Evaluation of Grazing Alfalfa Interseeded Native Grassland Pastures

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Low herbage biomass production has long been assumed to be an inherent characteristic of native rangeland. Simple deduction has led to the common belief that herbage and livestock production on grasslands would be increased if alfalfa could be seeded into the established plant community. The performances of herbage and cow-calf pairs on native rangeland and native range interseeded with alfalfa were compared in an alfalfa interseeded pasture grazing study that comprised two trials. Trial I was conducted from 1977 to 1981 by Paul E. Nyren and Dr. Harold Goetz. Trial II was basically a continuation of trial I with a few modifications and was conducted from 1984 to 1988 by Dr. Llewellyn L. Manske.

Procedures

The alfalfa interseeded pasture grazing study was conducted on two pastures located on the SW¼, sec. 23, T. 140 N., R. 97 W., at the Dickinson Research Extension Center. The established plant community was strongly rolling upland mixed grass prairie. The soils were Vebar, Parshall, and Flasher fine sandy loams. The control pasture was 18 acres of native rangeland with no mechanical treatments. The alfalfa interseeded pasture was 10 acres of native rangeland interseeded with Travois alfalfa in May 1977 at the seeding rate of 4 lbs per acre. The interseeding equipment was the Melroe 701 No-Till Drill with modification #4, which had a single straight coulter ahead of a 12-inch cultivator sweep followed by a stock double disk furrow opener followed by a pack wheel (Nyren 1979). The tools of the drill were set at 30-inch row spacings. Both study treatments had one replication each. On trial I, each treatment pasture was managed with one grazing period that started between mid June and mid July and ended between mid July and mid August during the growing seasons of 1979, 1980, 1981, and 1984. On trial II, each treatment pasture was managed with two grazing periods during the growing seasons of 1985, 1986, 1987, and 1988. The first grazing period started between early and mid June and ended between mid and late June. The second grazing period started between mid and late July and ended between mid and late August. The livestock on the alfalfa interseeded pasture were provided a product in block form that guarded against bloat. Research was not conducted on the alfalfa interseeded pasture grazing study during the growing seasons of 1978, 1982, and 1983; however, the pastures were not idle. During 1978, 1982, and 1983, the native range pasture was grazed at a mean stocking rate 133.7% greater than the research stocking rate. During 1978 and 1983, the alfalfa interseeded pasture was grazed at a mean stocking rate 93.6% greater than the research stocking rate. The alfalfa interseeded pasture was not grazed during 1982 because the vegetation had not recovered from the combined effects from the alfalfa interseeding treatment, the grazing treatment, and the drought conditions that occurred during 1980.

Cow and calf performance was determined by mean weight gains or losses. The cattle were weighed upon entering and leaving each pasture. Aboveground herbage biomass production was sampled by the clipping method at the beginning and end of each grazing period. Vegetation was clipped to ground level in quarter-meter square quadrats located both inside and outside exclosure cages, and the samples were oven dried. The difference between the aboveground herbage biomass values collected inside and outside the exclosure cages was the forage utilized. The forage use per acre included the forage ingested by the cattle, the loss in vegetation weight caused by senescence, and the loss in vegetation weight caused by parts broken from the plant, soiled by animal waste, consumed by insects and wildlife, and lost to other natural processes. On trial II, quantitative species composition was determined by percent basal cover sampled with the ten-pin point frame method. Species composition of the plant community on the alfalfa interseeded treatment was compared to the plant community on the native range control treatment with a percent similarity index method (Mueller-Dombois and Ellenberg 1974). Costs and returns for trial I and trial II were determined from total pasture and forage costs and value of calf weight gain for the grazing periods (Manske et al. 2002). Differences between means from treatment years were analyzed by a standard paired-plot t-test (Mosteller and Rourke 1973).

Results and Discussion

The mean growing-season precipitation (table 1) during the years of trial I and trial II was normal. During trial I, when the pasture treatments were managed with one grazing period, the mean growing-season precipitation was 91.5% of the long-term mean. During trial II, when the pasture treatments were managed with two grazing periods, the mean growing-season precipitation was 97.8% of the long-term mean. Trial I and trial II each had one drought growing season during the years the treatments were conducted (table 2). During trial I, the growing season of 1980 received 79.0% of the long-term mean precipitation. April received 2.1% of the long-term mean; May, June, and July received 51.8% of the long-term mean; and August, September, and October received 161.2% of the long-term mean. During trial II, the growing season of 1988 received 48.3% of the long-term mean. April received no precipitation; May, June, and July received 65.7% of the long-term mean; and August, September, and October received 30.1% of the long-term mean. The growing-season months of 1980 received 2.9 inches of precipitation less than the long-term mean, and the growing-season months of 1988 received 7.0 inches of precipitation less than the long-term mean. The growing-season months of 1988 received 4.2 inches of precipitation less than the growing-season months of 1980.

