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GRAZING ANNUAL FORAGES ON CROPLAND IN WESTERN NORTH DAKOTA

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North Dakota is famous worldwide for its agricultural production and has ranked as a major leader in our nation's production of flaxseed, durum wheat, spring wheat, sunflowers, barley, oats, beans, and rye for numerous years. North Dakota State University agricultural research has made major contributions towards the continued advancement in agricultural science and technology that has helped North Dakota agricultural producers maintain the state's leadership in agriculture. Even with these advancements from research, agriculture production in western North Dakota is not problem free. The present economic situation in our country is such that the prices received for agricultural commodities are relatively low compared to the relatively high costs of production which gives many producers of traditional agronomic crops relatively low net returns per acre from their capital investment. There are numerous different potential avenues to pursue through research to address these problems and several dedicated scientists are presently pursuing some of these many lines of study.

One avenue of study would be to look at the potential for increasing net return per acre by investigating the alternative use of cropland by growing annual forages for livestock production which would be harvested as forage in the form of hay or silage, or grazed in the field during the growing season. A study has been started at the Dickinson Research Extension Center to investigate the possibility of using traditional crop production land for livestock production by seeding cropland acres to annual forages and grazing cow-calf pairs during the summer. Two years of this study have been completed and the information collected has been included in this report.

The agronomists at the four western North Dakota State University research stations have been conducting investigations on alternative uses for cropland through the production of annual forages that are used for livestock production in the form of harvested hay or silage. A summary of some of their data is included in this report.

There are numerous factors that are unknown at the present time about the management strategies of grazing annual forages. Research results are needed to evaluate which forage types and varieties will work best during the different seasonal periods of the growing season. Scientific studies are needed to determine the seeding rates and the ratios of each forage type when used in mixtures and on the seeding dates to match a desired target grazing date. Scientific studies are also needed to understand the growth rate of forage types when seeded at different times and the phenological stage of growth to initiate grazing. Research results are needed to determine the length of time that the forage types can be grazed and to determine the optimum period of grazing during the growing season. Quantitative analyses are needed on the nutritional quality of the forages at various stages of growth. The level of stocking rate on the forages and the rate of growth of the cows and calves when grazing annual forages at various stages of plant growth needs to be determined, in addition to determining potential net returns per acre and how they compare to grazing native range or to traditional crop production on similar acres. Grazing annual forages in western North Dakota traditionally has been recommended as an emergency use measure during periods when perennial plant forage is expected to be limited. If this research project can address and resolve the inherent problems, we should be able to develop recommendations for management strategies for grazing annual forages to be used as standard livestock production practices for western North Dakota.

METHODS AND MATERIALS

The study site is located 20 miles north of Dickinson in southwestern North Dakota, U.S.A. (47^{o} 14' N. lat., 102^{o} 50' W. long.) on the Dickinson Research Extension Center ranch operated by North Dakota State University. Soils are primarily Typic Haploborolls. Long-term monthly temperature and precipitation data are shown in table 1. Average annual precipitation is 15.3 in. (389 mm) with 75% falling as rain between April and September. Temperatures average 66^{o} F (19^{o} C) in summer with average daily maximums of 80^{o} F (27^{o} C). Winter average daily temperatures are 16^{o} F (-9^{o} C) with average daily minimums of 2^{o} F (-17^{o} C).

The grazed annual forage fields were designed with two replications of four treatments for a total of eight fields. The fields were numbered 1-8 with fields #1-4 making up the north replication and fields #5-8 making up the south replication. Each replicated field was 8.3 acres in size. The annual forages selected for the 1993 and 1994 preliminary trial were: oats-peas, siberian millet, pearl millet, and winter rye. The original intent was to graze oats-

peas in June, early pearl millet in July, siberian millet in August, late pearl millet in September, and winter rye in October and the following May, and then repeat the entire sequence the following year. This management strategy required double cropping on some of the fields. The winter rye treatment was intended to be seeded on the oats-peas fields and the second pearl millet treatment was intended to be seeded on the winter rye fields after the livestock had finished grazing each of the previous treatments. The seeding dates were initially set to be six weeks ahead of initial grazing start dates for each forage treatment. The desired phenological stage of growth at the initial grazing date was pre-boot with three to five leaves. The management strategies that were designed to be tested initially during this study were developed during a two day conference from the collective knowledge of several agronomists, animal scientists, economists, and range scientists that work in western North Dakota.

Vegetation data were collected similarly on each forage treatment. Aboveground plant biomass was collected on initial and final grazing dates by clipping ten .25m^2 quadrants to ground level (Cook and Stubbendieck 1986) distributed across the length of each field. The major components were separated into seeded forage plants and unseeded weeds. Plant biomass samples were oven dried at 140^o F (60^o C). Values reported represent amount of aboveground herbage dry biomass present on the site on each sample date. The differences in herbage biomass between the initial and final grazing dates were considered to be the quantity of herbage used by the livestock. The term herbage use in this report follows the definition used by the Society for Range Management (Jacoby 1989), which refers to herbage use as "the proportion of current year's forage production that is consumed or destroyed by grazing animals". Herbage use should not be confused with herbage dry matter intake which would be just the amount of herbage consumed by the livestock. Herbage use includes the amount of herbage that was trampled, broken off, defecated on, etc., plus the amount of herbage consumed. Animal dry matter consumption was not measured during this study and is assumed to be 2% of body weight (Holechek, Pieper, and Herbel 1989). Percent use was determined by using the difference in herbage weight between the initial and final grazing dates as a percentage of the initial herbage weight.

Individual animals were weighed on and off each treatment. Liveweight performance of accumulated weight gain, average daily gain, and average gain per acre for cows and calves were used to evaluate each treatment. Body condition scores (Wagner *et al.* 1988) for cows were evaluated on each weigh date in 1994.

Commercial crossbred Angus-Hereford (baldy) cows with Charolais sired calves were used on this study.

Seventeen cow-calf pairs were used in 1993 and twelve pairs were used in 1994. Bulls were turned out with the cows from 5 June to 24 August in 1993, and from 7 June to 8 August in 1994. Calves were born between 4 February and 21 April 1993, and between 14 March and 9 April 1994. Herd health management programs followed North Dakota State University recommendations. All cows were vaccinated with Scourguard-III^{R} prior to calving and were given an injection of Preg-guard 9^{R} prior to breeding in 1993 and 1994. Calves were vaccinated with 7-way clostridial vaccine and injected with Type C and D antitoxin as a booster in 1993 and 1994. Calves were branded, castrated, and dehorned as needed in late April prior to turn out on pasture. Cattle had access to a free-choice salt (2 parts) and di-calcium phosphate (1 part) mixture while on pasture. Horn flies were controlled with insecticides applied as a pour-on along the backs of cows and bulls on weigh dates during the summer.

RESULTS

Weather Data

Weather conditions during this study (1993 and 1994) and the preceding year (1992) are summarized in table 2. Mean monthly temperatures in 1992 for the six month period of April - September were near long-term means. Mean monthly temperatures for July and August were below long-term means. Precipitation for April - September was less than 75% of the long-term mean which indicates that the growing season of 1992 was under drought conditions. Precipitation in April, May, June, and September was less than 50% of the long-term mean. Precipitation in July and August was 127% of the long-term mean.

Mean monthly temperatures in 1993 for the six month period of April - September were near long-term means. Mean monthly temperatures for June, July, August, and September were all below long-term mean temperatures. Precipitation for April - September was above long-term means. Precipitation in June and July was over 181% of the long-term mean. Precipitation in April, May, August, and September was below the long-term mean.

Mean monthly temperatures in 1994 for the six month period of April - September were near long-term means. April, May, June, and September had above long-term mean temperatures. Precipitation for April - September was below the long-term mean. June was the only month that precipitation levels were greater than the long-term mean. Precipitation in April, July, and August was only 43% of the long-term mean which caused considerable water stress

for growing plants during those months.

