9.15 Simple rotational grazing system effects

2016 EXT 17

Assessing and demonstrating effects of a simple rotational grazing system on forage production and soil fertility

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MBFI Location(s): First Street Pasture

Collaborating Partners: Jane Thornton, Farm Production Extension – Forage and Pasture, Manitoba Agriculture

Start Date: 2015 Status: In Progress

9.15.1 Introduction

In the spring of 2015, a 10-field simple rotational grazing system was developed at the First Street Pasture using single-strand interior electric fences and solid posts. The exterior perimeter is a four-strand barbed wire fence with solid posts. A shallow buried PVC pipeline with several spigots provides water to the fields. Fifty cow-calf pairs were rotated through the fields from June to September of 2015, and 50 heifers plus a few cow-calf pairs were rotated in the same months of 2016, with additional days in May. This system was implemented to improve the distribution of livestock use across the landscape, thereby improving efficiency of both forage growth and harvest.

Until 2015, some areas of the First Street Pasture had been underutilized, leading to an accumulation of old, weathered forage. Grazing stimulates soil and plant processes and halts the tie-up of nutrients that you may see in decadent forage of ungrazed systems, leading to diminished productivity[1]. However, we don't want to defoliate too much forage at one time: in a study in central Alberta[2], moderate levels of clipping (4" residual) produced higher total biomass, grass biomass and forb biomass than light or heavy clipping and it produced the highest crude protein yield. First Street Pasture's rotational system, with its multiple smaller fields, will confine cattle in areas they normally would not spend enough time in if they had free range over the whole pasture. This is expected to improve the freshness of the grass in all parts of First Street Pasture, resulting in more efficient sunlight capture, better feed quality, and more biological activity in the soil.

The rotational system designed for First Street Pasture provides each field a significant period of rest from grazing during the growing season. Effective rest is important because it allows forage plants to regrow leaf material so that they can replenish energy reserves and proceed to reproduce and maintain their existence within the stand. Simple rotational grazing schemes often involve only a single pass through each field during the growing season. Intensive rotational grazing systems take this a step further by dramatically increasing the number of fields (a.k.a. cells or paddocks) with the intent of concentrating livestock onto a smaller area to produce "herd effect" while providing a greater proportion of time for a field to rest after use. The rotational grazing system designed for the First Street Pasture lies in between these two types of rotational grazing strategies.

Improving livestock distribution provides better nutrient distribution[3], accelerates incorporation of forage biomass into the soil, and promotes more even regrowth of forage[4], which in theory can all lead to improved overall forage productivity. However, it is not necessary to adopt an intensive rotational grazing system to improve livestock utilization. This can be done simply by reducing distance to what attracts cattle most – water – either by pasture subdivision and water developments[5] or by water development alone[6]. This is the justification for our simple rotational grazing system and water pipeline.

No historical grazing records or forage production data were kept by the previous users of First Street Pasture. Critical components for grazing records include type and class of livestock, and herd entry and exit dates to and from each field. This data allows a person to calculate a standardized level of forage utilization, and to develop an expectation for next year's grazing capacity (by considering long-term annual grazing report data plus weather information). Without past grazing records from this pasture, it was difficult to know in 2015 how many cattle should be stocked at this pasture for the expected length of the grazing season. Long-term grazing records are helpful in assisting in the development of expectations for grazing capacity of pastures with similar vegetation and soil elsewhere in the province.

Grazing Response Index (GRI) will be helpful in explaining any changes to soil health, forage productivity, and pasture health with the implementation of rotational grazing at MBFI First Street Pasture. GRI is the total of ratings for three subcomponents – Frequency, Intensity, and Opportunity – as they pertain to how grazing affects key forage plants. If a positive score is achieved, then the forage plants are expected to have benefitted from the grazing regime[7]. If negative, they are expected to have been harmed.

Better GRI scores are expected for rotational grazing systems for the following reasons: they reduce the amount of time any forage could be grazed, for a better Frequency score, and they increase the amount of time for effective rest, for a better Opportunity score. The amount of forage utilized in a rotational system is under better control, so overgrazing is alleviated in some areas, while greater use is made of formerly underutilized areas. Depending on how an intensive rotational system is applied, Intensity can be scored as positive, neutral or negative, but any negative scores are offset by increased Frequency and Opportunity scores, leading to a positive overall score, meaning benefit to the forage stand.