The native range control pasture of trial I (table 3) was grazed for an average of 29 days, with one grazing period from 3 July to 1 August. The pasture was grazed by 8 cow-calf pairs and had a stocking rate of 2.21 acres per animal unit equivalent month (AUEM). The alfalfa interseeded pasture of trial I (table 3) was grazed for an average of 25 days, with one grazing period from 3 July to 28 July. The pasture was grazed by 8 cow-calf pairs and had a stocking rate of 1.36 acres per AUEM. The stocking rate on the alfalfa interseeded pasture was 64.4% greater than, but not significantly different ($P<0.05$) from, the stocking rate on the native range pasture (table 3).

The native range control pasture of trial II (table 3) was grazed for an average of 44 days, with two grazing periods. The pasture was grazed by 6 cow-calf pairs and had a stocking rate of 1.85 acres per AUEM. The first grazing period was 15 days, from 9 June to 24 June. The second grazing period was 29 days, from 22 July to 20 August. The alfalfa interseeded pasture of trial II (table 3) was grazed for an average of 44 days, with two grazing periods. The pasture was grazed by 6 cow-calf pairs and had a stocking rate of 1.01 acres per AUEM. The first grazing period was 15 days, from 9 June to 24 June. The second grazing period was 29 days, from 22 July to 20 August. The stocking rate on the alfalfa interseeded pasture was 80.0% greater than, and significantly different ($P<0.05$) from, the stocking rate on the native range pasture (table 3).

During the 1980 drought growing season of trial I, the pastures were managed with one grazing period and the stocking rates were reduced greatly. The stocking rate on the native range pasture was reduced 51.1%, and the stocking rate on the alfalfa interseeded pasture was reduced 70.3%. During the 1988 drought growing season of trial II, the pastures were managed with two grazing periods and the stocking rates were only slightly reduced. The stocking rate on the native range pasture was reduced 7.3%, and the stocking rate on the alfalfa interseeded pasture was reduced 8.1% (table 4). The decrease in stocking rate during the drought growing season was greater on the alfalfa interseeded pasture than on the native range pasture on both trial I and trial II.

Cow and calf performances on the native range and alfalfa interseeded pastures managed with one grazing period on trial I were compared using gain per head, gain per day, and gain per acre data (table 5). Cow gain per head on the native range pasture was 84.1% greater than, but not significantly different ($P<0.05$) from, cow gain per head on the alfalfa interseeded pasture. Cow gain per day on the native range pasture was 278.9% greater than, but not significantly different ($P<0.05$) from, cow gain per day on the alfalfa interseeded pasture. Cow gain per acre on the native range pasture was 21.9% greater than, but not significantly different ($P<0.05$) from, cow gain per acre on the alfalfa interseeded pasture. Calf gain per head on the native range pasture was 8.7% greater than, but not significantly different ($P<0.05$) from, calf gain per head on the alfalfa interseeded pasture. Calf gain per day on the native range pasture was 6.6% greater than, but not significantly different ($P<0.05$) from, calf gain per day on the alfalfa interseeded pasture. Calf gain per acre on the alfalfa interseeded pasture was 67.8% greater than, but not significantly different ($P<0.05$) from, calf gain per acre on the native range pasture.

Cow and calf performances on the native range and alfalfa interseeded pastures managed with two grazing periods on trial II were compared using gain per head, gain per day, and gain per acre data (table 6). Cow gain per head on the alfalfa interseeded pasture was 13.6% greater than, but not significantly different ($P<0.05$) from, cow gain per head on the native range pasture. Cow gain per day on the alfalfa

interseeded pasture was 16.8% greater than, but not significantly different (P<0.05) from, cow gain per day on the native range pasture. Cow gain per acre on the alfalfa interseeded pasture was 104.5% greater than, but not significantly different (P<0.05) from, cow gain per acre on the native range pasture. Calf gain per head on the alfalfa interseeded pasture was 11.7% greater than, but not significantly different (P<0.05) from, calf gain per head on the native range pasture. Calf gain per day on the alfalfa interseeded pasture was 10.4% greater than, but not significantly different (P<0.05) from, calf gain per day on the native range pasture. Calf gain per acre on the alfalfa interseeded pasture was 101.1% greater than, and significantly different (P<0.05) from, calf gain per acre on the native range pasture. Cow and calf performances were not significantly different between the native range pasture and the alfalfa interseeded pasture on trial I and trial II except that the calf gain per acre on trial II was greater on the alfalfa interseeded pasture than on the native range pasture.

Cow and calf performance on trial I during the 1980 drought growing season on the native range and alfalfa interseeded pastures managed with one grazing period (table 7) was compared to cow and calf performance during the nondrought growing seasons on the respective treatment pastures, using gain per head, gain per day, and gain per acre data. On the native range pasture, cow gain per head decreased 95.4%, cow gain per day decreased 94.1%, and cow gain per acre decreased 96.6% during the drought growing season. Calf gain per head decreased 42.8%, calf gain per day increased 3.1%, and calf gain per acre decreased 52.2% during the drought growing season. On the alfalfa interseeded pasture, cow gain per head decreased 2128.8%, cow gain per day decreased 1029.4%, and cow gain per acre decreased 653.0% during the drought growing season. Calf gain per head decreased 82.0%, calf gain per day decreased 52.1%, and calf gain per acre decreased 85.3% during the drought growing season.