Seeding Techniques

Table 3 shows the seeding information. Two replications of oats-peas were seeded each year of the study by conventional tillage practices. A commercially prepared mixture with inoculum was seeded. Two replications of siberian millet were seeded in early June each year of the study. A third treatment of siberian millet was seeded in August 1994 onto one treatment of winter rye after the livestock had been removed. This treatment was not successful and not grazed in 1994. Two treatments of pearl millet were seeded in 1993. One treatment was intended to be grazed early in July and the second was intended to be grazed late in September. The first treatment was not successful and not grazed. The second was low in herbage production but grazed. Pearl millet was not seeded in 1994 because of growth and stand establishment problems in 1993. These inconsistent growth problems with pearl millet indicate that additional small plot work with pearl millet on agronomic management techniques and seeding dates are needed for western North Dakota.

Winter rye was seeded on two treatments in August 1993. The plants were slow to develop primarily because August through October had low precipitation in 1993. In the fall of 1993, early growth of winter rye plants was consumed by grasshoppers to ground level. The growth on these treatments was slow in the spring of 1994 and required some additional time to develop. The treatments were grazed in July with the initial grazing started after the plants had reached flowering stage, which was too mature. Field #2-6 was seeded to siberian millet by reduced-till techniques over the winter rye but was not successful. Some winter rye plants were present in the spring of 1995 but were not numerous enough for grazing. Field #3-7 was mowed with a rotary mower and then worked with a tandem disk in August 1994. Field #3-7 did not have an adequate quantity of herbage to be grazed in October 1994. Field #3-7 had a successful stand of winter rye plants in spring 1995 and will be grazed as an early spring treatment.

Table 4 shows the desired and actual seeding and initial grazing dates. We had considerable difficulty in matching the actual seeding date with the desired seeding date because of work schedule priorities and weather conditions during this study, which confounded the problem of matching the actual initial grazing date near to the intended desired grazing date. Generally, the initial grazing dates have been at phenological stages of growth that were more mature than desirable. This in effect shortened the grazing period as the plants had little or no tillering and reached

mature phenological stages and became less desirable as forage by livestock which resulted in removal of the livestock while considerable herbage still remained in the field. The original plan of having the seeding date about 6 weeks ahead of the desired initial grazing date still seems to be a viable model to follow. Weather conditions around the seeding date and during early development stages cause variable rates of plant growth and seem to be the major problem that hinders the actual implementation of this concept into practice.

Grazing Data

Table 5 shows the grazing dates and stocking rates. These values should be considered as preliminary and they are expected to improve as the study develops. It was expected that each treatment could be grazed for a 30 day period, and based on herbage yields from agronomy plot data collected from hay production studies it was expected that only 0.50 acre would be required to carry one cow-calf pair for a month. This assumption was too optimistic. The field herbage yields did not match the agronomic plot yields primarily because of differences in soil type and management levels. All of the herbage production can not be considered as forage for the livestock. Some portion of the total herbage production will need to be allotted as residual vegetation because the livestock will not be able to consume all of the herbage. The amount of vegetation that will be left in the field after grazing is not known at the present time.

Herbage Production and Animal Performance

Herbage production for each annual forage treatment was evaluated from oven dried samples clipped before and after grazing. The change in herbage biomass between those dates was considered to be the quantity of herbage used by the livestock. Exclosure cage samples were not available to help evaluate the quantity of herbage biomass produced while the livestock were grazing each treatment. A value of 8.3 acres was used as the size of the seeded annual forage for each treatment. Each field also had small areas of perennial grass that were used as travel lanes to water. The quantity of forage on the travel lanes was not measured.

Animal performance on each treatment was evaluated as independent events and considered to be the change in live weight between the initial grazing date and the final grazing date. Animal dry matter intake was assumed to be 2% of body weight which would mean that a 1200 pound cow would be expected to consume 24 pounds of dry

forage per day.

Oats-Peas

Oats-peas were grazed for 14 days in 1993 and 26 days in 1994 (Table 5). This treatment required an average of 0.94 acres for each animal unit month (AUM) of grazing. The target grazing period for the month of June was not met. The grazing period in 1993 was from mid July to late July and in 1994 from mid July to early August. The phenological stage of growth for the oats plants at the initial grazing date both years was past head emergence in the milk or soft dough stage and the peas were past flowering with peas already formed in the pod. The phenological stages of growth after the boot stage and before hard dough stage would be ideal for harvest as hay or silage for oats plants. These late stages of growth appear to be too mature to be used as an optimum initial grazing date. Presently, it is felt that a vegetative stage before boot for the oats would be a more advantageous time to start grazing. This growth stage would coincide closely with the 5^{th} leaf stage as was recommended by Dodds (1986).

The herbage production (Table 6) for the oats-peas treatment was 2684 lbs/acre at the initial grazing date in 1993. Some additional growth from the oats-peas apparently occurred after mid July while livestock were grazing the fields because only 593 lbs/acre of plant biomass was used by the livestock. This quantity of herbage provided only 20.69 pounds of herbage use per cow-calf pair per day which seems to be low. A wet period existed in 1993 while the livestock were grazing the oats-peas treatment. Precipitation in July 1993 was 5.10 inches which was 226% of the long-term mean. Livestock were taken off of this treatment early because of muddy conditions. A large portion of the herbage had been trampled and 2091 lbs/acre of oats-peas were left in the field. The percent use on the oats-peas was only 22.1% in 1993.

The herbage production (Table 6) for the oats-peas treatment was 1692 lbs/acre on the initial grazing date in 1994. Livestock used 1222 lbs/acre of the herbage which provided an average of 32.5 pounds of herbage use per cow-calf pair per day. At the end of the grazing period, 470 lbs/acre of oats-peas were left in the field. The percent use on the oats-peas was 74% in 1994. The herbage that remained on the field in 1994 was mainly oats stems.

Animal performance (Table 7) on the oats-peas treatment was very good both years. The calves accumulated an average of 53 pounds per head while on the field and averaged a daily gain of 2.75 pounds and a gain per acre of

89.7 pounds. The cows accumulated an average of 48 pounds per head while on the oats-peas treatment with an average daily gain of 2.34 pounds and an average gain per acre of 78.5 pounds.

Siberian Millet

Siberian millet was grazed for 20 days in 1993 and 14 days in 1994 (Table 5). This treatment required an average of 1.13 acres per animal unit month of grazing. The original goal to graze siberian millet during August was not met. The grazing period in 1993 was from early September to mid October and in 1994 from late August to early September. The phenological stage of the initial grazing dates for both years was past head emergence during seed development. The seed developing stages of growth would be good for harvesting as hay or silage. These late stages of growth appear to be too mature to be used as an optimum initial grazing date for siberian millet. Presently, it is felt that a phenological stage of early growth before boot stage would be a more advantageous time to start grazing siberian millet.

A third treatment of siberian millet was seeded in August 1994 by reduced tillage techniques on top of the winter rye field #2-6. No herbicide treatments were used to reduce the winter rye plant population. The siberian millet developed poorly on this late seeding and the stand did not have adequate herbage to permit grazing in the fall of 1994. Some volunteer winter rye plants grew on the field in spring 1995 but were not dense enough to provide adequate herbage for spring grazing.

Herbage production (Table 8) for the siberian millet treatment was 1301 lbs/acre on the initial grazing date in 1993. Livestock used 745 lbs/acre of herbage which provided an average 18.20 pounds of millet use per cow-calf pair per day. In addition, 9.38 pounds of weed herbage was used per cow-calf pair per day. At the end of the grazing period 556 lbs/acre of siberian millet were left in the field. The percent use on siberian millet was 57.3% in 1993.