9.15.2 Objectives

There are three objectives: first to study and document plant productivity and soil fertility changes through time resulting from the implementation of a rotational grazing system; second, to demonstrate a method for keeping grazing records to help in future grazing decisions (timing of grazing periods, herd size, start and end dates); and, third, to demonstrate the Grazing Response Index method of assessing and adapting to current year's grazing management impacts.

9.15.3 Project Design and Methods

The first objective is to be achieved through manual forage harvest, plant species data collection, and shallow soil testing. It is necessary to start with baseline data collection so that we have a "before-and-after" comparison. It is necessary to account for temperatures, rainfall, antecedent precipitation (that occurring before the period of observation) and growing degree days, because they affect forage production and soil biological activity.

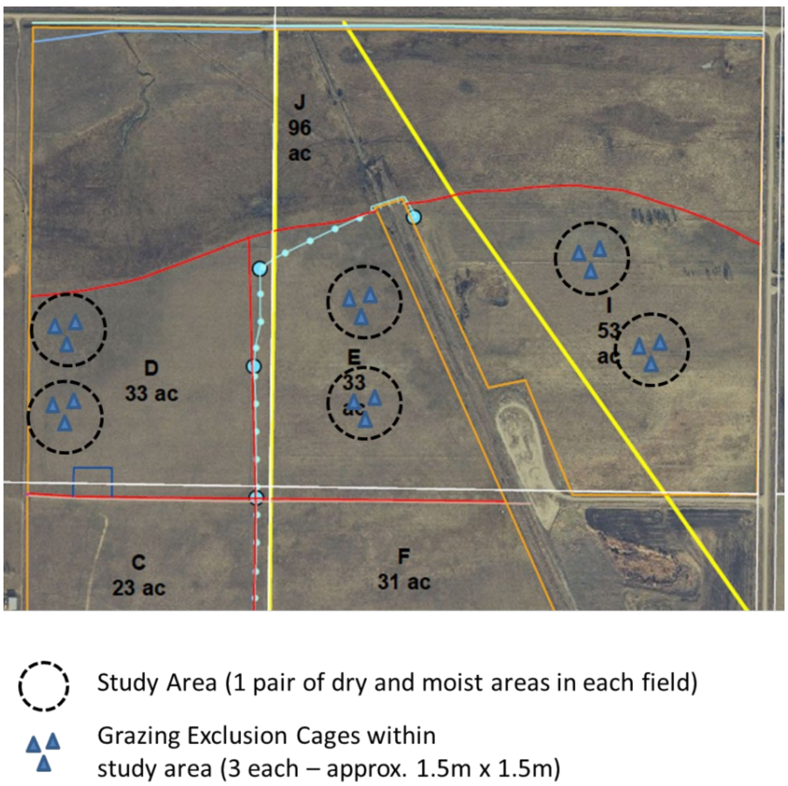

Fig. 9.15.1. First Street Pasture map

In three fields at First Street Pasture (D, E, and I), a dry location and a moist location (depressional, but without standing water) were selected for the full duration of this study. Three temporary grazing exclusion cages were installed at each location. They are rebar and mesh pyramids with a square, 132 cm base, fastened with 25 cm rebar pegs in each corner. Pegs are fully bent over to prevent livestock from dislodging the cage when scratching on them. None of the 18 cages were pushed over in 2015 or 2016.

Forage biomass is protected from grazing with these cages, and then collected each September, when forage has reached at least 95% of its growth. It is harvested from within a 50 x 50 cm frame placed in the centre of the cage. Forage is clipped to within 5 cm of the soil surface. No sorting is done to partition out legumes, weeds and grass. Dead litter from previous years' growth is removed, or a deduction is noted that represents a percentage of content. This step is important to prevent inflated forage productivity values due to forage left behind in the previous year that was ungrazed. Old growth in 2015 comprised a considerable amount, ranging from 15 to 50% for the harvested plots. It was less in

2016 (zero to 10%) due to greater biomass production and the influence of grazing pressure and trampling.