Cow and calf performance on trial II during the 1988 drought growing season on the native range and alfalfa interseeded pastures managed with two grazing periods (table 7) was compared to cow and calf performance during the nondrought growing seasons on the respective treatment pastures, using gain per head, gain per day, and gain per acre data. On the native range pasture, cow gain per head decreased 20.7%, cow gain per day decreased 10.3%, and cow gain per acre decreased 20.7% during the drought growing season. Calf gain per head decreased 17.4%, calf gain per day decreased 0.3%, and calf gain per acre decreased 17.4% during the drought growing season. On the alfalfa interseeded pasture, cow gain per head increased 7.0%, cow gain per day increased 30.1%, and cow gain per acre increased 7.0% during the drought growing season. Calf gain per head decreased 22.2%, calf gain per day decreased 6.7%, and calf gain per acre decreased 22.2% during the drought growing season. The decrease in cow and calf performance during the drought growing season on trial I was greater on the alfalfa interseeded pasture than on the native range pasture. The cow performance on the native range pasture on trial II decreased more during the drought growing season than the cow performance on the alfalfa interseeded pasture. The decrease in calf performance during the drought growing season on trial II was greater on the alfalfa interseeded pasture than on the native range pasture.

Aboveground herbage biomass on the native range and alfalfa interseeded pastures managed with one grazing period on trial I was compared at the start of the grazing period, at the end of the grazing period, and by the quantity of forage used per acre during the grazing period (table 8). Herbage biomass at the start of the grazing period on the alfalfa interseeded pasture was 63.9% grass and 36.2% alfalfa, and the total herbage biomass per acre was 36.5% greater than, but not significantly different (P<0.05) from, the total herbage biomass at the start of the grazing period on the native range pasture. Grass biomass per acre on the native range pasture was 14.8% greater than that on the alfalfa interseeded pasture. Herbage biomass at the end of the grazing period on the alfalfa interseeded pasture was 47.2% grass and 52.8% alfalfa, and the total herbage biomass remaining per acre was 29.5% greater than, but not significantly different (P<0.05) from, the total herbage biomass remaining at the end of the grazing period on the native range pasture. Grass biomass remaining per acre on the native range pasture was 63.8% greater than that remaining on the alfalfa interseeded pasture. The forage used during the grazing period on the alfalfa interseeded pasture was 14.9% grass and 85.1% alfalfa, and the total quantity of forage used per acre was 46.5% greater than, but not significantly different (P<0.05) from, the quantity of forage used per acre on the native range pasture. Grass forage used per acre on the alfalfa interseeded pasture was 24.7% greater than that used per acre on the native range pasture.

Aboveground herbage biomass on the native range and alfalfa interseeded pastures managed with two grazing periods on trial II was compared at the start of the first grazing period, at the end of the second grazing period, and by the quantity of forage

used per acre during both grazing periods (table 9). Herbage biomass at the start of the first grazing period on the alfalfa interseeded pasture was 45.3% grass and 54.7% alfalfa, and the total herbage biomass per acre was 52.0% greater than, but not significantly different ($P<0.05$) from, the total herbage biomass per acre at the start of the first grazing period on the native range pasture. Grass biomass per acre on the native range pasture was 45.1% greater than that on the alfalfa interseeded pasture. Herbage biomass at the end of the second grazing period on the alfalfa interseeded pasture was 49.0% grass and 51.0% alfalfa, and the total herbage biomass remaining per acre was 73.2% greater than, but not significantly different ($P<0.05$) from, the total herbage biomass remaining at the end of the second grazing period on the native range pasture. Grass biomass remaining per acre on the native range pasture was 17.9% greater than that remaining per acre on the alfalfa interseeded pasture. The forage used during both grazing periods on the alfalfa interseeded pasture was 32.3% grass and 67.7% alfalfa, and the total quantity of forage used per acre was 42.8% greater than, but not significantly different ($P<0.05$) from, the quantity of forage used per acre on the native range pasture. Grass forage used per acre on the native range pasture was 117.0% greater than that used per acre on the alfalfa interseeded pasture.

Total herbage biomass at the start and end of the grazing periods was greater on the alfalfa interseeded pasture than on the native range pasture on both trial I and trial II, but the differences were not significant. The grass biomass at the start and end of the grazing periods was greater on the native range pasture than on the alfalfa interseeded pasture on both trial I and trial II. The total forage used per acre was greater on the alfalfa interseeded pasture than on the native range pasture on both trial I and trial II, but the differences were not significant.

Herbage biomass on trial I during the 1980 drought growing season on the native range and alfalfa interseeded pastures managed with one grazing period (table 8) was compared to the herbage biomass during the nondrought growing seasons on the respective treatment pastures at the start of the grazing period, at the end of the grazing period, and by the quantity of forage used per acre during the grazing period. Herbage biomass per acre at the start of the grazing period on the native range pasture was 2.0% less during the drought growing season than during the nondrought growing seasons. Herbage biomass that remained per acre at the end of the grazing period on the native range pasture was 24.5% greater during the drought growing season than during the nondrought growing seasons. Forage used per acre during the grazing period on the native range pasture was 34.9% less during the drought growing season than during the nondrought growing seasons. Total herbage biomass, grass biomass, and alfalfa biomass per acre at the start of the grazing period on the alfalfa interseeded pasture were 58.1% less, 39.7% less, and 86.4% less, respectively, during the drought growing season than during the nondrought growing seasons. Total herbage biomass, grass biomass, and alfalfa biomass that remained per acre at the end of the grazing period on the alfalfa interseeded pasture were 56.8% less, 1.5% less, and 94.6% less, respectively, during the drought growing season than during the nondrought growing seasons. Total forage used, grass forage used, and alfalfa forage used per acre during the grazing period on the alfalfa interseeded pasture were 59.9% less, 62.5% less, and 43.4% less, respectively, during the drought growing season than during the nondrought growing seasons.

