Professional Paper

Integrated Resource Management

Extending the Grazing Season

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Contents

Chapter 1: Introduction

Agriculture has evolved over the millenniums into a modern industry intertwined with global markets, political pressures, changing consumer demands, and the unknown of climate change. Livestock producers around the world are experiencing the growing necessity to hone their production systems to maintain their competitive advantage and viability in today's ever-changing marketplace. One effective method to do this is extending the grazing season. This paper will discuss a number of ways this can be done.

Across every livestock operation, feed costs average the largest operational expenditure. Commodities, including hay, corn, and soy, have increased in price dramatically over the past few decades. These hikes in prices affect anyone that handles feed and/or feeds it. This in turn drives up costs to consumers. Any producer that raises livestock --namely ruminants-- has the opportunity to leverage their livestock's biological capability to graze and counter high commodity prices. This is done through extending the grazing season. Through it, producers can reduce hay and other feed requirements if not eliminate them. For most producers this means extending the grazing periods in spring and fall, the traditional times when livestock are moved off/onto pasture. Through these period extensions, less feed need be provided to supplement stock when they cannot fully feed themselves. In the Midwest, producers will be minimizing their winter forage slump. Producers in the California central valley would be minimizing their summer forage shortage. Proper implementation of grazing extension offers a variety of opportunities namely in cost reduction, increased self-efficiency, and sustainability.

Grazing is calculated as the cheapest feed resource for ruminant animal production (Frame, Piñeiro, & Laidlaw, 2011) and is usually the cheapest feed on a per pound of nutrient basis (D.C. Ditsch, J.T. Johns, S.G. Isaacs, T.B. Mark, & C.D. Lee, n.d.). Forage quality of young pasture growth and even leafy fall residues are usually higher in quality than stored hay since it is most commonly cut from older more fibrous forage (Don Ball, Ed Ballard, Mark Kennedy, Garry Lacefield, & Dan Undersander, 2008). Through this, animals grazing properly managed pasture typically perform better than those that do not. Even with the nutritional benefits, grazing remains more cost effective due to the reduction in labor requirements. When livestock are set out on pasture to graze there are no labor requirements to hand feeding, pen cleaning, or feed harvest and storage. In a regulatory perspective, costs to produce animals in confined animal feeding operations have increased through new laws and environmental concerns and some producers are reverting back to pasture based operations that do not fall under the same regulations in order to save money (Corson, Rotz, & Skinner, 2007).

Hay consumption grows with the more livestock a manager must feed. Typical winter hay requirements for a 1200 pound cow are approximately 30lbs of hay per day (Mark Warren, 2010). In Colorado and many other parts of the nation premium grass hay reached $300 per ton in February 2014 (USDA, 2014). Converging these values, it can cost upwards of $675 to feed one cow over a 5-month winter; that is $67,500 for a herd of 100 head. Cattlemen often produce their own feed or shift the market and purchase hay below premium pricing. Regardless, the magnitude of cost can only be reduced so far.

Adding to feed costs, purchased or produced hay must be stored and large hay losses/spoilage can be seen if poor practices and inclement weather are seen. In Missouri, studies have shown that feeding losses of large bales can be as high as 12% when stored inside, 25% when stored outside uncovered, and 13%-15% when stored outside covered (Belyea, Martz, & Bell, 1985). Losses seen with large round bales are higher; they are 15%, 40%, and 20% respectively (Belyea et al., 1985). With stored feed typically accounting for 25% or more of production costs, extending the grazing season is not only a means of cutting costs it is in general good forward planning (Don Ball et al., 2008). As example, Irish dairies utilize low-cost grass based feeding systems for their herds and this practice has made Ireland one of Europe's leading low cost milk producers (Läpple, Hennessy, & O'Donovan, 2012).

Chapter 2: Review of Methods

There are a variety of methods that can be utilized to extend the grazing season. The following is a review of some prominent methods discussed in the literature. Those reviewed in this paper include stockpiling, seeding, livestock management, byproducts, cover crops and residue grazing, and soil health.

