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INTEGRATING CROP AND LIVESTOCK SYSTEMS WITH PULSES AND CEREAL-PEA INTERCROPS

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Abstract

Alternatives to cereal crops grown for grain are needed to improve the economics of dryland crop production in the northern Great Plains. The objective of this project is to determine the potential of lentil and pea for both seed and forage production. Lentil and pea cultivars were compared for seed yield and quality in dryland environments, and also for forage yield and quality, in 1997 and 1998. Barley-pea, oat-pea, and oat-lentil mixtures were compared for forage yield and quality in 1996, 1997, and 1998 in a separate experiment. The grazing potential of barley-lentil, lentil, oat-pea, and pea pastures was compared in 1998, along with barley and oat pastures. Crossbred heifer calves were fed different rations, with some comprised of oat-pea hay, in an experiment in 1997 and 1998. Spring wheat yield was compared following pea and other crops in a 2-yr rotation in 1998. Preliminary results suggest that pea is adapted for forage production in the northern Great Plains, whether grown alone or in combination with barley or oat. Lentil produces high-quality forage, but yields are low. Additional data are needed before preliminary conclusions can be made about the grazing potential of lentil and pea pastures, the feeding potential of rations comprised of oat-pea hay, or the impact of pea in rotation with wheat.

Introduction

Wheat and other cereals are the most widely grown crops in southwestern North Dakota and across the northern Great Plains (NGP). Negative economic returns were projected for cereal grain crops grown in southwestern North Dakota during 1998 (Swenson and Haugen, 1997). For example, returns to labor and management were estimated to be -$15.80/acre for spring wheat following fallow,-$4.51/acre for recropped spring wheat, -$24.51/acre for feed barley, and -$23.35/acre for oats. Economic reality suggests that new production and marketing methods are needed for cereal crops to be grown profitably in southwestern North Dakota and similar agro-ecoregions. Some producers have begun rotating non-cereal crops with cereal crops to enhance economic returns generated from annual cropping systems. Others have developed forage-based, annual cropping systems as an alternative to the traditional cash grain market. Uncertainty exists about optimizing production and returns by diversifying crop rotations, or producing annual crops for forage rather than grain or seed. This project addresses some of this uncertainty.

Objectives:

1. Identify lentil and pea accessions and improved genotypes that are adapted to growing conditions in the NGP.
2. Identify cereal-pulse mixtures that are adapted in the NGP for forage and feed grain production.
3. Determine the influence which pulse crops have on soil fertility, water, and yield of subsequent crops when sown alone and intercropped with cereal crops.

Materials and Methods

Objective 1

Lentil and pea forage experiments

Ten field pea and four lentil cultivars were evaluated for forage yield and quality in separate experiments in 1998. Plots were arranged in a randomized complete block design with four replicates. Lentil was seeded at 550,000 pure live seed (PLS)/acre. Lentil cultivars were cut for forage at 30% to 50% full bloom. Field pea was seeded at 325,000

PLS/acre. Pea cultivars were cut for forage at 30% to 50% full bloom.

Lentil and pea seed yield experiments

Seven lentil and eight pea cultivars were evaluated for seed yield and quality in 1998. Experimental design and seeding rates were identical to those used in the forage yield and quality experiments.

Objective 2

Cereal pea hay forage experiment

Horsford forage barley and Dumont oat were each seeded alone at 750,000 PLS/acre, and at 50%, 100%, and 150% of the sole crop rate with Trapper pea. Trapper pea was seeded at 50%, 100%, and 150% of its sole crop rate (325,000 PLS/acre) with the cereal crops, and was seeded at the sole crop rate in sole pea plots. Dumont oat was seeded at its sole crop rate with Indianhead forage lentil. The forage lentil was seeded at 278,000 PLS/acre in plots with Dumont oat, and in sole lentil plots.

Plots were arranged in a randomized complete block design with four replicates. Intercrops and sole crops were harvested for forage when the cereal component was at the early heading (Feekes 10.1), kernel milky ripe (11.1), kernel soft dough (11.2) and kernel hard dough (11.3) growth stages. Pea and lentil sole crop plots were harvested when cereal sole crop plots were harvested. Treatments were evaluated for ease of establishment, influence on pathogens and crop plant development, and suitability to mechanical harvesting methods. Forage yield and quality also were determined.