Herbage production (Table 8) for the siberian millet treatment was 1648 lbs/acre on the initial grazing date in 1994. Livestock used 379 lbs/acre of herbage which provided an average of 18.70 pounds of siberian millet use per cow-calf pair per day. An additional 3.12 pounds of weed herbage was used per cow-calf pair per day. At the end of the grazing period 1270 lbs/acre of siberian millet were left in the field. The percent use on the siberian millet was 23% in 1994. Millet does not have an extensive root system and can be easily pulled out of the ground while livestock are

grazing the pasture (Helm 1988). No additional growth occurs after plants have been pulled out of the ground and the plants desiccate the same as if cut for hay. This phenomenon happened on the siberian millet fields in 1994 and the livestock were removed early. The quantity of herbage that was left in the field when the livestock were removed was 0.64 tons/acre. Of this amount, 223 lbs/acre (17.6%) remained standing with roots in the ground, and 1047 lbs/acre (82.4%) remained as dry hay. If the livestock would have been permitted to remain on the treatment and if they would have consumed 50% of the herbage (percent use was 57.3% in 1993), the standing millet would have provided 2.4 days of additional grazing and the dry millet would have provided 11.2 additional days of grazing. The estimated additional days of grazing were determined by using 1200 lbs as the average weight of the cows and 420 lbs as the average weight of the calves and they were assumed to consume 2% body weight daily which would be 32.4 lbs/day of dry matter per cow-calf pair. The siberian millet treatment had the potential of 27.6 days of grazing in 1994 if the 14 days of actual grazing are combined with the 13.6 days of estimated additional grazing. The fact that livestock can easily pull the short rooted millet plants out of the ground has been previously known but we do not know at the present time if this is a major problem or a minor problem.

Animal performance (Table 9) on siberian millet treatment was very good both years, but better in 1993. The calves accumulated an average of 50.4 pounds per head with an average daily gain of 2.94 pounds and a gain per acre of 91.27 pounds. The cows accumulated an average of 31.0 pounds per head while on the field, with an average daily gain of 1.72 pounds and a gain per acre of 58.77 pounds.

Pearl Millet

Pearl millet was grazed for 23 days in 1993 and not grazed in 1994 (Table 5). This treatment required 0.65 acres for each animal unit month of grazing. The target grazing period for pearl millet was for one early seeded field to be grazed in July and a second later seeded field to be grazed in September. The first target period was not met. The second target period was late by about two weeks. The grazing period in 1993 was from mid September to early October. Sedivec and Schatz (1991) recommend a period of 4-6 weeks of growth between the seeding date and the initial grazing date or to wait until the plants are 24 to 30 inches in height. We waited nearly 9 weeks and most of the plants on this study headed out before reaching 24 inches in height. Using plant height as the criterion to determine initial grazing date does not seem to work under all conditions in western North Dakota. The phenological stage of the pearl millet on the initial grazing date was past head emergence during the seed development stage.

This late stage of growth would be good for harvesting as hay or silage, but it appears to be too mature to be used as the optimum initial grazing date for starting grazing on pearl millet. Presently, it is felt that a vegetative stage before boot stage would be more advantageous to start grazing pearl millet which would be about 6 weeks after seeding for an early grazing date, but it may require a longer growing period for a late grazing date.

Herbage production (Table 10) for the pearl millet treatment was 671 lbs/acre on the initial grazing date in 1993. Livestock used 449 lbs/acre of the herbage which provided an average of 9.53 pounds of millet use per cow-calf pair per day. The level of herbage dry matter intake was considered not to be adequate on this treatment. It would appear that some growth did occur on the pearl millet field while livestock were grazing. At the end of the grazing period, 222 lbs/acre of pearl millet were left in the field. The percent use on the pearl millet was 67% in 1993.

Livestock performance (Table 11) on pearl millet was much less than desirable. The calves accumulated an average of 30 pounds per head with an average daily gain of 1.29 pounds and a gain per acre of 61 pounds. The cows lost 58 pounds per head while on the field with an average daily gain of -2.51 pounds and a gain per acre of -118 pounds. The reason that the cows lost weight is not fully known at the present time. The actual quantity of daily forage dry matter intake is not known but assumed to be low and not sufficient for the cows. It is not likely that the amount of additional growth on the millet after the initial starting date was adequate to provide 24 pounds of dry matter for a 1200 pound cow. The poor livestock performance most likely can be attributed to low herbage production, mature phenological stage of growth, and low dry matter intake.

Winter Rye

Winter rye was grazed for 14 and 13 days on two treatments (fields #2-6 and #3-7), respectively, during the early summer of 1994 (Table 5). These treatments required an average of 1.57 acres for each animal unit month of grazing. The target grazing period for winter rye was for a fall period in October 1993, a spring period in May 1994, and a fall period in October 1994. The fall grazing of 1993 was not successful on either field #2-6 and #3-7 because when the young plants were developing their third leaf, grasshoppers moved into the fields and consumed all of the aboveground herbage. A desired early spring grazing period in May 1994 was not met because of the slow growth of the winter rye presumably as a result of the previous damage from the grasshoppers. The grazing period in the spring of 1994 was from mid June to late June on field #2-6 and from late June to mid July on field #3-7. The

phenological stage on the initial grazing date was past head emergence, with many plants at the flowering stage and some at the early seed development stage. These late development stages appear to be too mature to start grazing on winter rye. Presently, it is felt that a vegetative stage of 3 to 5 leaves would be more advantageous to start grazing winter rye. The fall grazing period of 1994 was not successful on either field #2-6 or field #3-7. Field #2-6 was seeded to siberian millet in August 1994 and not grazed in fall of 1994 because the amount of herbage was not adequate for grazing. Field #3-7 was mowed with a rotary mower and worked with a tandem disk in August 1994. The quantity of herbage on field #3-7 was not adequate for grazing in fall 1994 but a successful stand was starting in early spring of 1995 and field #3-7 will be grazed sometime in May 1995.

Herbage production (Table 12) for the winter rye treatment on field #2-6 was 1040 lbs/acre on the initial grazing date in spring 1994. Livestock used 99 lbs/acre of the herbage which provided an average of 4.88 pounds of winter rye use per cow-calf pair per day. They also used 9.39 pounds of weed herbage per day. The quantity of herbage on the ungrazed field #3-7 increased 70% during the same period that livestock were grazing field #2-6. It can be assumed that some additional growth occurred on field #2-6 while the livestock were grazing. At the end of the grazing period on field #2-6, 941 lbs/acre of winter rye were left in the field. Percent use on winter rye was 9.5% and percent use on weed herbage was 64.4%.

Herbage production (Table 12) for the winter rye treatment on field #3-7 was 1686 lbs/acre on the initial grazing date. Livestock used 41 lbs/acre of winter rye herbage and 67 lbs/acre of weed herbage which provided an average of 2.20 pounds of winter rye and 3.55 pounds of weeds per cow-calf pair per day. The quantity of herbage on the ungrazed field #2-6 increased 16% during the same period that livestock were grazing field #3-7. It can be assumed that some additional growth occurred on field #3-7 while the livestock were grazing. At the end of the grazing period on field #3-7, 1645 lbs/acre of winter rye herbage were left in the field. Percent use on the winter rye was 2.5% and percent use on weed herbage was 46.2%.

Livestock performance (Table 13) on winter rye was less than desirable. The calves accumulated 14 and 18 pounds on fields #2-6 and #3-7, respectively. Calf average daily gains were 1.01 and 1.41 pounds and calf gains per acre were 20 and 27 pounds on fields #2-6 and #3-7, respectively. Cows lost 120 and 4 pounds on fields #2-6 and #3-7, respectively. Cow average daily gains were -8.59 and -0.28 pounds and cow gains per acre were -174 and -5 pounds on fields #2-6 and #3-7, respectively. The poor livestock performance on the winter rye treatments can most

likely be attributed to mature phenological stage of growth and low dry matter intake of winter rye plants. Livestock did not seem to desire to consume the mature winter rye plants.

DISCUSSION

Grazing Annual Forages

The data collected during these two years of preliminary study show that development of guidelines for grazing annual forages throughout the growing season in western North Dakota will be difficult. This study shows more procedures that do not work than do work. There are numerous inherent problems in designing guidelines for grazing management strategies on annual forages. One major problem is trying to coordinate the seeding date and the plant growth rate to have the forage plants at the desired phenological stage of growth on a selected initial grazing date. Another major problem is trying to match the period of grazing with the stages of growth of the plants that provide adequate nutritional quality for the livestock. And another problem is trying to match the number of cow-calf pairs (AUMs of grazing pressure) to the quantity of available herbage. The relationships among these factors are variable and the relationships seem to change with time during the growing season. A considerable amount of information must still be collected in order to understand the complexities of management strategies for grazing annual forages.