The biomass is placed in a paper bag, and dried in a high capacity oven for 48 hours at 35 to 38°C. It is weighed immediately afterward because it will take up moisture from the air.

Multiplying the weight from the sample by 40 yields the production value in kg/ha. The grazing exclusion cages are moved each April to a patch that has received typical use by cattle in the past year. They cannot be re-installed in fall after grazing because they will catch snow and alter the potential biomass production for the following year. Cages are installed in a spot that represents the area being sampled, with no set distance apart (they are typically five to 15 m apart).

Baseline plant species composition was sampled in the general area of the exclusion cages on Aug. 3, 2016, as estimates of proportion of biomass represented by each species from five- 50 x 50 cm frames placed randomly around the cluster of grazing cages at each location. At the same time, eight indicators of pasture health were evaluated from each location according to the method set out by Adams et al. in Alberta's Rangeland Health Assessment for Grassland, Forest & Tame Pasture[8]. These indicators include representation by desirable and productive forages, representation by disturbance-induced weeds or low productivity species, amount and cover of plant litter, soil cover and erosion, and presence and abundance of noxious weeds (e.g. leafy spurge).

Baseline soil samples (nutrient and organic matter content) were taken by Manitoba Agriculture staff on June 10, 2015 in the vicinity of all study locations, plus within the two fenced grazing exclosures in D and H, manually with a 32 mm soil core. Five subsamples were taken from each location and composited to form a single sample for each site and for each depth. Two depths were sampled: 0 to 15 cm and 15 to 30 cm, because that is where most of the nutrient and organic matter change is expected to take place (this is where the majority of the plant roots exist, with the first 15 cm separated out because most soil biological activity is expected to take place in that zone). Analysis was completed by AgVise. They will be taken again in June of 2017 to see if any changes have taken place. The exclosure samples in 2017 will help us to determine if there is a grazing effect by seeing if there is a difference between ungrazed pasture and grazed areas. It should be noted that if there is any change, it is likely to be small, as it takes several years or more for significant change to be seen even with very dramatic changes in grazing systems.

In order to achieve the second objective we are using operational recordkeeping, field tours and presentations, and dialogue with MBFI staff and cooperators as a means of helping people to understand how and why to record grazing data. In 2015, the grazing report form that was used for the Prairie Farm Rehabilitation Community Pastures (PFRA Pastures) was delivered by AAFC to the Manitoba Agriculture collaborator for First Street Pasture (Jane Thornton), who designs the grazing system each year. It includes the field name, what type of animal grazed it, herd size, and entry and exit dates for this field. MBFI has made a digital form and reported on the 2016 grazing season using this format.

In the fall of 2015, staff diary entries from First Street Pasture were used to input the necessary data into this form, and then calculate the standardized stocking rates in the following manner. In each field, numbers of animals of each type are converted to Animal Units using conversion tables (1 cow/calf pair = 1.4 AU; 1 bull = 1.5 AU; one yearling = 0.75 AU). Animal Units are added together for each grazing period in each field and multiplied by the number of days to give Animal Unit Days (AUD). If desired, these are convertible to Animal Unit Months (AUM) by dividing by 30.5. This data can be used to calculate a standardized forage utilization level for each field, and have the potential to be a start for a long-term stocking rate data set.

Field tours in 2015 or 2016 did not emphasize the demonstration of this data collection, but there is potential in future years, especially as MBFI and its cooperators continue recording grazing data for this pasture.

In order to achieve the third objective, we are using the Grazing Response Index (GRI) method that has been introduced in western Canada for native pasture, and has been studied and adapted by AAFC and Ducks Unlimited in Saskatchewan for tame pasture. Basic methods are presented here and further details can be found in reading the background paper by Reed et al.[7]. A factsheet and worksheet for applying GRI can be found on the federal government website[7].

The GRI score for a field in a certain year is totaled from the ratings of three subcomponents – Frequency, Intensity, and Opportunity – as they pertain to how grazing affects key forage plants. Scores range from -4 to +4; if a positive score is achieved, then the forage plants are expected to have benefitted from the grazing regime; if negative, they are expected to have been harmed. Consecutive years of negative scores in one field is expected to damage the health and production potential of the stand. Management decisions can be made based on these scores. A field with a negative score could gain some relief if grazing pressure or duration is shifted to a field that tends to have positive scores.