Stockpiling:

Often referred to as deferred grazing, it is the management method of accumulating standing forage for livestock grazing use at a latter date. It is primarily performed to provide grazing forage into autumn and winter months but can be used to provide feed during slumps in the growing season (Don Ball et al., 2008). To many, this is a new concept as mechanical forage harvest and storage for later use has been economical and the standard practice among many producers (Stephen K. Barnhart, 2010)

Process:

In temperate environments when it is cooler than 11 degrees Celsius, plant grown is primarily influenced by temperature rather than solar radiation; in higher temperatures, solar radiation is the limiting input provided sufficient water is present (Frame et al., 2011). These growth-limiting restraints make forage growth out of season difficult if not impossible. Forage produced for stockpiling is grown in the regular growing season, leveraging the natural cycle of production. Once regular grazing pastures are exhausted in the normal grazing season, stockpiled pastures are cycled into the rotation to continue grazing. This is a relatively simple process and can be done by anyone with grazing land at his or her disposal.

A basic method to stockpile pasture is to mow the plants 60-90 days prior to the end of the growing season and then allow them to rest (Don Ball et al., 2008). This can alternatively be done through grazing provided adequate grazing pressure is administered to ensure even pasture utilization. Livestock will need to be taken off the pasture before stand height drops to 4 inches to ensure plant vigor. Regardless of method, this is done to spark fresh vegetative growth. After mowing or grazing, nitrogen application can be performed to expand plant growth. Nitrogen application earlier than 90 days before the end of the growing season does not sponsor significant increased yield or quality (Don Ball et al., 2008). Nitrogen is a common limiting nutrient in many pastures and soil tests can be administered to calculate proper application rates.

Tall fescue is the plant species most widely used for stockpiling however most any forage can be used (Don Ball et al., 2008). What makes tall fescue most popular is its strong late season growth and retention of nutritional quality. Tall fescue accumulates high concentrations of soluble carbohydrates in the fall and has a waxy layer on its leaves making the plant resistant to frost damage and weathering (Don Ball et al., 2008). Not only does this allow the plant to grow longer into the growing season it also maintains the plants soluble carbohydrate, total digestible nutrient, and crude protein at high levels through the winter (Don Ball et al., 2008). Through this unique feature, stockpiled tall fescue commonly has higher nutritional value than the average hay fed to cattle (Don Ball et al., 2008). This species is also very persistent under grazing and low residual heights have little effect on spring regrowth (Belyea et al., 1985; Don Ball et al., 2008). Birdsfoot trefoil, a legume alternative, offers similar benefits and does not cause bloat (Hall & Jung, n.d.).

Since plants vary in palatability and weathering resistance it is prudent to graze those with higher current nutrition first; for instance, brome grass and orchard grass before fescue (Stephen K. Barnhart, 2010). Clovers and small grains lose nutritional value very quickly in comparison and should be used as close to their growing times as possible (Don Ball et al., 2008). These plants should not be left in dormancy long before they are utilized. In a mixed pasture setting this may happen naturally as livestock generally select feed that is more nutritious than the pastures average. Provided low grazing pressure, this can help offset nutritional shortages especially as browse tends to hold nutritional value longer through weather and can remain a viable feed source for one or more growing seasons (Vallentine, 2001).

When grazing stockpiled grounds, areas that may become less accessible in weather should be grazed first. This helps ensure each stockpiled location can be utilized in the winter regardless of weather. As for method of grazing, strip grazing is the most economical. Strip grazing can see efficiency levels of 70% or more by limiting losses due to trampling (Don Ball et al., 2008; Stephen K. Barnhart, 2010). This strip grazing method can also be used effectively if the forages are windrowed. Windrowing involves the cutting of forages and leaving them in windrows on the field at the end of the season in lieu of bailing it. Although this is not as labor and equipment minimalistic as stockpiling standing forage, it has its benefits. Windrowed feed tends to have higher nutritional values than standing stockpile since cutting prevents the plant from reabsorbing nutrients from its foliage in dormancy (Brummer, 2014a).

If sufficient protein content is not available in stockpiled crops, protein supplementation should be provided to maintain good rumen function. Supplementation can be done in multiple ways. Perhaps the most common is to provide a protein tub or block. This is a free choice method that can be moved through pastures and is a good median to supply other minerals and nutrients that might be in shortage as well. A potentially cheaper alternative is to keep a standing pasture of cool season annual pasture. This is not a viable option in areas with deep snow. However, as little as 30 minutes of cool season pasture grazing each day can meet livestock protein needs (Stephen K. Barnhart, 2010). Also, protein rich legumes including alfalfa and clover can be inter-seeded into pastures for stockpiling. This will boost nutritional quality but legumes tend to get pushed out of stockpiled mixed strands (Stephen K. Barnhart, 2010). Regular inter-seeding would be required to ensure long term viability.