Summer grazing on annual forage experiment

In 1998, 12 paddocks (2.5 acre/paddock) were blocked into two, 6-paddock groups (2 paddocks/forage type). One group was seeded to pea, oat or oat-pea intercrop, while the other group was seeded to lentil, barley or barley-lentil intercrop. Paddocks were grazed by bred beef heifers (.75 AU/heifer) at a constant stocking rate of .9 AU/acre. Paddocks seeded (Table 8) to pea/oat combinations were grazed first (mid-June to mid-July), followed by paddocks seeded to the barley-lentil combinations (mid-July to mid-August). Grazing potential of each forage type was

evaluated as in earlier experiments. This seeding/grazing sequence will be repeated in a second set of paddocks in 1999.

Drylot feeding of beef heifers experiment

In 1997, eighty, crossbred heifer calves were randomly allotted into 4 pens (20 heifers/pen). Pens were then assigned one of two dietary treatments (Table 1). Heifers were weighed at the beginning and end of the feeding period. Body condition scores were recorded at the end of the feeding period. Heifers were fed for 63 days. Feed was delivered daily and feed refusals were recorded weekly. Intake was calculated as the difference between cumulative feed delivery and refusal.

In 1998, ninety-six heifer calves were blocked by weight and allotted within block into 12 feedlot pens. Four dietary treatments (Table 1) were formulated to contain 12.4% CP. Heifer weights and feed disappearance were recorded as in 1997, while body condition was recorded at the beginning and end of the experiment. Heifers were fed for 84 days. Similar dietary treatments will be used in a separate feeding experiment utilizing heifer calves in 1999.

Objective 3

Replicated, randomized plots (30 ft x 150 ft) of corn, proso millet, oat, pea, pinto bean, and hard red spring wheat were established along with fallow plots at the Dickinson Research Extension Center in 1997. Growing season precipitation and temperature data were collected at a nearby weather station. Soil water content at planting and after crop harvest were determined gravimetrically. Soil N and P content also was determined. Hard red spring wheat was seeded in each plot in 1998. Grain yield was determined by harvesting a 5-ft wide swath from the center of each plot using a research combine.

Results and Discussion

Objective 1

Lentil forage experiment

Mean forage yield was 1.1 tons dry matter (DM)/acre in 1998 (Table 2). Yield ranged from 0.7 tons DM/acre for Crimson to 1.2 tons DM/acre for CDC Richlea, Indianhead, and CDC Milestone. Two-yr average yield for the three cultivars seeded in both yrs was: CDC Richlea, 1.5 tons DM/acre; Indianhead, 1.6 tons DM/acre; and CDC Milestone, 1.2 tons DM/acre. These data suggest that forage yield for CDC Richlea is equal to yield of the forage cultivar Indianhead. Results of other experiments at Dickinson suggest that forage yield of lentil is less than yield of other cool season, annual crops that are grown for forage (Eriksmoen et al., 1998).

Crude protein (CP) concentration of lentil forage ranged from 17% for CDC Milestone to 22% for Indianhead in 1998 (Table 2). Two-yr mean CP concentration of the three cultivars evaluated in 1997 and 1998 was: CDC Richlea, 18%; Indianhead, 20%; and CDC Milestone, 17%. These data suggest that Indianhead lentil may be preferred for forage compared with CDC Richlea and CDC Milestone because of higher CP concentration. No differences in acid detergent fiber concentration (ADF), neutral detergent fiber concentration (NDF), or relative feed value (RFV) existed among CDC Richlea, Indianhead, and CDC Milestone in either 1997 or 1998 (Table 3).

Pea forage experiment

Pea forage yield ranged from 1.8 tons DM/acre for Motazz to 2.9 tons DM/acre for Yorkton in 1998 (Table 4). Carneval, an upright, semi-leafless cultivar developed for seed production, produced equal or greater amounts of forage compared with other pea cultivars in both 1997 and 1998. These data failed to reveal any yield advantage for cultivars developed for forage production (e.g., Nutrigreen) compared with cultivars developed for seed yield (e.g., Carneval).