Frequency represents the number of times a key forage plant could be grazed consecutively while cattle are in a field during the growing season, based on evidence that key grasses can re-grow in seven to 10 days to a height where they can be regrazed. Grazing only once (index value = +1) will positively affect plants. Grazing twice in sequence (index value = 0) would have relatively little effect. Continuing to graze three or more times in sequence (index value = -1) will negatively impact plants. Livestock in a field for a period of 13 days during the growing season could have grazed a key forage plant up to two times, generating a frequency index value of zero. We can rate Frequency at the end of the grazing season based on the grazing record.

Intensity is a measure of how much leaf material has been removed during the grazing period, and is described using three levels of defoliation – light, moderate and heavy – for index ratings of +1, 0, and -1, respectively. As GRI was designed, moderate grazing for native stands is between 40 and 55% of forage removed. Ducks Unlimited – Saskatchewan Region, in their adaptation for tame pasture, defined moderate as between 65 and 80%[9]. Ideally we should rate Intensity immediately after the cattle leave the field, as it is hard to judge intensity at the end of a season for a field that was grazed early.

Opportunity relates to how much time plants have for growth prior to grazing, or for regrowth after grazing. If plants appear ungrazed at the end of the season, or if it was observed that plants had reached full growth before grazing, then the rating would be +2. Under a continuous grazing system, the site would score -2. If there was a small chance for growth or regrowth it could rate as a 0 or -1. In our rotational system, with most of the season available for forages to grow or re-grow, we would expect a rating of +2 or +1. Opportunity is deemed to be the most important of the three components and therefore has double the magnitude. We can rate Opportunity at the end of the grazing season based on the grazing record, and observations of seasonal growing conditions or other growth-limiting factors such as grasshopper infestation.

9.15.4 Results and Discussion

It is an interim year for data collection, and thus no final results are available pertaining to the first objective. However, it may be useful for other purposes to show the baseline and interim results for soil quality, forage yield, pasture species composition, and pasture health indicators.

Forage production is strongly influenced by growing season precipitation amounts and patterns. We now have two contrasting years in terms of growing conditions. In 2015, precipitation accumulation was below average for most of the growing season, whereas in 2016 there was greater than average precipitation except for dry spring conditions ending in late May, and a lull in precipitation in August. Accumulated growing degree days were also better in 2016 than 2015, although both years were above average.

Our study tracks a representative moist area and a representative dry area in each field. The contrast in yields between moist and dry areas at this pasture was very distinct in both 2015 and 2016 (Table 1). In the moister year, the average forage yield in the dry area was more than twice the yield of the drier year, but the average forage yield in the moist area only increased by 29% from the dry year to the moist year.

Table 9.15.1. Forage yield in selected fields at MBFI First Street Pasture (kg/ha)

	Field D	Field E	Field I	Average	%Change
		September 2015			
Yield of Dry Sites	1381	1205	1819	1468	-
Yield of Moist Sites	4136	4959	4147	4414	-
		September 2016			
Yield of Dry Sites	3531	3750	2988	3423	+133%
Yield of Moist Sites	4521	5284	7279	5694	+29%

Species composition (Table 2) estimates in 2016 showed that all study locations are dominated by exotic grasses (Kentucky bluegrass, smooth brome, and quackgrass). None of the locations had adequate amounts of highly productive exotic or native forages (smooth brome, quackgrass, green needle grass, or alfalfa). Field D had the best cover of smooth brome, a highly productive forage species (56 to 58%). Quackgrass, another highly productive forage species, was greatest in the moist area of Field I, but only with 52% composition. Legume content (alfalfa, black medic, milkvetch) was inadequate, ranging from three to 13% of current year's growth. Leafy spurge ranges from seven to 29%, with the lowest amounts being in field D and in the moist area of Field I.