Benefits:

Stockpiling has a variety of benefits. It is relatively cheap and allows a producer to leverage the growing season to produce sufficient feed for winter without much equipment. In the upper Midwest, winters can be a seven to eight month period; any increase in the number of days on pasture is money in the pocket. Stored feed production is expensive, grazing grasses can be one quarter to one third the cost to produce grass silage (Frame et al., 2011). Fescue when stockpiled typically produces about 3,000 pounds of forage per acre; with a 1000 pound cow eating 2.6% her bodyweight per day at 70% efficiency, one acre provides food for 80 days (Don

Ball et al., 2008). Feeding livestock fescue often raises concerns of gestational toxicity from entophyte infected tall fescue. Stockpiling helps mitigate this as aging reduces the toxicity (Don Ball et al., 2008).

Forage stockpiling need not take place on pastures in regular rotation; it can be done anywhere. An example includes planting seed in a pasture, hay, or crop field that needs to be renovated. This provides future feed and can create an absence of preferred species, breaking the cropping cycle and allowing for a wider spectrum of herbicides to be used for future reseeding preparations (D.C. Ditsch et al., n.d.).

Disadvantages:

Weather is the main variable with stockpiled crops. Precipitation can ruin standing forages and poor weather in general can reduce nutrient quality and drive plants into dormancy, reducing their digestibility (Stephen K. Barnhart, 2010). Snow can bury feed. However, animals can easily learn to graze through upwards of 9 inches and also use it as a water source when feeding (Stephen K. Barnhart, 2010). When snow melts or wet ground conditions are seen, caution should be taken with animal trafficking. Areas with poor drainage and heavy animal presence can result in soil compaction, increased soil erosion, lower feed utilization and torn surfaces requiring tillage for correction (D.C. Ditsch et al., n.d.). It is good practice to have a backup plan in case conditions are so poor livestock cannot graze. Due to this, stockpiling does not necessarily eliminate the need for stored feed.

Stockpiling can lower stored feeding costs but it is not free food. Producing stockpiled feed and moving livestock through the pastures may be more labor intensive than current practices. This method of feeding also requires some management. Certain feeds have poor acceptance, for instance switchgrass, and grazing certain stands of grasses too far can result in crown damage which will thin out pastures over time(Don Ball et al., 2008). Changes in labor and management costs should be included in calculations to determine if stockpile feeding is a viable choice for business operations.

Seeding:

Often the slump in pasture growth during a growing season is a result of the biological functionality of the plants. Pasture plant varieties are made up of two principle groups, cool season and warm season. Cool season plants are the most productive in cooler temperatures seen in spring and fall seasons while warm season plants perform best in hotter temperatures seen in summer. Outside of their preferred temperature bands their productivity tends to be limited. Balancing both types of plants can provide more forage growth consistently year round.

Process:

Across the United States different plant types dominate the variety of unique environments. Generally cool species thrive in the northern states with most of their growth taking place in the spring and autumn and warm season perennials thrive in the southern states where warm weather is common almost year round (Don Ball et al., 2008). Many northern producers are moving to seeding warm season grasses into pastures to offset summer slumps in forage production (Corson et al., 2007). This is a logical management move. However, there are limitations between which cool season and warm season plants are viable in the opposite climatic zones. Careful local weather and soil compatibility research should be made for each location to ensure plant viability.

Generally it is best to plant warm season and cool season plant species in different fields. In mixed strands plant species require careful management; less dominant species decline resulting in species makeup shifts over time (Don Ball et al., 2008). This can be countered with regular overseeding however some species combinations may thrive with little to no management depending on environment and grazing. There are many variables and mixture possibilities. In mixed pasture stands it is ideal to mix bunch and sod grasses together to reduce the amount of bare ground (Brummer, 2014b). When mixtures can be sustained, longer more constant, and larger quantities of forage supplies are seen through the year than their monoculture equivalents (Don Ball et al., 2008).