We do not know what forage types or which varieties will work best during the different seasonal periods throughout the growing season. Oats-peas and siberian millet had good results during this study and, with minor adjustments, these two forage types can be improved. Winter rye did not perform very well during this study, but with some changes and adjustments it should be possible to improve this treatment. Pearl millet did not perform very well during this study, but is a forage type that has considerable potential if agronomic management guidelines can be developed that provide herbage production levels that are relatively consistent from year to year within the variable parameters set by the climate of western North Dakota.

There are several other potential forage types available for use in grazing annual forage systems. North Dakota State University agronomists have a long history of testing forage types and varieties for use in North Dakota. These historical studies have generally been reported in research station publications and in Dodds and Ball 1986.

Recently, the agronomists at the four western research stations have started a major effort to evaluate forage types and varieties for herbage production and nutritional quality for use as harvested forage for livestock production. Tables 14 and 15 summarize the latest years of herbage production data and tables 16 and 17 summarize the latest crude protein levels at harvest date from the four western research stations.

The annual forage research efforts currently being conducted by the four western research station agronomists are extremely important. Besides screening forage types and varieties, they are also studying seeding rates and ratios of forage types in mixtures. They are starting to gather nutritional quality information of the forage types. This is much needed data and will be very helpful. At the present time, the nutritional data is being collected for the harvest date, but eventually we will have adequate sample points to show the changes in quality at growth stages over the entire grazing period. For more detailed information on nutritional quality and quantity of herbage production for annual forage types and varieties for the different regions of western North Dakota you should contact the station agronomists or consult individual research station publications.

Seeding date information for forages intended to be harvested as hay is being collected by research station agronomists which is necessary and important but seeding dates for forages intended to be harvested by grazing animals may not be the same. Plant rate of growth and length of time required to develop to specific phenological stages are different for different seeding dates. The intention to have four or five different types of annual forages grazed at selected periods require that sequential forage types need to be at the desired phenological growth stage at the same time the previous forage type is depleted of herbage quantity and/or quality. This seeding date information is not at the present time under study but some seeding date information can be extracted from the present grazing study. The general premise that we have been working with is that it requires about 6 weeks between the seeding date and the date of initial grazing. We were not successful in starting grazing on the treatments six weeks after the seeding dates in 1993 and 1994. The six week period between seeding date and the initial grazing date should be fairly close to being valid as a general guideline for the forage types with initial grazing dates between 1 June and 1 August. It will most likely require a greater growing period for late season initial grazing dates of 1 September and 1 October. We were not able to properly coordinate the fall grazing on summer seeded winter rye in 1993 and 1994 because of less than adequate time for plant growth. The pearl millet treatment was not very successful but its growth rate also indicates that greater than 6 weeks would be required for the 1 September grazing date.

The phenological stage of growth at the initial grazing date was not specifically studied. All of the initial grazing dates for all of the forage treatments in 1993 and 1994 were at phenological stages of growth that were too mature. The oats, winter rye, siberian millet, and pearl millet were past the boot stage and at seed development stages of growth. The peas were past flower stage and peas were formed in the pods. The phenological stage of growth at the initial grazing date should be advanced enough to handle grazing pressure but not past the boot stage. At the present time, we speculate that it would probably be best if the growth stage was between the three to five leaf stage. Grazing before the boot stage should promote some tillering if the forage type has that potential. Very little tillering would be expected of plants that were more mature than the boot stage. The nutritional quality of the herbage would be expected to decrease fairly rapidly after the boot stage. Additional research will be required to determine the proper phenological stage of growth for each forage type to start grazing.

Length of time that the forage types can be grazed and the optimum period during the grazing season that the forage types can be grazed were not specifically studied during these two years. The initial grazing periods for this study were selected as a result of a general collective consensus from many scientists of several disciplines working in western North Dakota and based upon the best information available at the time. The length of the grazing period and the optimum period during the grazing season for each forage type will depend on the phenological stage of growth in which grazing can start, the quantity of stimulated tillers, the length of time that plant growth can keep up with grazing, the number of livestock, the stage of growth in which livestock selectivity terminates, and time or growth stage when the nutritional quality drops below the requirements of the livestock. The preliminary expectations were to graze each forage type for 30 days. Several years of research will be required before we will have a working understanding on the length of grazing period and the optimum period of the grazing season for the forage types.

Stocking rates during this study ranged from 0.74 acre per AUM on siberian millet to 1.62 acres/AUM on winter rye field #3-7. The preliminary expectation was optimistically estimated at 0.50 acre per AUM. Some forage types may eventually be able to reach that level of stocking but currently most forage types require 1.00 acre or more per AUM. With only two years of data we are a long way from determining the stocking rate levels of the forage types.

Livestock growth was very good on the oats-peas and siberian millet treatments which gives optimism for the potential weight gains by livestock on annual forage pastures. With adjustments in the management strategies, the

gain per acre of the calves should improve.

Net Returns Grazing Annual Forages

We have two years of data on animal performance while grazing annual forages which are expected to improve as adjustments are made in the grazing strategies. We don't know the optimal initial starting date, the expected duration of a grazing period, or the stocking rate, but these two years of production values can give us some general expected net return values if interpretations of comparisons are viewed cautiously and considered preliminary. The costs and returns used in this report are not intended to be complete economic analyses of the treatments, but just simple comparisons of a relative dollar value of the different production levels from the various treatments. Table 18 shows the projected general costs and returns for the grazing annual forage treatments in 1993 and 1994.

Oats-Peas

Calf gains of 86 and 93 lbs/acre were reached during this study on oats-peas and were considered to be very good (Table 18). With the present costs of cropland rent and seed, the net return per acre for oats-peas ($9.00 - $31.00) (Table 18) would be comparable to net returns from spring or durum wheat ($13.00 - $21.00) (Table 24). Seed costs per cow-calf pair ($68.00 - $89.00) are high in relation to other treatments and in effect reduce net return per acre. Eventually, seed peas should become more readily available and the price should be reduced which would increase the net return per acre for this treatment. The initial starting date of grazing should be changed to an earlier phenological growth stage which should lengthen the grazing period and increase the expected calf gain per acre.

Siberian Millet

Calf gains of 126 and 57 lbs/acre were good (Table 18). With the stocking rate of 1993, the net return per acre ($48.00 - $73.00) for siberian millet was very impressive (Table 18). The early removal of cattle in 1994, reduced the stocking rate and the calf gain per acre which caused considerable reduction in return per acre for this treatment

($-1.00 - $10.00) (Table 18). With some adjustments in the management strategies for siberian millet, this treatment should be able to produce net returns per acre that would be greater than for traditional crop production on the same land. The initial starting date of grazing should be changed to an earlier phenological growth stage which should

lengthen the grazing period and increase the calf gain/acre.

Pearl Millet

Pearl millet would be a highly desirable annual forage if agronomic management techniques could be developed for western North Dakota that would assure consistent production results. Because of the difficulty to get consistent growth production in western North Dakota, pearl millet may not be a good selection for this type of project. We had low herbage production (671 lbs/ac), low calf performance (1.29 lbs/day), and low net return per acre ($1.00 - $13.00) (Table 18). The net return per acre would be expected to be comparable to other annual forage types, during years with growing conditions that were favorable for pearl millet herbage production in western North Dakota. The net return during years with unfavorable conditions would be expected to be very low or negative.

Winter Rye

We had a problem with the initial turn out date which allowed plants to reach a mature stage of growth which livestock did not prefer to consume and subsequently resulted in low calf gain per day and gain per acre. The low calf gain per acre did not cover the land rent and seeding costs during this study (Table 18). The net returns per acre were negative and ranged from ($-25.00 - $-15.00) (Table 18). Winter rye is more palatable to livestock at an early growth stage and if grazed early should provide respectable performance of calf gain per acre. This treatment requires some major changes in management strategies but it has very good potential. When these problems are solved during the future work of this study, the net return per acre on this treatment should improve and be very good. The calf gains per acre on the winter rye of 20 and 27 pounds (Table 18) are expected to greatly improve when the proper period of grazing is used.