In the 2016 Pasture Health Assessment (Table 2), the D Field locations most closely resembled tame pastures seeded with productive forages, and thus were scored as a "Tame Pastures". The others in Fields E and I were scored as "Modified Tame Pastures" due to a shortage of seeded exotic species (smooth brome), and an increase in Kentucky bluegrass, quackgrass, leafy spurge, and/or native herbs. Only one tame pasture and one modified pasture were determined to be "Healthy". The others were "Healthy with Problems". Most deficiencies in health resulted from inadequate species composition, inadequate litter cover, and/or presence and abundance of noxious weeds (leafy spurge). Minor deductions came from soil exposure and movement.

Baseline soil test results in 2015 show very low values for nitrates, ranging from 5.6 to 14.6 kg/ha (in the top 30.5 cm of soil. In the top 15.2 cm, phosphorus was very-low to low at three to seven ppm, and sulfur was very low to moderate, ranging from 7 to 34 kg/ha in the top 30.5 cm. Potassium is medium to high, ranging from 121 to 256 ppm.

Being a perennial pasture, organic matter levels are low compared to estimated pre-European levels in Manitoba (10 to 15%)[10]. We would like to see higher values to indicate a pasture that is active in its forage growth and soil biological activity. Our organic matter values for the top six inches range from 2.6 to 5.7%. Our highest organic matter soils are in locations identified as having clay loam surface texture, and they have the highest cation exchange capacity rates. Cation exchange capacity, representing the ability of the soil to hold positively charged nutrients (calcium, magnesium, potassium, sodium, and most other micronutrients), ranges from 12.2 to 22.1 meq, and is within expectations for the soil textures that we have. This ability comes from clay and organic matter. We have not verified how much clay is in each of our soils, but it appears that both clay loam texture and organic matter are having an effect on the soil's ability to hold nutrients. Organic matter on its own (as humus) provides cation exchange capacity in the triple digit values, but in true soil this capacity is significantly diluted because it makes up a small percentage of a the soil. Increasing organic matter is our best opportunity of increasing the soil's capacity to hold any nutrients that are added.

In pursuing the second objective, MBFI has established a method for recording grazing data that includes number of head, type of cattle, and entry and exit dates for each field. We now have two years of grazing data to put towards a Historical Stocking Rate Record for each field at First Street Pasture. Table 3 is referenced and calculated based on the grazing report provided by MBFI at the end of the grazing season.

Stocking levels in some fields will be difficult to monitor through time because of grazing trials. For example, Paddock C will have been subdivided into 24 paddocks by the end of 2018, which is further complicated by the gradual conversion, and then again with some paddocks being grazed together with the larger area during certain periods, and grazed separately during others. Paddock J is complicated by its wetness – in the fall of 2016 it needed to be halved and the fence between the west half of J and E lifted so that the cattle could reach fresh drinking water.

The following is an example of how the grazing and forage yield records can be used to determine the grazing potential of the pasture. Assuming that the average of the forage yield samples from the Dryland study sites in Fields D, E, and I are a conservative reflection of the forage yields throughout the entire pasture, we can expect to supply 54 cows for 130 days in an average to below-average year, or 126 cows for 130 days in an above-average year (Table 4). While the number of cows calculated to meet the forage supply at First Street Pasture in 2015 is close to the actual number of cows stocked, the actual number of days grazed that year was only 86, resulting in only about two-thirds of the potential use calculated for 130 days. The grazing season in 2016 was up significantly to 126 days, but actual herd size was far lower than the forage it could provide, due to above-average precipitation and the smaller forage demand of heifers. It should be noted that these calculations are based on dry matter yield only, and that feeding strategies should consider the quality and palatability of forage.

Table 9.15.2. Species composition and pasture health in selected fields at MBFI First Street Pasture. All values listed as percentages of their total possible value

	Field D		Field E		Field I	
	Dry	Moist	Dry	Moist	Dry	Moist
Smooth brome	56	58	26	18	34	2
Quack grass				11		52
Kentucky bluegrass	21	23	26	52	16	35
Junegrass			1		3	
Green needle grass			1.2			
Alfalfa				2		
Black medic	13	12	9		8	
Wild milkvetch				1	0.4	
Leafy spurge	9	7	29	16	21	8
Other herbs	1	0	8	0	18	3
Pasture Type	Tame	Tame	Modified Tame	Modified Tame	Modified Tame	Modified Tame
Species component	63	63	29	33	29	75
Litter component	33	100	67	100	67	100
Soil component	56	100	78	100	100	100
Exotic component	33	33	0	0	0	33
Final health score	55	78	50	63	53	83
Health rating	Healthy with Problems	Healthy	Healthy with Problems	Healthy with Problems	Healthy with Problems	Healthy