Forage selection for seeding cool and warm season strands should be based off a wide array of variables to meet production goals. Characteristics beyond forage distribution, including dry matter yield, forage quality, winter tolerance, and disease resistance should be considered (Don Ball et al., 2008; Sampoux et al., 2011). Thanks to the generations of forb and grass breeding programs, most combinations of desired attributes can be selected for (Don Ball et al., 2008; Sampoux et al., 2011). Common cool season perennial forages utilized between the West, Midwest, Northeast, and Deep South include tall fescue, brome, orchardgrass, and white clover. Warm season perennials that can grow in the same areas include varieties of bermudagrass, native grasses, and weeping lovegrass (Don Ball et al., 2008).

Some alternative warm season grasses to compliment cool season dominant plants include sudangrass, sorghum-sudangrass hybrids and pearl millet. These complement by offering large, quick forage production but should be planted separate from cool season plants due to shading from their tall upright structure which also can creates grazing management issues (Frame et al., 2011).

A variety of cool season plants exist to complement warm season dominant land. Annual ryegrass grows primarily in early to mid spring and is a productive winter annual in most areas it is utilized (Don Ball et al., 2008). In the northern parts of the country, winter cereal grains, spring barley, oats and triticale, when planted in spring, can provide forage growth from late spring and into autumn (Don Ball et al., 2008). As for legumes, hairy vetch, arrowleaf clover, alfalfa, red clover and crimson clover are safe choices and can perform well in heat (Don Ball et al., 2008). When mixed with warm season perennial grass sods or planted as a single species these plants can extend the grazing season by 30-60 or more days (Don Ball et al., 2008).

In general when seeding new species into pastures it is best to plant as early as the weather permits. The sooner the plants grow the sooner they can be grazed and help extend the grazing season. When interseeding new species into existing pastures, standing forage should be grazed or mowed closely prior to germination to prevent shading and over competition (Don Ball et al., 2008). Depending on the vigor of the seed, the new species may not need any additional treatment, i.e. irrigation or repeated mowing. Grazing should not commence until new plants are fully established and well rooting into the ground. It should not be forgotten that more or less arable acreages not currently utilized can be sown into permanent grasslands or temporary grasslands of good yield potential and nutrition over a 2 -5 year timeframe (Sampoux et al., 2011).

A number of new pasture grazing species alternatives have come to light in recent times. Brassicas are an example and a current hot topic that has seen growing interest as an alternative livestock feed. This plant variety includes: kale, turnip, turnip hybrids, rape, and swede. They are highly productive, digestible, high in protein and frost tolerant (Hall & Jung, n.d.) Grazing can be initiated 80-150 days after seeding and some varieties even lend themselves well to stockpiling (Hall & Jung, n.d.). A more extreme alternative that does not require annual seeding are leguminous shrubs and trees. They can be used as animal fodder in a range of environments. Tagasaste shrub, willows, poplars, black locust, and amorpha can be used in a suitable grazing regime to offset forage slumps (Frame et al., 2011).

Benefits:

Leveraging plant species and their diversity provides a slew of benefits. Each plant has a different growth cycle and matures and changes in nutrition at a different rate. Providing a variety of balanced plant populations negative relationships between forage availability and forage quality are minimized (Vallentine, 2001). Longer grazing of fresh plant species in general is more nutritious and helps mitigate the need for supplementation and the costs relating. Furthermore, diverse plant populations in pastures increase soil, pasture health, and drought tolerance. This tethered to forage yield and quality improvement, stock numbers can potentially be increased or more land taken out of regular season pasture rotations for stockpiling. Mixed plant species interseeding techniques can also be utilized in stockpiled pastures to boost their quality.

Disadvantages:

The main negative aspect to pasture and range seeding surrounds management. Much research can be required to determine ideal seed mixtures of warm and cool season plants in a given environment. Once growing, managing multiple plant species can become difficult when juggling different growth cycles and interspecies interactions. Poor decisions in implementation and maintenance can result in large expenses in seeding and equipment with little to no lasting rewards, especially if there is no germination.

Timing is another important consideration. Seeding can be laborious and time consuming to complete. Many seeding plans may take pastures out of a grazing cycle to establish the new species. Depending on resources available and pasture rest cycles this can increase costs dramatically through replacement feed requirements.