Calf gains per acre for some of the annual forage treatments were very impressive ranging from 126 to 57 pounds (Table 18) on the oats-peas, siberian millet, and pearl millet annual forage treatments. The net returns per acre ranged from $9.00 - $73.00 per acre for oats-peas 1993 and 1994 and siberian millet 1993 (Table 18). Grazing annual forages should be very profitable after effective management strategies have been developed to address the current problems identified through this preliminary study.

Net Returns Grazing Native Range

We have included general costs and returns (Table 19) of cow-calf production on native range managed with four different grazing treatments for comparative purposes. The type of grazing system used on native range greatly affects stocking rate, individual animal performance, and calf gain per acre. The annual cost of feed per cow can be reduced by improving animal performance and reducing the number of acres required to carry the cow-calf pair during the grazing season. The twice-over rotation grazing system decreases the costs of feed and increases the net return per cow-calf pair and per acre for a livestock operation. The calf gain per acre on the twice-over rotation system was 28.5 pounds (Table 19) which was greater than double the 14 lbs of calf gain per acre for the 6.0 month seasonlong grazing treatment. These higher calf gains per acre on the rotation system on native range give acceptable net returns per acre ($15.00 - $22.00) (Table 19), which are comparable to net return for spring and durum wheat ($13.00 - $21.00) (Table 24).

Net Returns from Cereal Crop Production

This project was designed to investigate the potential of using cropland acres for grazing livestock on annual forages to receive a return equal to or greater than current net returns received for traditional cereal crops. The costs and returns for cereal crops were determined from county averages reported in ND Ag Statistics 1993 and 1994. The fifteen counties of southwestern North Dakota were used in this study. We used the reported county grain yields (Table 20), open market prices received (Table 21), reported county cropland cash rent values (Table 22), and average state custom farm work rates (Aakre 1993) (Table 23), to standardize the values (ND Ag Statistics 1993, 1994). Individual farm values will vary from these county average values. Using cash rent for land values and custom farm work rates for labor and machinery, the net returns for spring and durum wheat ranged from $13.13 to $20.77 per acre (Table 24). Barley net returns were $2.69 and $4.97, and oats net returns were negative values in 1993 and 1994 (Table 24) without government subsidized payments. If the amount of government subsidized payments is reduced in the future, the use of cropland for livestock production grazing annual forages may look very attractive. The net returns from grazing oats-peas 1993 and 1994 and siberian millet 1993 (Table 18) show that the potential of grazing annual forage can surpass the net returns of traditional cereal crops. A few additional years of research should obtain enough usable data to show animal gains to be very good and profitable on annual forages. Additional research on forage type and varieties, and seeding dates and techniques should help to determine optimal

management strategies for grazing annual forages and further improve net returns from livestock production by grazing annual forages.

SUMMARY

Net returns per acre from traditional cereal crop production are relatively low because of low prices received and high costs of production. The use of cropland acres to grow annual forages and grazed by cow-calf pairs may provide greater net returns per acre than cereal crop production if government subsidized payments are reduced in the future.

Results from a two year study show that there are numerous inherent problems in grazing annual forages for an entire grazing season and these problems need to be addressed and resolved. Data from the oats-peas and siberian millet treatments showed that grazing annual forages has the potential to surpass the net returns per acre of traditional cereal crops. A considerable amount of information still needs to be collected and analyzed before recommendations for management strategies for grazing annual forages can be developed and before they can be used as standard livestock production practices in western North Dakota.

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Brand Name Disclaimer

Brand names are necessary to report factually on available data, however, the Dickinson Research Extension Center, NDSU, neither guarantees nor warrants the standards of the products, and the use of the brand names by

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Table 1. Long-term monthly temperature and precipitation at the Dickinson Research Center Ranch Headquarters for the years 1982 - 1994.

	1982-1994	
	Average F	Inches
	Temperature	Precipitation
January	14.6	0.44
February	18.7	0.33
March	30.7	0.79
April	42.6	1.46
May	54.7	1.81
June	63.5	3.07
July	68.6	2.26

August	68.2	1.45
September	56.2	1.39
October	44.1	1.37
November	27.1	0.53
December	16.1	0.41
Total Precipitation		15.31

Table 2. Monthly temperature and precipitation at the Dickinson Research Center Ranch Headquarters for the years 1992, 1993, and 1994.

Month	1992		1993		1994	
	Average F Temperature	Inches Precipitation	Average F Temperature	Inches Precipitation	Average F Temperature	Inches Precipitation
January	25.6	0.46	7.8	.040	1.9	0.86
February	28.5	0.30	12.8	0.37	5.5	0.33
March	35.6	0.72	33.9	0.37	34.2	0.38
April	41.5	0.81	42.3	1.41	43.1	0.86
May	56.8	0.68	55.0	1.71	57.8	1.46

June	64.6	1.59	58.8	4.57	63.6	4.51
July	62.4	2.70	61.9	5.10	67.0	1.07
August	64.4	2.02	64.3	1.24	67.6	0.31
September	56.2	0.72	53.8	0.18	61.7	1.08
October	46.5	0.16	42.6	0.05	46.3	4.58
November	26.9	0.91	25.8	1.28	29.5	0.52
December	9.4	0.16	21.1	0.68	22.0	0.18
Total Precipitation		11.23		17.36		16.14

Table 3. Seeding information for grazed annual forage fields.

Treatment	Field #	Variety	Type of Tillage[1]	Germination	Seed Rate		Price	Seed Cost
Year				%	PLS[2] lb/ac	Bulk lb/ac	$/lb	$/ac
Oats - Peas								
1993	3-7	Otana-Trapper	Conventional	90	99	110[3]	0.17	18.70
1994	1-5	Otana-	Conventional	90	99	110[3]	0.17	18.70

		Trapper						
Siberian Millet								
1993	1-5	Common	Conventional	95	19	20	0.35	7.00
1994	4-8	Common	Conventional	95	19	20	0.35	7.00
	2-6	Common	Reduced-till	95	19	20	0.35	7.00
Pearl Millet								
1993	2-6	Hybrid Pearl	Conventional	95	19	20	0.45	9.00
	4-8	Hybrid Pearl	Conventional	95	19	20	0.45	9.00
1994	Treatment not seeded							
Winter Rye								
1993	2-6	Dacold	Reduced-till[4]	97	58.2	60	0.085	5.09
	3-7	Dacold	Conventional[4]	97	58.2	60	0.085	5.09
1994	2-6	Dacold	No agronomic management					
	3-7	Dacold	Mowed and Disked					

[1] All treatments fertilized at seeding date with 60 lbs/acre of 28-28-0 [2] Pure live seed [3] Commercially prepared mixture with inoculum [4] Plus heavy duty disk

Table 4. Seeding and grazing dates for annual forage fields.

		Desired			Actual		
Treatment Year	Field #	Seed Date	Initial Graze Date	Age of Stand # Weeks	Seed Date	Initial Graze Date	Age of Stand # Weeks
Oats-Peas							
1993	3-7	E Apr	1 June	6	24 Apr	13 Jul	11.4
1994	1-5	E Apr	1 Jun	6	7-8 May	13 Jul	9.6
Siberian Millet							
1993	1-5	Mid Jun	1 Aug	6	1-7 Jun	1 Sep	13.1
1994	4-8	Mid Jun	1 Aug	6	E June	23 Aug	12.0
	2-6				Aug	Not Grazed	
Pearl Millet							
1993	2-6	Mid May	1 Jul	6	1-7 May	Not Grazed	
	4-8	L Jun	1 Sep	9	Mid Jul	15 Sep	8.9
1994	Treatment not seeded						
Winter Rye							
1993	2-6	Mid Aug	1 Oct	6	E Aug	Oct[1]	
			1 May	34			
	3-7	Mid Aug	1 Oct	6	E Aug	Oct[1]	

			1 May	34			
1994	2-6	Mid Aug	1 May	34	Aug 1993	15 Jun	43.4
	3-7	Mid Aug	1 May	34	Aug 1993	1 Jul	45.6
	3-7	Mid Aug	1 Oct	6	Aug[2]	Oct[1]	
			1 May	34			

[1] Not grazed [2] Mowed and disked

Table 5. Stocking rates for grazed annual forage fields.