Field	Size (ha)	2015 Days	2016 Days	2015 Grazing Use (Animal Unit Days)	2016 Grazing Use (Animal Unit Days)
A	9	8	11	561	488
B	10	3	12	219	530
C	10	8	12	584	526
D	13	11	14	788	665
E	14	0	4+	0	178
F	13	9	12	651	567
G	19	13	8	919	362
H	15	13	16	911	725
I	21	14	16	1002	704
J	38	5	11+	358	502
E + J	33	0	9	0	388
Total	161	86	126	5993	5635

Table 9.15.3. Grazing summary data for fields at MBFI First Street Pasture

Table 9.15.4. Calculation of forage supply for First Street Pasture based on yield samples from Dry Locations

	Sample Yield (kg/ha)	Pasture Area (ha)	Safe-Use Factor	Total Forage Supply (kg)	Animal Unit Days	Heifer-Days	Cow-Days	Heifers for 130 Days	Cows for 130 Days
Dry Yield 2015	1,468	161	50%	118,174	9,848	13,130	7,034	101	54
Dry Yield 2016	3,423	161	50%	275,552	22,963	30,617	16,402	236	126

Working towards the third objective, the grazing data and general observations from 2015 and 2016 were used to assign Grazing Response Index scores to the six study locations at First Street Pasture (Table 5). With minimal effort, MBFI could set up additional permanent GRI assessment locations in all of the other fields at this pasture. Ideally Intensity should have been scored immediately after each grazing period, but general observation suggests that the intensity of forage harvest from each field is conservative.

As an example of how the sites were scored, in 2016, Field D was grazed once for 14 days during a dry period in August. That leaves a chance for two consecutive defoliations of any single plant, for a Frequency rating of zero. The total amount of forage removed from either of the study locations in Field D was low to moderate, for an intensity rating of +1. The field had a full chance to grow before grazing, and time after grazing for recovery, for an Opportunity rating of +2. Overall this leaves a GRI score of +3 which is very high (maximum score is +4). Factors which result in slightly lower GRI scores are longer grazing periods that result in more potential consecutive defoliations, and a second grazing pass which, in some cases (not always), interrupts the effective rest period.

In 2015 and 2016, all GRI scores for the study locations were positive, indicating that the grazing system has benefitted those forage stands. Because all the scores are good, there is room in any field for increasing the number of grazing days or expanding the size of the grazing herd to use up old forage and stimulate new forage growth and biological activity. Such a strategy will reduce Frequency scores and Intensity scores for a targeted field, and may reduce Opportunity scores, but there is flexibility in a rotational grazing system to shift that kind of pressure away from that field into a different field in subsequent years.

Table 9.15.5. Grazing Response Index Scores for Rotational Study Locations at MBFI First Street Pasture

Study Location	Frequency	Intensity	Opportunity	Total
			2015	
Field D - Dry	0	+1	+2	+3
Field D - Moist	0	+1	+2	+3
Field E - Dry	+1	+1	+2	+4
Field E - Moist	+1	+1	+2	+4
Field I - Dry	0	+1	+2	+3
Field I - Moist	0	+1	+2	+3
			2016	
Field D - Dry	0	+1	+2	+3
Field D - Moist	0	+1	+2	+3
Field E - Dry	+1	+1	+1	+3
Field E - Moist	+1	+1	+1	+3
Field I - Dry	0	+1	+1	+2
Field I - Moist	0	+1	+1	+2

In 2016, the second season of the study, forage yield sampling and grazing data collection continued. MBFI's First Street Pasture Historical Grazing Record is in its second year, and from this and the forage yield data we were able to make some initial comparisons of forage demand versus forage supply. We conducted the baseline plant species composition of the study areas in early August, followed by an evaluation of eight indicators of pasture health according to the method set out by Adams et al. in Alberta's Rangeland Health Assessment for Grassland, Forest & Tame Pasture[8]. These indicators include representation by desirable and productive forages, representation by disturbance-induced weeds or low productivity species, amount and cover of plant litter, soil cover and erosion, and presence and abundance of noxious weeds (e.g. leafy spurge). Grazing Response Index was rated for each study location for both the 2015 and 2016 grazing seasons, according to the method established by Reed et al.[7], which evaluates the direct impacts of the grazing system on key forages. It draws from annual grazing rotation data and observations of cattle use around the study locations to determine frequency of defoliation of individual plants during a grazing period, intensity of the plants' defoliation, and opportunity for the plants to grow before and after grazing.