Livestock Management

Proper grazing of pastures for the forage species they contain is key to maintaining plants at a healthier and more productive state over time. Healthy and productive plants produce more feed, reduce the need for alternative methods of feeding throughout the seasons and can weather environmental stresses far superior. Plants grazed too close to the ground have slower regrowth, reduced yield, and are weakened due to the over depletion and taxation of food reserves (Don Ball et al., 2008). Plants have different susceptibility to grazing stress and leaving a sufficient stand height, approximately 4 inches, after grazing is the easiest way to ensuring plant vigor (Frame et al., 2011). This is easily accomplished by moving livestock through grounds with an appropriate technique. Management through the right technique ensures land is properly utilized, limiting both overuse and forage waste which is commonly seen through poor grazing application (Don Ball et al., 2008).

Process:

Historically most livestock have been fed through continuous grazing. Through this method livestock are left out in an area, year long, to graze and find whatever they want to eat.

This results in more palatable plants seeing excessive grazing pressure, shifting plant species populations and wasting forage. Superior and more progressive livestock grazing management techniques include limit grazing, strip grazing, rotational stocking and forward stocking (Don Ball et al., 2008). Limit grazing is giving animals access to pasture for only a few hours at a time. This entices animals to engorge quickly and not be selective. Strip grazing is the allocating of only a strip of pasture at a time for animals to graze. This is an excellent means to supply stockpiled crops as it limits trampling losses. It can also reduce selectivity in consumption depending on the size of the strip. Rotational stocking is one of the most popular methods today and involves the rotation of animals through different pastures or paddocks. Through this method, grazing pressure is limited by moving the livestock quickly through each section. This increases grazing efficiency while maintaining plant vigor by allowing for plant rest. Timing can be adjusted each year to alter when grazing pressure is seen in each paddock to better equalize plant stress across each species. Forward grazing is the placing of animals with higher nutritional requirements first in a pasture to graze. This is often used in tandem with rotational stocking where these first animals can pick and choose the most nutritious plants for consumption.

Simply put, timing has a lot to do with pasture yield. Leveraging the above techniques by adjusting grazing durations and available forage can ensure more even feed availability through the year. In tropical climates growth is essentially constant. However, in most temperate areas, timing of growth is similar to the following pattern: 1 initial growth (slow), 2 flush growth (rapid), 3 reduced growth (slow), 4 maturity -early dormancy (no growth), 5, post maturity (herbage loss and deterioration) (Vallentine, 2001). Since early season growth can be quite rapid, increased grazing pressure must be applied at this flushing time to utilize the increasing grass growth efficiently (Frame et al., 2011). This can be done either through increasing stocking rates or reducing pasture size allotment. Grazing during this rapid growth phase, when done before the boot phase when reproductive growth occurs, should result in substantially greater annual forage production and quality through the growing season provided sufficient water is available (Vallentine, 2001) (Hennessy & Kennedy, 2009).

Specifically timed grazing should not be repeated at the same time year after year in any pasture. Repeated summer pasture grazing results in loss of vigor, lower yields, and weaker strands of better forage quality plants while repeated winter grazing can do the same to plants more dormant vulnerable (Vallentine, 2001). Likewise, repeated spring or fall grazing will overly stress palatable plants attempting to grow. Varying grazing patterns each year spreads out grazing stress and ensures all plant species have equal opportunity to thrive and provide their benefits to pasture health and nutrition. An easy way to do this is to stager the grazing in fall paddocks so that the last grazed section is the first one livestock enter in the spring (Frame et al., 2011). Grazing paddocks should be closed off when post grazing sward heights reach 4 inches to ensure sufficient energy stores for regrowth, good winter tillering, and productive growth come spring (Hennessy & Kennedy, 2009).

Often pastures available to graze or needing grazing have poor nutritional quality. This is common during winter or summer forage slumps. At these times a supplement diet can be provided to complement. This can be done by providing protein through mineral blocks, alfalfa, cubes, or even supplementary pasture grazed time sequentially (Vallentine, 2001). Regardless of technique available, proper nutrition ensures good health and metabolic function for higher digestive efficiency to keep healthy productive livestock.