Forage Year	Dates	Number of Days	Number of Cow-Calf Pairs	AUMS[1]	AUM/ac	Acre/AUM
Oats-Peas						
1993	13 Jul - 27 Jul	14	17	7.80	0.94	1.06
1994	13 Jul - 8 Aug	26	12	10.23	1.23	0.81
Siberian Millet						
1993	1 Sep - 15 Sep and 8 Oct - 14 Oct	20	17	11.15	1.34	0.74
1994	23 Aug - 6 Sep	14	12	5.51	0.66	1.51
Pearl Millet						

1993	15 Sep - 8 Oct	23	17	12.82	1.54	0.65
1994	-	-	-	-	-	--
Winter Rye						
1993	-	-	-	-	-	-
1994 *Field #2-6*	15 Jun - 1 Jul	14	12	5.51	0.66	1.51
Field #3-7	1 Jul - 14 Jul	13	12	5.11	0.62	1.62
[1] Animal Unit Months						

Table 6. Aboveground biomass on oats and peas grazed annual forage fields.

Year	Forage	lbs/acre			Percent Use
		Initial Date	Final Date	Difference	
1993		*13 Jul*	*27 Jul*		
	Oats	1326 .4	1030.4	296.0	22.3
	Peas	1357.5	1060.2	297.2	21.9
	Weeds	427.6	496.0	-68.3	-16.0
	TOTAL	3111.5	2586.6	524.9	16.9
		13 Jul	*8 Aug*		
	Oats	1316.8	383.7	933.0	70.9

1994	Peas	375.4	86.2	289.1	77.0
	Weeds	91.0	107.1	-16.1	-17.7
	TOTAL	1783.1	577.1	1206.1	67.6
Negative values indicate growth exceeded use.					

Table 7. Animal performance on oats and peas grazed annual forage fields.

Year Livestock	Initial Date	Final Date	Number of Days	Gain per Head	Average Daily Gain	Gain per Acre
1993	13 Jul	27 Jul	14			
Cow LW[1] lbs	1160.0	1189.0		29.0	2.07	59.34
BCS[2]	-	-	-			
Calf LW lbs	323.9	366.0		42.1	3.01	86.27
1994	13 Jul	8 Aug	26			
Cow LW lbs	1075.2	1142.7		67.5	2.60	97.65
BCS	5.8	6.3		+0.5		
Calf LW lbs	278.7	343.1		64.4	2.48	93.13

[1] Liveweight [2] Body condition score

Table 8. Aboveground biomass on siberian millet grazed annual forage fields.

Year	Forage	lbs/acre			Percent Use
		Initial Date	Final Date	Difference	
1993		1 Sep	14 Oct		
	Siberian	1301.4	556.1	745.4	57.3
	Weeds	705.0	320.9	384.1	54.5
	TOTAL	2006.5	877.0	1129.5	56.3
1994		23 Aug	6 Sep		
	Siberian	1648.4	1269.9	378.5	23.0
	Weeds	154.5	91.4	63.1	40.9
	TOTAL	1803.0	1361.3	441.7	24.5

Table 9. Animal performance on siberian millet grazed annual forage fields.

Year Livestock	Initial Date	Stop Date[1]	Start Date[2]	Final Date	Number of Days	Gain per Head	Average Daily Gain	Gain per Acre
1993	1 Sep	15 Sep	8 Oct	14 Oct	20			
Cow LW[3] lbs	1202.6	1226.4	1168.6	1191.1		46.3	2.32	94.83
BCS[4]	-	-	-	-		-		

Calf LW lbs	451.8	492.7	522.4	542.9		61.4	3.07	125.60
1994	23 Aug			6 Sep	14			
Cow LW lbs	1189.9			1205.6		15.7	1.12	22.71
BCS	6.6			6.7		+0.1		
Calf LW lbs	379.9			419.3		39.4	2.81	56.93

[1] Intermediate stop date [2] Intermediate start date [3] Liveweight [4] Body condition score

Table 10. Aboveground biomass on pearl millet grazed annual forage fields.

Year	Forage	lbs/acre			Percent Use
		Initial Date	Final Date	Difference	
1993		15 Sep	8 Oct		
	Pearl	671 .0	222.1	448.9	66.9
	Weeds	230.3	450.5	-220.1	-95.6
	TOTAL	901.3	672.6	228.7	25.4
1994					
	Pearl	-	-	-	-
	Weeds	-	-	-	-
	TOTAL	-	-	-	-

Negative values indicate growth exceeded use.

Table 11. Animal performance on pearl millet grazed annual forage fields.

Year Livestock	Initial Date	Final Date	Number of Days	Gain per Head	Average Daily Gain	Gain per Acre
1993	15 Sep	8 Oct	23			
Cow LW[1] lbs	1226.4	1168.6		-57.8	-2.51	-118.38
BCS[2]	-	-		-		
Calf LW lbs	492.7	522.4		29.8	1.29	60.96
1994						
Cow LW lbs	-	-		-	-	-
BCS	-	-		-		
Calf LW lbs	-	-		-	-	-

[1] Liveweight [2] Body condition score

Table 12. Aboveground biomass on winter rye grazed annual forage fields.

Year	Forage	lbs/acre			Difference	Percent Use	Difference	Percent Use
		Initial	Intermediate	Final				

		Date	Date	Date				
1993	Rye	-	-	-	-	-	-	-
	Weeds	-	-	-	-	-	-	-
	TOTAL	-	-	-	-	-	-	-
1994		15 Jun	1 Jul	14 Jul				
	Field #2-6	Grazed		Ungrazed	Grazed		Ungrazed	
	Rye	1040.3	941.4	1095.0	98.8	9.5	-153.6	-16.3
	Weeds	294.9	104.9	143.3	190.0	64.4	-38.4	-36.6
	TOTAL	1335.2	1046.3	1238.3	288.8	21.6	-192.0	-18.4
	Field #3-7	Ungrazed		Grazed	Ungrazed		Grazed	
	Rye	990.7	1686.4	1645.0	-695.8	-70.2	41.4	2.5
	Weeds	84.9	144.5	77.8	-59.6	-70.2	66.8	46.2
	TOTAL	1075.6	1830.9	1722.8	-755.4	-70.2	108.2	5.9
Negative values indicate growth exceeded use.								

Table 13. Animal performance on winter rye grazed annual forage fields.

Year	Initial Date	Final Date	Number of Days	Gain per Head	Average Daily Gain	Gain per Acre
Livestock						

1993						
Cow LW[1]lbs	-	-	-	-	-	-
BCS[2]	-	-	-	-	-	-
Calf LW lbs	-	-	-	-	-	-
1994	16 Jun	30 Jun	14			
Field #2-6						
Cow LW lbs	1199.1	1078.8		-120.3	-8.59	-173.86
BCS	6.8	6.2		-0.6		
Calf LW lbs	246.2	260.3		14.1	1.01	20.36
Field #3-7						
Cow LW lbs	1078.8	1075.2		-3.7	-0.28	-5.30
BCS	6.2	5.8		-0.4		
Calf LW lbs	260.3	278.7		18.4	1.41	26.57
[1] Liveweight [2] Body condition score						

Table 14. Herbage yield (100% dry matter) for annual forages harvested for hay.