Herbage biomass on trial II during the 1988 drought growing season on the native range and alfalfa interseeded pastures managed with two grazing periods was compared to the herbage biomass during the nondrought growing seasons on the respective treatment pastures at the start of the first grazing period, at the end of the second grazing period, and by the quantity of forage used per acre during both grazing periods. Herbage biomass per acre at the start of the first grazing period on the native range pasture was 69.5% less during the drought growing season than during the nondrought growing seasons. Herbage biomass that remained per acre at the end of the second grazing period on the native range pasture was 80.5% less during the drought growing season than during the nondrought growing seasons. Forage used per acre during both grazing periods on the native range pasture was 58.1% less during the drought growing season than during the nondrought growing seasons. Total herbage biomass, grass biomass, and alfalfa biomass per acre at the start of the first grazing period on the alfalfa interseeded pasture were 68.6% less, 70.0% less, and 67.4% less, respectively, during the drought growing season than during the nondrought growing seasons. Total herbage biomass, grass biomass, and alfalfa biomass that remained per acre at the end of the second grazing period on the alfalfa interseeded pasture were 83.3% less, 83.9% less, and 82.7% less, respectively, during the drought growing season than during the nondrought growing seasons. Total forage used, grass forage used, and alfalfa forage used per acre during both grazing periods on the alfalfa interseeded pasture were 51.3% less, 28.9% less, and

63.3% less, respectively, during the drought growing season than during the nondrought growing seasons.

During the 1980 drought growing season, the stocking rates on trial I were reduced 51.1% and 70.3% on the native range and alfalfa interseeded pastures, respectively. By early July, the quantity of grass herbage on the native range pasture during the drought year was only slightly below the quantity on the native range pasture at the start of the grazing period during nondrought years. The stocking rate was reduced more than was needed, and, as a result, greater herbage remained at the end of the grazing period and less forage was used per acre during this season than during nondrought growing seasons. The grass herbage at the start of the grazing period on the alfalfa interseeded pasture was greatly reduced from the effects of low precipitation and the competition for soil water from the alfalfa plants: the quantity of grass herbage on the alfalfa interseeded pasture at the start of the grazing period was lower during the drought season than during nondrought growing seasons. During the drought growing season, the grass herbage biomass production on the alfalfa interseeded pasture was less than the grass herbage biomass production on the native range pasture. The alfalfa herbage on the alfalfa interseeded pasture at the start of the grazing period was greatly reduced from the effects of water stress, and the quantity of the alfalfa herbage at the start of the grazing period was lower during the drought growing season than during nondrought growing seasons. The stocking rate reduction was about correct for the quantity of herbage produced by the grass plants, and about the same amount of grass herbage remained at the end of the grazing period during the drought growing season as during nondrought growing seasons. Most of the alfalfa biomass was grazed, and very little alfalfa herbage remained at the end of the grazing period.

During the 1988 drought growing season, the stocking rates on trial II were reduced 7.3% and 8.1% on the native range and alfalfa interseeded pastures, respectively. The herbage biomass production was greatly reduced on both treatment pastures because the region received no precipitation during April. Near-normal precipitation was received in May. The first grazing period was started in early June, with the herbage biomass below that of nondrought growing seasons. June, July, and August 1988 received precipitation that was 43.8% of the long-term mean. There was very little herbage growth during the 1988 growing season. The cattle on the treatment pastures grazed most of the current year's growth and most of the residual standing biomass from the previous year.

The basal cover (table 10) of cool-season grasses, warm-season grasses, sedges, forbs, and woody species on the alfalfa interseeded pasture was lower than, but not significantly different ($P<0.05$) from, the basal cover of the respective plant biotypes on the native range pasture. The basal cover of invader grass species on the alfalfa interseeded pasture was 1333.3% greater than, and significantly different ($P<0.05$) from, the invader grass basal cover on the native range pasture. The basal cover of alfalfa plants on the alfalfa interseeded pasture was significantly greater ($P<0.05$) than that on the native range pasture. The native range pasture had no alfalfa plants.

The plant species composition on the native range and that on the alfalfa interseeded pastures were compared by the percent similarity index where an 80% similarity indicates that the species compositions are similar, a 20% similarity indicates that the species compositions are dissimilar, and intermediate percentages indicate degree of similarity or dissimilarity. The plant species composition on the native range and that on the alfalfa interseeded pastures had progressively greater dissimilarity over a three-year period (table 11). The trend of the plant community on the alfalfa interseeded pasture was a decrease of the native plant species and an increase of the invader grass species. The ecological processes changed by the mechanical treatment and by the introduction of alfalfa plants in the spring of 1977 had not recovered 28 years later. The regression of the species composition continued toward a degraded plant community that comprises primarily alfalfa, smooth bromegrass, and crested wheatgrass with a few depauperate native species. Interseeding alfalfa into grassland pastures eliminated the advantages of native rangeland over domesticated cool-season grass for summer grazing.

