties available in the market to greatest quality in summer. More than overall production, a finishing program will require the greatest quality sorghum (moderate crude protein, high soluble carbohydrates, and adequate dry matter content.) The faster growing ones may not be the best choices.

A forage chain of summer annuals

Combining forage soybeans and corn or sorghums and even with perennial pasture grazings is a good alternative to sustain high weight gains in summer. If a plan does not want to rush, it should not include sorghums and could use soybeans and corn pastures. After coming off perennial pastures in late spring, cattle could enter the soybeans pasture for about month and, when corn (planted is a sequence every 10 to 15 days during two months) is ready for grazing, we can switch them into corn pasture or rotate half a day in each. The rotation will help to better use the soybeans and will save some corn pasture; but, if cattle are about 20 days from a planned selling date, it would be better to keep them on the corn field to affect the least the rate of gain.

A similar rotation of daily or half a day grazing on alfalfa pasture and corn pasture is also possible to improve the rate of gain, compared to alfalfa pasture alone during mid summer. During fall, corn and alfalfa pastures are an excellent combination in half-half-a-day grazing rotations to significantly improve weight gains, compared to gains on 100% alfalfa pasture.

Use of high-quality summer annuals, combined with alfalfa based pastures and early planted winter annuals ensure finishing potential year around. And, being targeted for a fairly short period of the year (two to three months of use), a field with several summer annuals, with several species and planting sequences, can be will be planted during spring without complicating the field rotation program. The field will be grazed and freed for other planting in fall. After grazing corn, sorghums or soybeans we can easily fallow the field for a short period and plant a winter annual, or start a new rotation cycle with an alfalfa based perennial pasture. Furthermore, in mixed grain-grazing cattle crop operations, a winter wheat grain crop could be planted. Most likely, the wheat crop will be planted unfertilized because the crop will cash on the fertility distributed back by the cattle in the intensive grazing program imposed on the summer annuals.

What weight gains to expect?

Weight gains will depend on the animal's size, breed, biotype and category, and on the plant nutrition, health and maturing stage; but, under normal circumstances a green corn pasture could produce gains of 2.0 to 2.8 lb/day. Other species (grazing soybeans and sorghum

pastures) would have a lower potential ranging from 1.8 to 2.2 lb/day. The more mature the summer annuals get the lower the rate of gain we accomplish, except for corn pasture, which has a very steady quality up until grain formation, and at that stage grain compensates the lower quality on the plant stem and leaves.

Grass-fed beef programs may not want to get this far in corn maturation anyway because of the effects of corn starch on intramuscular lipid profiles, which would affect fat characteristics and overall beef quality