	Dickinson[1]		Hettinger[2]		Minot[3]		Williston[4]	
	Seed	ton/acre	Seed	ton/acre	Seed	ton/acre	Seed	ton/acre

	Rate lb/ac			Rate lb/ac			Rate lb/ac				Rate lb/ac		
		1993	1994		1993	1994		1992	1993	1994		1993	1994
CEREALS													
Barley	60	2.70	3.00	60	2.77	1.58	80	-	3.10	3.00	100	2.98	2.02
Forage Barley	55	2.70	4.00	55	3.48	2.18	80	-	2.70	1.90	80	2.40	1.87
Oats	55	2.90	2.80	55	3.50	1.93	65	1.26	3.29	2.50	65	2.96	2.46
Forage Oats	39	2.80	3.70	39	4.80	-	65	1.71	3.33	2.70	65	3.03	2.67
Triticale	-	-	-	75	3.66	1.40	75	1.08	2.88	1.70	75	2.41	2.03
Winter Triticale	-	-	-	-	-	-	-	-	-	-	-	-	-
Spring Rye	-	-	-	65	2.90	-	-	-	-	-	-	-	-
Winter Rye	-	-	-	-	-	-	-	-	-	-	-	-	-
Spring Wheat	-	-	-	90	1.95	1.13	-	-	-	-	-	-	-
Winter Wheat	-	-	-	-	-	-	-	-	-	-	-	-	-
Speltz	-	-	-	60	3.30	-	-	-	-	-	-	-	-
PULSE													
Faba Beans	-	-	-	-	-	-	-	-	-	-	-	-	-

Field Peas	100	2.90	3.20	100	2.40	1.19	100	-	2.10	-	-	-	-
Winter Peas	-	-	-	-	-	-	-	-	-	-	-	-	-
CEREAL-PULSE CROPS													
Barley - Peas	45-50	2.40	2.30	-	-	-	50-60	-	3.10	-	-	-	-
	90-100	2.70	2.40	-	-	-	-	-	-	-	-	-	-
Forage Barley - Peas	33-50	2.10	3.70	-	-	-	50-60	-	2.70	-	50-60	2.54	1.75
	66-100	2.90	4.20	-	-	-	-	-	-	-	-	-	-
Oats - Peas	33-61	2.90	2.20	-	-	-	35-60	1.62	3.60	-	35-60	2.67	2.48
	66-122	3.30	2.50	55-100	4.80	1.92	-	-	-	-	-	-	-
Forage Oats - Peas	23-50	2.60	4.00	-	-	-	35-60	-	3.42	-	35-60	2.47	-
	46-100	2.90	4.40	-	-	-	-	-	-	-	-	-	-
Triticale - Peas	-	-	-	-	-	-	50-60	1.44	2.88	1.60	50-60	2.07	2.02

[1] Carr, P. 1993, 1994, 1995. [2] Eriksmoen, E. 1993, 1994, 1995. [3] M[c]Kay, K. 1993, 1994, 1995. [4] Riveland, N. 1993, 1994, 1995.

Table 15. Herbage yield (100% dry matter) for annual forages harvested for hay.

WARM SEASON ANNUALS	Dickinson[1]			Hettinger[2]			Minot[3]				Williston[4]		
	Seed Rate lb/ac	ton/acre		Seed Rate lb/ac	ton/acre		Seed Rate lb/ac	ton/acre			Seed Rate lb/ac	ton/acre	
		1993	1994		1993	1994		1992	1993	1994		1993	1994
Sudan	-	-	-	20	3.21	1.42	20	0.50	-	-	20	1.07	1.87
Sorghum/Sudan	-	-	-	20	4.26	1.97	20	0.60	-	-	20	1.63	1.93
Forage Sorghum	-	-	-	20	4.30	1.42	20	0.30	-	-	-	-	-
Pearl Millet	-	-	-	15	3.16	1.93	20	0.40	-	-	20	0.73	1.68
Proso Millet	-	-	-	15	3.63	1.76	-	-	-	-	-	-	-
Siberian Millet	-	-	-	15	3.25	2.84	20	1.17	2.30	-	20	0.63	2.12
German Millet	-	-	-	15	2.40	2.64	20	1.26	2.50	-	20	1.44	1.29
Corn (hay)	-	-	-	-	3.14	1.30	-	-	-	-	-	-	-
Corn (silage)	18,000[5]	3.16	3.68	-	3.50	1.88	18,000[5]	3.00	3.00	3.71	-	-	-

[1] Carr, P. 1993, 1994, 1995. [2] Eriksmoen, E. 1993, 1994, 1995. [3] M[c]Kay, K. 1993, 1994, 1995. [4] Riveland, N. 1993, 1994, 1995. [5] Seeds per acre

Table 16. Percent crude protein for annual forages harvested for hay.

	Dickinson[1]		Hettinger[2]		Minot[3]			Williston[4]	
	% Protein		% Protein		% Protein			% Protein	
	1993	1994	1993	1994	1992	1993	1994	1993	1994
CEREALS									
Barley	-	-	12.6	-	-	-	11.5	8.2	11.0
Forage Barley	12.8	-	12.6	-	-	9.6	14.5	9.7	11.8
Oats	10.8	-	14.3	-	12.1	9.3	13.6	9.2	10.9
Forage Oats	-	-	-	-	11.1	7.9	14.2	8.3	12.0
Triticale	-	-	13.8	-	11.1	9.2	15.0	9.1	13.2
Winter Triticale	-	-	-	-	-	-	-	-	-
Spring Rye	-	-	11.4	-	-	-	-	-	-
Winter Rye	-	-	-	-	-	-	-	-	-
Spring Wheat	-	-	14.6	-	-	-	-	-	-
Winter Wheat	-	-	-	-	-	-	-	-	-
Speltz	-	-	14.3	-	-	-	-	-	-

PULSE									
Faba Beans	-	-	-	-	-	-	-	-	-
Field Peas	-	-	-	-	-	-	-	-	-
Winter Peas	-	-	-	-	-	-	-	-	-
CEREAL-PULSE									
Barley - Peas	-	-	-	-	-	-	-	10.9	-
Forage Barley - Peas	12.8	-	-	-	-	11.7	-	9.8	9.9
Oats - Peas	11.0	-	-	-	13.6	10.3	-	12.3	11.7
Forage Oats - Peas	-	-	-	-	-	9.2	-	10.0	-
Triticale - Peas	-	-	-	-	12.5	13.0	14.7	10.8	12.9

[1] Carr, P. 1995. [2] Eriksmoen, E. 1993, 1995. [3] M[c]Kay, K. 1995. [4] Riveland, N. 1995.

Table 17. Percent crude protein for annual forages harvested for hay.

WARM SEASON ANNUALS	Dickinson[1]	Hettinger[2]	Minot[3]	Williston[4]
	% Protein	% Protein	% Protein	% Protein

	1993	1994	1993	1994	1992	1993	1994	1993	1994
Sudan	-	-	8.8	-	10.8	-	-	7.2	9.4
Sorghum/Sudan	-	-	9.2	-	12.2	-	-	8.3	12.0
Forage Sorghum	-	-	9.1	-	12.6	-	-	-	-
Pearl Millet	-	-	15.1	-	13.1	-	-	7.2	14.4
Proso Millet	-	-	12.5	-	-	-	-	-	-
Siberian Millet	-	-	-	-	12.7	-	-	8.6	9.6
German Millet	-	-	-	-	12.2	-	-	8.0	10.6
Corn (hay)	-	-	8.6	-	-	-	-	-	-
Corn (silage)	-	-	-	-	-	-	-	-	-

[1] Carr, P. 1995. [2] Eriksmoen, E. 1993, 1995. [3] M[c]Kay, K. 1995. [4] Riveland, N. 1995.

Table 18. Projected general costs and returns for cow-calf production on cropland annual forages in southwestern North Dakota.