Costs and returns on the native range and alfalfa interseeded pastures on trial I were compared using pasture costs and value of calf weight gain (table 12). On the native range pasture managed with one grazing period on trial I, a cow and calf required 2.10 acres per period, at a cost of $18.39 for the 29-day period, or $0.63 per day. Calf weight gain was 1.97 lbs per day and 26.09 lbs per acre; accumulated weight gain was 56.13 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $39.29 per calf, and the net returns after pasture costs were $20.90 per cow-calf pair and $9.95 per acre. The cost of calf weight gain was $0.33 per pound. On the alfalfa interseeded pasture managed with one grazing period on trial I, a cow and calf required 1.35 acres per period, at a cost

of $14.49 for the 25-day period, or $0.58 per day. Calf weight gain was 1.84 lbs per day and 43.77 lbs per acre; accumulated weight gain was 51.23 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $35.86 per calf, and the net returns after pasture costs were $21.37 per cow-calf pair and $19.08 per acre. The cost of calf weight gain was $0.28 per pound.

Pasture cost on the alfalfa interseeded pasture was 21.2% lower than, but not significantly different ($P<0.05$) from, pasture cost on the native range pasture. Value of calf weight gain on the alfalfa interseeded pasture was 8.7% lower than, but not significantly different ($P<0.05$) from, calf weight gain value on the native range pasture. Net return per cow-calf pair on the alfalfa interseeded pasture was 2.2% greater than, but not significantly different ($P<0.05$) from, net return per cow-calf pair on the native range pasture. Net return per acre on the alfalfa interseeded pasture was 91.8% greater than, but not significantly different ($P<0.05$) from, net return per acre on the native range pasture. Cost per pound of calf accumulated weight on the alfalfa interseeded pasture was 15.2% lower than, but not significantly different ($P<0.05$) from, cost per pound of calf accumulated weight on the native range pasture.

Costs and returns on the native range and alfalfa interseeded pastures on trial II were compared using pasture costs and value of calf weight gain (table 13). On the native range pasture managed with two grazing periods on trial II, a cow and calf required 2.64 acres per period, at a cost of $23.13 for the 44-day period, or $0.53 per day. Calf weight gain was 2.30 lbs per day and 33.27 lbs per acre; accumulated weight gain was 99.80 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $69.86 per calf, and the net returns after pasture costs were $46.73 per cow-calf pair and $17.70 per acre. The cost of calf weight gain was $0.23 per pound. On the alfalfa interseeded pasture managed with two grazing periods on trial II, a cow and calf required 1.45 acres per period, at a cost of $18.76 for the 44-day period, or $0.43 per day. Calf weight gain was 2.54 lbs per day and 66.89 lbs per acre; accumulated weight gain was 111.48 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $78.03 per calf, and the net returns after pasture costs were $59.27 per cow-calf pair and $40.88 per acre. The cost of calf weight gain was $0.17 per pound.

Pasture cost on the alfalfa interseeded pasture was 53.5% lower than, and significantly different ($P<0.05$) from, pasture cost on the native range pasture. Value of calf weight gain on the alfalfa interseeded pasture was 11.7% greater than, but not significantly different ($P<0.05$) from, value of calf weight gain on the native range pasture. Net return per cow-calf pair on the alfalfa interseeded pasture was 26.8% greater than, but not significantly different ($P<0.05$) from, net return per cow-calf pair on the native range pasture. Net return per acre on the alfalfa interseeded pasture was 131.0% greater than, and significantly different ($P<0.05$) from, the net return per acre on the native range pasture. Cost per pound of calf accumulated weight on the alfalfa interseeded pasture was 26.1% lower than, and significantly different ($P<0.05$) from, cost per pound of calf accumulated weight on the native range pasture.

Costs and returns on trial I during the 1980 drought growing season on the native range and alfalfa interseeded pastures managed with one grazing period (table 14) were compared to costs and returns during the average growing seasons on the respective treatment pastures. On the native range pasture, pasture cost increased 15.1%, value of calf weight gain decreased 42.8%, net return per cow-calf pair decreased 93.8%, net return per acre decreased 94.6%, and cost per pound of calf accumulated weight increased 100.0% during the drought growing season. On the alfalfa interseeded pasture, pasture cost increased 20.8%, value of calf weight gain decreased 82.0%, net return per cow-calf pair decreased 151.8%, net return per acre decreased 143.0%, and cost per pound of calf accumulated weight increased 578.6% during the drought growing season.