Benefits:

As discussed, grazing management can increase grazing efficiency and ensure productivity through pasture health and plant diversity. This stretches forage availability out further into the year or can allow more livestock to be reared in a given area. Beyond this, it is an excellent means to ensure animal nutritional needs are met (Don Ball et al., 2008). Methods such as forward grazing or limit grazing can be used for special needs animals. However, grazing management in general ensures pasture health and nutrition while providing stock a more equal opportunity to consume the feed they desire. Weaker animals are less likely to be pushed away from special desirable plants. Since livestock are moved through pastures more evenly and quickly, their dung and urine are well distributed reducing fertilizer needs to maintain optimal forage production (Don Ball et al., 2008).

Disadvantages:

Initial set up and implementation of a grazing management system can be costly and require more sustained management. Proper grazing requires continual observation to ensure plant growth and limit overutilization. Depending on fencing and water availability there may be some significant implementation constraints. With this some systems may require regular livestock visits and in some cases someone may need to live with the animals year round.

Weather is a huge variable and may cause restraints to animal abilities to move to new ground and even how much plants can grow. The selling of stock early may be required to ensure enough pasture is left for permanent stock without overgrazing. This is a tough management decision and bad management in general can mess up the land quickly if grazing management strategies are not implemented properly. An easy mistake is allowing too much defoliation in the wrong growth stage. Such heavy grazing of sprouting fall or spring crops will give the advantage to warm season plants and heavy grazing summer plants that are initiating their growth will allow cool season species to dominate (Vallentine, 2001). This will prevent consistent season long production and promote undesirable species such as toxic weeds to enter pastures.

Byproducts, cover-crops, and residue grazing

At the end of harvest many byproducts and crop residues are left in fields and otherwise unused. Also, many winter annuals are planted after harvest to allow year round production on croplands. They provide cover, treatment of soil during winter months, and can be excellent forage. Combining these winter annuals with crop residuals and byproducts, livestock can be furnished with enough forage to extend their grazing deep into, if not through winter(Don Ball et al., 2008).

Process:

The first step to finding any of these alternative feeds is to look around at anything that could be grazed. Possibilities are endless, corn, sorghum, alfalfa, melons, tomatoes, weeds, brassicas, and essentially anything growing in a field that is harvested. The following are some common western United States examples.

Residues in corn and grain sorghum fields are an excellent high energy feed source for livestock and can provide many days of feed. Regardless the crop, livestock select the most palatable and nutritious feed first. This is of especial concern in corn or sorghum fields and to prevent overloading and more even consumption strip grazing is recommended (Don Ball et al., 2008). This can be alternatively done through supplementation of minerals or hay in key, less nutritious parts of the field, to draw animals there. However, initial demand may be low with initial grazing (Don Ball et al., 2008)

When grazing winter dormant alfalfa, growth should be accumulated for roughly 6 weeks before the first killing frost is expected (Don Ball et al., 2008). This allows for carbohydrate reserves to be replenished and sufficient vigor come spring. Once dormant this accumulated growth can be grazed by livestock and has high nutritional value especially if done promptly before leaves drop off. Hay fields can be grazed but are more prone to grazing pressure and adequate stubble height should be left after grazing.

Brassicas, mentioned earlier in the stockpiling and seeding sections, are highly productive and digestible forbs used in crop rotations. High in crude protein, livestock generally eat the top leafy greens and may consume portions of root bulbs in the ground. Dry matter content is variable but generally low and should accordingly make up no more than 2/3 of the diet to ensure proper rumen function (Don Ball et al., 2008). Providing dry forage while strip grazing is an excellent way to ensure high consumption of brassica.

Cereal crops, such as wheat, rye, oats, barley or triticale can provide good autumn and early winter grazing provided they are planted 3-4 weeks earlier than for standard grain production (Don Ball et al., 2008). Many of these species can sustain light to moderate grazing pressure in fall and when allowed to re-grow, produce an unaffected yielding grain crop (Don Ball et al., 2008). If harvest is not economical or otherwise undesirable the crop can be re-grazed again as well.

Existing crops and those just harvested can be overseeded with a companion species to boost their nutritional quality when grazing will occur. Annual ryegrass is an excellent candidate for this as it is high in feed quality, easy to manage, has rapid regrowth after grazing and can be no-tilled seeded into many crops including standing corn, soybeans, summer row crops after harvest and even alfalfa fields (Don Ball et al., 2008).