	Oats-Peas		Siberian Millet		Pearl Millet	Winter Rye	
	1993	1994	1993	1994	1993	Field #2-6	Field #3-7
						1994	
PRODUCTION							

Acres/Month	(ac)	1.06	0.81	0.74	1.51	0.65	1.51	1.62
Acres/4.5 Months	(ac)	4.77	3.65	3.33	6.80	2.93	6.80	7.29
Calf ADG	(lbs)	3.01	2.48	3.07	2.81	1.29	1.01	1.41
Calf Gain/Acre	(lbs)	86.27	93.13	125.60	56.93	60.96	20.36	26.57
Calf Gain/4.5 months	(lbs)	411.51	339.46	418.25	386.84	178.31	138.35	193.70
GROSS RETURNS Gross per C-C pr 4.5M								
@ 0.90/lb	($)	370.36	305.51	376.42	348.16	160.48	124.51	174.33
@ 0.80/lb	($)	329.21	271.57	334.60	309.47	142.65	110.68	154.96
@ 0.70/lb	($)	288.06	237.62	292.77	270.79	124.82	96.84	135.59
COSTS								
Cropland Rent per C-C pr 4.5M @ 20.43/ac & 21.18/ac	($)	97.45	77.31	68.03	144.02	59.86	144.02	154.40
Seeding Costs @ 12.53/ac	($)	59.77	45.73	41.72	85.20	36.71	85.20	91.34
Seed Costs	($)	89.20	68.26	23.31	47.60	26.37	34.61	37.11
Total Cost/C-C pr	($)	246.42	191.30	133.06	276.82	122.94	263.83	282.85
NET RETURNS Net Return per C-C pr 4.5M								
@ 0.90/lb	($)	123.94	114.21	243.36	71.34	37.54	-139.32	-108.52

@ 0.80/lb	($)	82.79	80.27	201.54	32.65	19.71	-153.15	-127.89
@0.70/lb	($)	41.64	46.32	159.71	-6.03	1.88	-166.99	-147.26
Net Return per Acre								
@0.90/lb	($)	25.98	31.29	73.08	10.49	12.81	-20.49	-14.89
@0.80/lb	($)	17.36	21.99	60.52	4.80	6.73	-22.52	-17.54
@0.70/lb	($)	8.73	12.69	47.96	-0.89	0.64	-24.56	-20.20

Table 19. Projected general costs and returns for cow-calf production on four native range grazing systems in southwestern North Dakota.

		Grazing Management System			
		Deferred 4.0 M	Seasonlong 4.5 M	Seasonlong 6.0 M	Rotation 4.5 M
PRODUCTION					
Acres/Month	(ac)	2 .22	2.86	4.04	2.04
Acres/4.5 Months	(ac)	10.00	12.70	18.00	9.00
Calf ADG	(lbs)	1.80	2.09	1.80	2.21
Calf Gain/Acre	(lbs)	20.40	20.50	13.70	28.50
Calf Gain/4.5 Months	(lbs)	230.00	284.00	247.00	309.00
GROSS RETURNS Gross Return per C-C pr 4.5M					

@ 0.90/lb	($)	207.00	255.60	222.30	278.10
@ 0.80/lb	($)	184.00	227.20	197.60	247.20
@ 0.70/lb	($)	161.00	198.80	172.90	216.30
COSTS Pasture Rent					
C-C Pr, 4.5 M, @ 8.76/ac	($)	87.60	111.25	157.68	78.84
NET RETURNS Net Return per C-C pr 4.5M					
@ 0.90/lb	($)	119.40	144.35	64.62	199.26
@ 0.80/lb	($)	96.40	115.95	39.92	168.36
@ 0.70/lb	($)	73.40	87.55	15.22	137.46
Net Return per Acre					
@ 0.90/lb	($)	11.94	11.37	3.59	22.14
@ 0.80/lb	($)	9.64	9.13	2.22	18.71
@ 0.70/lb	($)	7.34	6.89	0.85	15.27

Table 20. Grain yield (bu/acre) for five year mean, 1987 - 1991 and 1988 - 1992, in southwestern North Dakota.

Counties	Spring Wheat		Durum Wheat		Barley		Oats	
	87-91	88-92	87-91	88-92	87-91	88-92	87-91	88-92
Adams	17.8	19.0	20.1	21.6	27.4	27.0	28.1	31.7

Billings	18.6	19.3	21.1	23.3	26.4	25.5	32.9	31.8
Bowman	19.6	20.6	21.2	22.5	27.2	26.8	33.8	36.9
Dunn	19.0	20.6	22.3	24.4	27.7	30.9	35.0	38.6
Golden Valley	22.7	24.7	22.8	25.2	33.6	36.6	39.9	43.7
Grant	17.1	18.6	16.7	17.7	23.9	25.6	31.7	35.0
Hettinger	21.2	23.5	24.1	26.9	29.9	30.5	32.7	35.8
McKenzie	22.3	25.3	22.1	25.6	27.2	30.1	38.4	43.4
McLean	21.7	24.0	22.2	25.5	32.1	34.9	38.0	40.2
Mercer	21.9	23.7	23.7	25.9	29.6	32.8	40.8	43.7
Morton	17.7	19.2	18.8	19.2	25.0	28.7	31.6	36.6
Oliver	16.5	19.6	16.8	16.8	26.8	30.9	31.2	37.2
Sioux	14.5	15.8	13.3	14.8	22.5	25.6	26.1	29.2
Slope	21.8	22.6	21.7	22.2	32.2	33.1	33.8	35.4
Stark	18.3	19.4	18.7	20.1	24.8	25.3	32.8	34.7
Mean	19.4	21.1	20.4	22.1	27.8	29.6	33.8	36.9
	±2.5	±2.7	±3.0	±3.7	±3.2	±3.7	±4.1	±4.4

ND Ag Statistics 1993
ND Ag Statistics 1994

Table 21. Open market grain prices received ($/bu) for five year mean, 1988 - 1992 and 1989 - 1993, in southwestern North Dakota.

Dollars/Bushel		Spring Wheat	Durum Wheat	Barley	Oats
1988 - 1992	($)	3.26	3.19	1.85	1.26
1989 - 1993	($)	3.21	3.23	1.84	1.11

ND Ag Statistics 1993
ND Ag Statistics 1994

Table 22. Land cash rent ($/acre) for 1993 and 1994 in southwestern North Dakota.

Counties	Cropland		Pasture	
	1993	1994	1993	1994
Adams	19.20	18.70	10.10	9.00
Billings	17.80	19.90	10.50	9.20
Bowman	18.00	17.20	7.30	8.20
Dunn	18.60	19.50	9.10	9.90
Golden Valley	22.80	22.10	6.50	6.10
Grant	20.10	21.50	8.70	9.50
Hettinger	21.70	22.80	9.70	10.00
McKenzie	24.60	25.10	6.60	7.80
McLean	26.90	27.50	7.90	9.30

Mercer	19.10	19.80	8.40	8.50
Morton	22.10	22.70	8.90	10.40
Oliver	20.00	20.70	8.70	9.00
Sioux	18.00	19.80	7.70	8.20
Slope	17.50	19.20	8.10	8.80
Stark	20.10	21.20	9.80	11.00
Mean	**20.43**	**21.18**	**8.53**	**8.99**
	±2.72	±2.61	±1.21	±1.18

ND Ag Statistics 1993
ND Ag Statistics 1994

Table 23**. Custom farm work rates ($/acre) for 1992 in North Dakota.**

	Conventional Till		Reduced Till	
Primary Tillage	*Plow*	6.43		
Secondary Tillage	*Disk*	4.50	*Chisel*	4.51
Seeding	*Drill*	4.76	*Drill*	8.02
Swathing	*Swather*	4.22		
Combining	*Behind Swather*	13.13	*Straight*	13.15
Total ($)	33.04		25.68	

Other Costs:	Seed Seed Preparation Fertilizer Fertilizer Application Pesticide Application Drying Grain Hauling Crops
Aakre 1993 ND Ag Statistics 1993 ND Ag Statistics 1994	

Table 24. Projected general costs and returns for crop production in southwestern North Dakota, 1993 -1994.

		Spring Wheat		Durum Wheat		Barley		Oats	
		1993	1994	1993	1994	1993	1994	1993	1994
PRODUCTION									
Grain Yield	(bu/ac)	19.40	21.10	20.40	22.10	27.80	29.60	33.80	36.90
Prices Received	($)	3.26	3.21	3.19	3.23	1.85	1.84	1.26	1.11
GROSS RETURNS									
Dollars per Acre	($)	63.24	67.73	65.08	71.38	51.43	54.46	42.59	40.96
COSTS									
Cropland Rent per Acre	($)	20.43	21.18	20.43	21.18	20.43	21.18	20.43	21.18
Custom Farm Work	($/ac)	25.68		25.68		25.68		25.68	

Seed Costs	($)	4.00		3.75		2.63		2.30	
Total Costs	($)	50.11	50.86	49.86	50.61	48.74	49.49	48.41	49.16
NET RETURNS									
Net Return per Acre	($)	13.13	16.87	15.22	20.77	2.69	4.97	-5.82	-8.20

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