Costs and returns on trial II during the 1988 drought growing season on the native range and alfalfa interseeded pastures managed with two grazing periods (table 14) were compared to costs and returns during the average growing seasons on the respective treatment pastures. On the native range pasture, pasture cost decreased 11.5%, value of calf weight gain decreased 17.4%, net return per cow-calf pair decreased 20.4%, net return per acre decreased 10.2%, and cost per pound of calf accumulated weight increased 8.7% during the drought growing season. On the alfalfa interseeded pasture, pasture cost decreased 10.4%, value of calf weight gain decreased 22.2%, net return per cow-calf pair decreased 25.9%, net return per acre decreased

17.4%, and cost per pound of calf accumulated weight increased 11.8% during the drought growing season.

The costs and returns on the native range and alfalfa interseeded pastures managed with one grazing period on trial I were not different. When the pastures were managed with two grazing periods on trial II, the costs were lower on the alfalfa interseeded pasture than on the native pasture. The returns per acre were greater on the alfalfa interseeded pasture than on the native range pasture, but the returns per cow-calf pair on the two treatments were not different. The increases in pasture cost and costs per pound of calf accumulated gain and the decreases in returns per cow-calf pair and returns per acre during the drought growing seasons were smaller on the native range pasture than on the alfalfa interseeded pasture on both trial I and trial II.

Conclusions

Total herbage biomass was a little greater on the alfalfa interseeded pasture managed with one grazing period than on the native range pasture, but the difference was not significant. Grass herbage biomass was greater on the native range pasture than on the alfalfa interseeded pasture. Stocking rate was a little greater on the alfalfa interseeded pasture than on the native range pasture, but the difference was not significant. Cow performance was greater on the native range pasture than on the alfalfa interseeded pasture, but the difference was not significant. Calf gain per head and gain per day were a little greater on the native range pasture than on the alfalfa interseeded pasture, but the difference was not significant. Calf gain per acre was greater on the alfalfa interseeded pasture than on the native range pasture, but the difference was not significant. The decrease in cow and calf performance on the alfalfa interseeded pasture during drought conditions was greater than that on the native range pasture. Pasture cost and cost per pound of calf accumulated weight were slightly less on the alfalfa interseeded pasture than on the native range pasture, but the difference was not significant. Net returns per cow-calf pair and per acre were slightly higher on the alfalfa interseeded pasture than on the native range pasture, but the difference was not significant. The increase in pasture cost and cost per pound of calf gain and the decrease in returns per cow-calf pair and per acre during drought conditions were greater on the alfalfa interseeded pasture than on the native range pasture. Herbage and livestock performances on the alfalfa interseeded pasture and the native range pasture managed with one grazing period were not different.

Total herbage biomass was greater on the alfalfa interseeded pasture managed with two grazing periods than on the native range pasture, but the difference was not significant. Grass herbage biomass was greater on the native range pasture than on the alfalfa interseeded pasture. Stocking rate was greater on the alfalfa interseeded pasture than on the native range pasture. Cow performance was greater on the alfalfa interseeded pasture than on the native range pasture, but the difference was not significant. Calf gain per head and gain per day were greater on the alfalfa interseeded pasture than on the native range pasture, but the difference was not significant. Calf gain per acre was greater on the alfalfa interseeded pasture than on the native range pasture. The decrease in calf performance on the alfalfa interseeded pasture during drought conditions was greater than that on the native range pasture. Pasture cost and cost per pound of calf accumulated weight were lower on the alfalfa interseeded pasture than on the native range pasture. Net return per cow-calf pair was slightly higher on the alfalfa interseeded pasture than on the native range pasture, but the difference was not significant. Net return per acre was greater on the alfalfa interseeded pasture than on the native range pasture. The increase in pasture cost and cost per pound of calf gain and the decrease in returns per cow-calf pair and per acre during drought conditions were greater on the alfalfa interseeded pasture than on the native range pasture. Herbage performance on the alfalfa interseeded and native range pastures managed with two grazing periods was not different. Stocking rate, calf gain per acre, and net return per acre were greater on the alfalfa interseeded pasture than on the native range pasture. Cow performance and calf gain per head and gain per day on the alfalfa interseeded and native range pastures managed with two grazing periods were not different.

Total herbage biomass, weight gain of cows and calves, and net return per cow-calf pair and per acre were greater on the alfalfa interseeded pasture and native range pasture managed with two grazing periods than on the respective pastures managed with one grazing period.

Management Implications

The alfalfa interseeded pasture managed with two grazing periods had a higher stocking rate, produced more pounds of calf weight per acre, and had greater net returns per acre than the native range pasture on the short term. However, on the long term, the native grassland ecosystem on the alfalfa interseeded pasture was devastated. The mechanical interseeding treatment disrupted ecological processes

on the disturbed portions of the pasture. The established alfalfa plants competed with the native plants for soil water and sunlight. The competition caused the native plants to progressively decrease in density and decline in herbage production and permitted invading plants to increase and replace the native plants.

Interseeding alfalfa into native range pastures does not benefit the grassland ecosystem, and it does not increase aboveground herbage biomass production. Low herbage production on native rangeland is not the actual problem; it is a symptom of a problem. The problem is low activity of rhizosphere organisms that is caused by antagonistic management practices. Changing traditional management practices to management methods designed to enhance biological and ecological processes corrects the actual problem and increases herbage biomass production. Biologically effective management applies grazing treatments to grass plants at the appropriate phenological growth stages to stimulate the activity of the symbiotic rhizosphere organisms and the biological processes that increase vegetative tiller development (Manske et al. 2003). Interseeding alfalfa into native range pastures does not solve the problem of low herbage production, and it is not a recommended practice.