Benefits:

Grazing these alternative feeds can be very cost effective. At times they may be free, minus transportation costs and any temporary fencing requirements. If they are not free, they can be reasonably priced and offer extra benefits. In the case of corn, grazing fields in late fall/early winter increases animal production per unit of land and allows producers to cash in on positive changes in livestock prices from fall to spring (D.C. Ditsch et al., n.d.). If corn is a supplement normally fed, grazing cornfields eliminates cereal storage requirements. Beyond this, grazing alternative crops reduces hay dependency and allows pastures to rest and accumulate for extended grazing through winter and healthy development in spring (D.C. Ditsch et al., n.d.). It is estimated that for every acre of corn stalks grazed approximately ½ ton of hay that would otherwise be fed is saved (Don Ball et al., 2008).

Similar to the previously discussed methods, grazing these alternative feeds will spread manure to the land, reducing the need to clean out dry lots while promoting nutrient cycling and reducing potential ground and surface water impacts (D.C. Ditsch et al., n.d.). Livestock consumption and trampling down of forage on the croplands can reduce and eliminate tillage requirements. In the case of alfalfa winter grazing, the reduction in standing biomass can reduce weevil populations (Don Ball et al., 2008). Byproduct, cover crop, and residue grazing can be a good situation for the crop producer and the livestock producer by offering high quality nutritional sources that would otherwise be unaffordable.

Disadvantages:

These alternative feeds can be variable in terms of nutrition and their position in the field. Careful attention should be made towards what is consumed and what is in it to ensure herd health. Restrictive grazing techniques may need to be implemented to prevent over consumption of starch rich food, i.e. corn, to prevent acidosis. Depending on the field and location this may create transportation, labor, fencing, and water availability concerns. Some crops may have limiting nutritional value and supplementation may be required. In addition to knowing what crop is consumed, knowledge of when and which pesticides and herbicides have been applied should be gathered. Livestock should not be grazed until fields have been cleared of residues (Don Ball et al., 2008).

Weather conditions can limit the effectiveness of this method. High animal traffic in poorly drained soils in wet conditions can result in soil compaction, soil erosion, lower feed utilization and may require tillage to rectify surface conditions (D.C. Ditsch et al., n.d.). Weed exposure may also be an issue. Grazing livestock can hold plant seeds in their gut and move them to new fields through their feces. Any weed content in feed or pastures livestock consume before transportation may spark distress from the landowner.

Maintaining Soil Health

Forage production starts with soil health. Without a fertile and hospitable environment, plant production cannot exist. By managing soil health to ensure a nutrient rich environment this basic necessity for growth is met. Through optimization of conditions, maximum growth potential is ensured and the management practices mentioned earlier can be implemented to best utilize the vegetative matter produced.

Process:

Plants need few core items to survive. They are light, air, water, and nutrients. The first two should be abundant in a pasture setting but water and nutrients may have issues or imbalances. These can be easily adjusted through fertilization and irrigation. In certain systems, fertilizer can be applied through the irrigation. Soil tests should be taken randomly across each pasture in order to calculate appropriate nutrient applications. These tests will provide information on soil pH, texture, salt content, and available Nitrogen, Phosphorus, Potassium and micronutrients. Soil pH, texture and salt content are generally difficult to change. Nutrients are easy to add and nitrogen is the most common growth limiting factor (Don Ball et al., 2008).

Generally soil mineral nitrogen levels will be higher in autumn and low in early spring due to the rapid uptake of nitrogen during spring flush (Frame et al., 2011). Due to this, applied nitrogen will have a higher effect in early spring than late autumn (Frame et al., 2011). To target this timeframe, late winter is the ideal time for nitrogen application so soils can be ready when plants come out of dormancy (Frame et al., 2011). Many tools exist to determine when in winter the fertilizer should be applied. T-sum 200 is a popular system that originated in the Netherlands. Through this system maximum and minimum daily temperature in Celsius are summed together starting from on January 1st(Frame et al., 2011). Once the total sum reaches 200 it is time to apply the fertilizer.

Pastures may have additional deficiencies beyond nitrogen. Phosphorous and potassium are common but micronutrients could also be lacking such as iron. Soil tests should be taken every few years to determine any new imbalances once normal soil conditions are known. If desired, it is possible to alter small imbalances in soil ph. In many climates with high precipitation the soils are acidic; lime can be applied to bring the soil up to a more favorable ph of 7 (Don Ball et al., 2008).