9.15.5 Economic Analysis

Since this is an interim report, and the project is directly linked to project *INT18 – Low cost management techniques to improve pasture production*, a detailed economic analysis for both projects will be deferred to 2017. The forage production and forage supply data collected from any year in this project can be contributed to that project, with the caution that any annual forage supply data is highly dependent on quality of seasonal growing conditions. Some considerations of benefits tied to forage supply, grazing records, and grazing response index scoring are given below. Costs are not described here but result from cost of fencing supplies, watering supplies, labour to install these, labour required to move cattle among fields, and time spent determining an annual grazing strategy.

Efficiency of utilization of a pasture's forage stands needs to be considered in an economic analysis. Total forage supply was calculated on a 50% "take-half/leave-half" basis to conserve overall pasture health, but that supply MUST BE EATEN by livestock in order to have any economic benefit. The fencing required for a simple rotational grazing system allows for considerable control of where livestock are grazing in the pasture, reducing the prevalence of unused forage supply that would exist in remote areas of a large continuous pasture.

The implementation and use of a historical grazing record also allows for the determination of efficiency of a pasture's use. A comparison of forage demand from the First Street Pasture's grazing records and the forage supply calculated for 2015 and 2016 suggests that a target of 50% use of the entire pasture's forage production will not be met with current stocking levels and/or length of grazing season in a year with average growing conditions. According to these calculations, in 2015, the pasture could have been grazed for approximately 35 more days with the number of head provided, or for the actual 86 days with approximately 30 more cow-calf pairs. The amount of forage supply left unused was greater in 2016 with the better seasonal growing conditions and by switching to heifers that have smaller forage dry matter requirements. It should be noted as part of this consideration that quality of the forage supply must be taken into account when adding time or livestock numbers to the grazing rotation, and there will be a cost for the additional supplementation if necessary.

The valuation of time required for keeping grazing records and determining grazing response index scores (as part of Objectives 2 and 3 of this project) is minimal. After several hours in initial training, and using a 10-field rotational system like the one at First Street Pasture, a producer or practitioner can expect to spend no more than 15 hours per year in total, from making observations in a notebook when livestock are moved (+15 min/move x 12 to 16 moves) and at the end of the season when adding the information to digital records and contemplating the long-term trends.

9.15.6 Summary

Soil fertility, organic matter content, and forage productivity are unsatisfactory at the First Street Pasture. Our project seeks to determine if improvements in organic matter content and forage productivity will result from the new rotational grazing system's potential benefits.

Long-term records of actual grazing rotations, temperature, precipitation, and annual forage production can aid in determining the grazing potential that can be achieved for any field or the whole pasture in a wet, dry or average year. A series of annual Grazing Response Index evaluations can be used to adjust grazing pressure or timing of grazing in any field, in order to help alleviate overgrazing or underutilization of forage.

An initial comparison of stocking rates and forage yields from 2015 and 2016 suggest that a larger herd size and/or longer grazing season can be accommodated at the First Street Pasture.

9.15.7 Acknowledgements

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9.15.8 References

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Fig. 9.15.2. Grazing exclusion cages were set up in early June 2015 in the dry site in Field I at First Street Pasture; photo by Mae Elsinger.

Fig. 9.15.3. First Street Pasture is underlain by a mixture of soil types that affect fertility and water holding capacity. This utility excavation through Field H shows some of the most coarse-textured and infertile upland soils, September 2016; photo by Mae Elsinger.

Fig. 9.15.4. This late September photograph shows how vegetation can be protected by a grazing exclusion cage until biomass is harvested from the center with a 50 x 50 cm sampling frame, September 2013; photo by Mae Elsinger.