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Table 1. Mean precipitation in inches for growing-season months at the Dickinson Research Extension Center, North Dakota.

Years	Apr	May	Jun	Jul	Aug	Sep	Oct	Growing Season
Long-term mean	1.43	2.31	3.58	2.25	1.75	1.33	0.94	13.59
One grazing period								
1979-1981, 1984	1.22	0.60	3.61	1.47	3.12	1.42	1.00	12.44
% of LTM	85.1	25.8	100.7	65.3	178.4	107.0	106.4	91.5
Two grazing periods								
1985-1988	0.84	2.80	2.54	3.10	1.32	1.98	0.71	13.29
% of LTM	58.9	121.2	71.0	137.7	75.3	148.5	75.0	97.8

Table 2. Drought-year precipitation in inches for growing-season months at the Dickinson Research Extension Center, North Dakota.

Years	Apr	May	Jun	Jul	Aug	Sep	Oct	Growing Season
Long-term mean	1.43	2.31	3.58	2.25	1.75	1.33	0.94	13.59
One grazing period								
1980	0.03	0.12	2.67	1.43	3.31	0.76	2.41	10.73
% of LTM	2.1	5.2	74.6	63.6	189.1	57.1	256.4	79.0
Two grazing periods								
1988	0.00	2.18	1.45	1.72	0.15	0.82	0.24	6.56
% of LTM	0.0	94.4	40.5	76.4	8.6	61.7	25.5	48.3

Table 3. Mean stocking rates on treatments managed with one grazing period and with two grazing periods.

Treatments	Dates Pasture Grazed	Days in Period	Months in Period	No. of cow-calf pairs	No. of AUEM	Stocking Rate: AUEM per acre	Stocking Rate: Acres per AUEM
One grazing period 1979-1981, 1984							
Native Range	3 Jul-1 Aug	29	0.95	8	8.13a	0.45a	2.21a
Alfalfa Interseeded	3 Jul-28 Jul	25	0.82	8	7.36a	0.74a	1.36a
Two grazing periods 1985-1988							
Native Range	9 Jun-24 Jun	15	1.44	6	9.78x	0.55x	1.85x
	22 Jul-20 Aug	29					
Alfalfa Interseeded	9 Jun-24 Jun	15	1.44	6	9.92x	0.99y	1.01y
	22 Jul-20 Aug	29					

Means in the same column and followed by the same letter are not significantly different ($P<0.05$).

Table 4. Mean stocking rates during drought growing seasons on treatments managed with one grazing period and with two grazing periods.

Treatments	Dates Pasture Grazed	Days in Period	Months in Period	No. of cow-calf pairs	No. of AUEM	Stocking Rate: AUEM per acre	Stocking Rate: Acres per AUEM
One grazing period 1980							
Native Range	7 Jul-23 Jul	16	0.53	7	3.95	0.22	4.56
Alfalfa Interseeded	7 Jul-16 Jul	9	0.30	7	2.22	0.22	4.51
Two grazing periods 1988							
Native Range	6 Jun-21 Jun	15	1.18	6	9.11	0.51	1.98
	22 Jul-12 Aug	21					
Alfalfa Interseeded	6 Jun-21 Jun	15	1.18	6	9.11	0.91	1.10
	22 Jul-12 Aug	21					

Table 5. Mean cow and calf performance on treatments managed with one grazing period.

	COW			CALF		
Treatments	Gain per Head (lbs)	Gain per Day (lbs)	Gain per Acre (lbs)	Gain per Head (lbs)	Gain per Day (lbs)	Gain per Acre (lbs)
One grazing period 1979-1981, 1984						
Native Range	15.31a	0.52a	7.99a	56.13a	1.97a	26.09a
Alfalfa Interseeded	2.43a	-0.93a	6.24a	51.23a	1.84a	43.77a

Means in the same column and followed by the same letter are not significantly different (P<0.05).

Table 6. Mean cow and calf performance on treatments managed with two grazing periods.

	COW			CALF		
Treatments	Gain per Head (lbs)	Gain per Day (lbs)	Gain per Acre (lbs)	Gain per Head (lbs)	Gain per Day (lbs)	Gain per Acre (lbs)
Two grazing periods 1985-1988						
Native Range	47.30x	1.13x	15.77x	99.80x	2.30x	33.27x
Alfalfa Interseeded	53.75x	1.32x	32.25x	111.48x	2.54x	66.89y

Means in the same column and followed by the same letter are not significantly different (P<0.05).

Table 7. Mean cow and calf performance during drought growing seasons on treatments managed with one grazing period and with two grazing periods.