Plant growth is most commonly limited by lack of water during the warm summer season. This can result in slow, limited growth, or even placing the plant into dormancy. Irrigation can help mitigate this by allowing plants that would otherwise not grow, to thrive in hot dry environments. This is how California produces most all of its crops. Likewise it is useful to have irrigation options in areas that see regular rainfall. In times of drought or an extended dry spell, irrigation can be applied to maintain sufficient soil moisture to maintain growth. Careful attention should be made to what soil moisture is appropriate for each plant; being extra moist is not always the solution. Sagebrush and alfalfa will die if their roots are too wet.

Wet soils are prone to compaction when livestock are allowed on them (D.C. Ditsch et al., n.d.). Every effort should be made to prevent excessive access to fields currently or just irrigated. This includes fields that have been rained on. Compacted soils reduce drainage, microbial growth, and the ability for plants to root. Compaction will reduce naturally with time through biological means including root growth and worms (Brummer, 2014b). Severe compaction may need mitigation through heavy equipment.

Benefits:

Healthy soils produce more and maintain vegetative life far superior. This means more forage is available in good years and bad years, reducing the effects of droughts and bad weather. Through healthy soils, more plant diversity is possible through the increased fertility and degradation is far less likely. Plants will be more able to cope with grazing pressure and help prevent other landscape issues such as erosion at superior levels.

The extending of the grazing season methods of stockpiling, pasture/range seeding, livestock management, byproducts, cover crops and residue grazing are all related to soil health. If done properly soil health is maintained or improved and if done poorly, it can hurt soil health. Likewise each of these methods can be done far easier and have higher yields provided high soil health is maintained.

Disadvantages:

Outside of managing livestock properly and seeding plants that complement each other, maintaining and improving soil health can be expensive. In some cases increased yields may not be worth the investment costs. This is especially the case with operations that take place on large ranges. Fertilizers by themselves can be expensive. However, new regulatory restrictions may preclude or fine operations applying them at the certain times or beyond certain levels regardless if it is best for soil health (Läpple et al., 2012). Irrigation systems are also expensive to buy, run, and maintain. Depending on water rights available, it may not even be possible for an operation to start irrigating in some parts of the country. Water is not the cure-all for hot climates, in some extremely hot areas, the high temperature may be the limiting growth factor (Vallentine, 2001).

Chapter 3:

Conclusions and Synthesis

Extending the grazing season can be done through the execution of many different options. There is no one set of strategies applicable for every producer. Nor is it something only a select few can do; in almost every area, including those with poorer soils and locations, there is benefit from improvement of grazing strategies (Läpple et al., 2012).

Each strategy has its benefits and its disadvantages but they all have one similarity. That is to maximize grazing potential by exploiting forage growth differences and maximizing plant growth. There is no set strategy that is better than the other, only ones that work superior in certain environments and business situations. For instance, interseeding legumes into rangeland would not be economically viable for someone who runs their stock on 16,000 acres in the Great Basin. To mesh strategies with business goals additional operations may be needed including: changing the breeding season, and even selling animals at different times of the year to match nutritional requirements with the nutrition available for consumption (Don Ball et al., 2008). It is most approachable for a producer to take little steps towards extending the grazing season starting with determining how many AUM's are needed each month for current production. Afterwards the producer can calculate where current grazing shortfalls are so a cost benefit analysis can be performed to see if new strategies and changes are viable to meet business goals. It may involve implementing a combination of strategies. This is why it is best to know your options.

Extending the grazing season benefits livestock businesses outside of reducing cost and increasing feed self-sufficiency. Grazing livestock on pasture is considered more environmentally and animal welfare friendly. The more time livestock are outside feeding and not in a confined feeding system the less time activists will be raising concerns on animal welfare and public perception will improve. Grazing also has many benefits on an emissions standpoint. While the livestock are out on pasture or the range they are spreading their own manure, eliminating the need for manure spreading allotments. Also, ammonia emissions of livestock grazing are much less than when they are housed and fed (Webb et al., 2005). Urine excreted on grazing land can rapidly infiltrate soil where in yards or on floors it remains on the surface much longer. As example, if the average UK cattle herd could extend their grazing season from 6 to 8 months ammonia emissions from the livestock could be reduced by 15% (Webb et al., 2005). The more options producers know the more they can succeed both as a business and in sustainable agriculture.

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