	COW			CALF		
Treatments	Gain per Head (lbs)	Gain per Day (lbs)	Gain per Acre (lbs)	Gain per Head (lbs)	Gain per Day (lbs)	Gain per Acre (lbs)
One grazing period 1980						
Native Range	0.70	0.04	0.27	32.10	2.01	12.48
Alfalfa Interseeded	-49.30	-5.48	-34.51	9.20	1.02	6.44
Two grazing periods 1988						
Native Range	37.50	1.04	12.50	82.40	2.29	27.47
Alfalfa Interseeded	57.50	1.60	34.50	86.70	2.41	52.02

Table 8. Mean aboveground herbage biomass and forage utilized on treatments managed with one grazing period.

	Aboveground Herbage Biomass			
	Period #1		Forage Utilized	Forage per cow-calf pair
Treatments	ungrazed (lbs/acre)	grazed (lbs/acre)	(lbs/acre)	(lbs/day)
One grazing period 1979-1981, 1984				
Native Range	1410.83a	832.50a	578.33a	44.87
Alfalfa Interseeded	1925.14a	1077.84a	847.30a	42.37
Drought 1980				
Native Range	1389.10	976.50	412.60	66.31
Alfalfa Interseeded	943.60	543.00	400.60	63.59

Means in the same column and followed by the same letter are not significantly different (P<0.05).

Table 9. Mean aboveground herbage biomass and forage utilized on treatments managed with two grazing periods.

	Aboveground Herbage Biomass					
	Period #1		Period #2		Forage Utilized	Forage per cow-calf pair
Treatments	ungrazed (lbs/acre)	grazed (lbs/acre)	ungrazed (lbs/acre)	grazed (lbs/acre)	(lbs/acre)	(lbs/day)
Two grazing periods 1985-1988						
Native Range	1688.77x	948.57x	1357.87x	841.75x	1256.32x	85.66
Alfalfa Interseeded	2567.66x	1911.97x	2595.62x	1457.70x	1793.61x	67.94
Drought 1988						
Native Range	660.60	265.00	475.90	205.50	666.00	55.50
Alfalfa Interseeded	1018.70	471.30	800.30	307.90	1039.80	48.14

Means in the same column and followed by the same letter are not significantly different (P<0.05).

Table 10. Mean basal cover of biotypes on treatments managed with two grazing periods.

Treatments	Introduced Alfalfa	Introduced Invader Grasses	Grasses Cool Season	Grasses Warm Season	Sedges	Forbs	Woody	Total
Two grazing periods 1985, 1986, 1987								
Native Range	0.0x	0.03x	6.18x	9.94x	10.47x	3.90x	0.07x	30.56x
Alfalfa Interseeded	3.16y	0.40y	5.88x	8.53x	8.42x	3.09x	0.05x	25.97x
% of Control		1333.33	95.15	85.81	80.42	79.23	74.63	84.98

Means in the same column and followed by the same letter are not significantly different ($P<0.05$).

Table 11. Percent similarity of the plant species composition between the communities on the native range and alfalfa interseeded treatments managed with two grazing periods.

	Years			
	1985	1986	1987	Mean
% Similarity	76.83	69.99	67.00	71.27

Table 12. Costs-returns on treatments managed with one grazing period.

Treatments	Acres per Period (Acres)	Cost per Acre ($)	Cost per Period ($)	Calf Gain per Period (lbs)	Calf Value @ $0.70/lb ($)	Net Return per Cow-Calf pair ($)	Net Return per Acre ($)	Cost per pound Accumulated Weight ($)
One grazing period 1979-1981, 1984								
Native Range	2.10a	8.76	18.39a	56.13	39.29a	20.90a	9.95a	0.33a
Alfalfa Interseeded	1.12b	12.94	14.49a	51.23	35.86a	21.37a	19.08a	0.28a

Means in the same column and followed by the same letter are not significantly different (P<0.05).

Table 13. Costs-returns on treatments managed with two grazing periods.

Treatments	Acres per Period (Acres)	Cost per Acre ($)	Cost per Period ($)	Calf Gain per Period (lbs)	Calf Value @ $0.70/lb ($)	Net Return per Cow-Calf pair ($)	Net Return per Acre ($)	Cost per pound Accumulated Weight ($)
Two grazing periods 1985-1988								
Native Range	2.64x	8.76	23.13x	99.80	69.86x	46.73x	17.70x	0.23x
Alfalfa Interseeded	1.45y	12.94	18.76y	111.48	78.03x	59.27x	40.88y	0.17y

Means in the same column and followed by the same letter are not significantly different (P<0.05).

Table 14. Costs-returns during drought growing seasons on treatments managed with one grazing period and with two grazing periods.

Treatments	Acres per Period (Acres)	Cost per Acre ($)	Cost per Period ($)	Calf Gain per Period (lbs)	Calf Value @ $0.70/lb ($)	Net Return per Cow-Calf pair ($)	Net Return per Acre ($)	Cost per pound Accumulated Weight ($)
One grazing period 1980								
Native Range	2.42	8.76	21.17	32.10	22.47	1.30	0.54	0.66
Alfalfa Interseeded	1.35	12.94	17.51	9.20	6.44	-11.07	-8.20	1.90
Two grazing periods 1988								
Native Range	2.34	8.76	20.47	82.40	57.68	37.21	15.90	0.25
Alfalfa Interseeded	1.30	12.94	16.80	86.70	60.69	43.89	33.76	0.19

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