The CP concentration of forage was greater for Nutrigreen than other cultivars in 1998, except Trapper and Yorkton (Table 3). In 1997, the CP concentration was greater for Nutrigreen than other cultivars except Grande, Motazz, Highlite, Precourse, and Totem. The CP concentration was less for Carneval compared with Nutrigreen in both years. These data suggest that cultivars developed for forage may be superior to cultivars developed for seed production because of quality of the forage produced.

Lentil seed yield experiment

Lentil cultivars were equal in seed yield in 1998 (Table 5). Mean seed yield was 1688 lb/acre for the seven cultivars evaluated at Dickinson. More seed was produced by Brewer and Eston than Laird in 1997. No cultivar was identified in 1996, 1997, or 1998 that was superior to CDC Richlea for seed yield. CDC Richlea is the most widely grown lentil cultivar in North Dakota, and these data support its continued production for seed yield.

Test weight was heavier for Eston than other cultivars in 1998 (Table 5). Conversely, test weight was lighter for Laird than other cultivars. CDC Richlea was intermediate for test weight compared with other Lentil cultivars.

Field pea seed yield experiment

Seed yield ranged from 2739 lb/acre (46 bu/acre) for Adagio to 3355 lb/acre (56 bu/acre) for Atomic peas in 1998 (Table 6). Only Adagio produced less peas than Atomic among the eight pea cultivars evaluated. Grande was the only cultivar tested in 1998 that was included in adaptation experiments in both 1996 and 1997. The 3-yr mean (1996-98) yield for Grande was 2480 lb/acre (41 bu/acre). By comparison, the 3-yr mean yield for 2375 hard red spring wheat was 2898 lb/acre (48.3 bu/acre) (Eriksmoen et al., 1998). These preliminary data support the production of peas for seed yield in southwestern North Dakota, suggesting that peas will produce about 86% of the yield of HRSW cultivars.

Problems are encountered when harvesting many pea cultivars because of a propensity to lodge. Grande and Totem did lodge prior to harvesting seed in 1998 (Table 6). Conversely, Atomic, Highlight, Phantom, and Scuba lodged very little, if at all. These data suggest that pea cultivars exist which do not lodge. Seed produced by cultivars that do not lodge can be harvested with small grain harvesting equipment without difficulty (data not provided).

Objective 2

Cereal pea hay forage experiment

Mean forage yield was 1.5 tons DM/acre across sole crop and intercrop treatments at the first harvest date (early heading) in 1998 (Table 7). Differences in yield did not exist between treatments.

Yield differences did not exist between treatments which included either Horsford barley or Dumont oats at the

second harvest date (kernel milky ripe) (Table 7), with one exception. Seeding Dumont oat and Trapper pea each at 50% of the sole crop rate (375,000 and 162,500 kernels or seed/acre, respectively) produced less forage than seeding Dumont oat or Horsford barley alone, or with peas or lentils at 150% of the sole crop rate. Other research indicates that forage yield is reduced when the cereal component is seeded at less than the sole crop rate with peas compared with cereal sole crop (Carr et al., 1998). Lentil and pea sole crops produced less forage than any treatment including a cereal crop at the second harvest date, and peas produced more forage than lentils.

Dumont oat seeded alone or with Indianhead lentil produced more forage than other treatments at the third harvest date (kernel soft dough), except when Dumont oat was seeded with Trapper pea at a sole crop or heavier seeding rate (Table 7). Forage yield was equal among other treatments that included a cereal crop. Lentil and pea sole crops produced less forage than other treatments, and more forage was produced by pea sole crop than lentil sole crop.

Lentil sole crop produced less forage than other treatments at the fourth harvest date (kernel hard dough) (Table 7). No differences existed between other treatments for forage yield. Harvesting regrowth of treatments harvested during the first harvest date produced less than 1 ton DM/acre.

The CP concentration of lentil sole crop forage was greater than that of other treatments at the first harvest date (Table 8). The CP concentration of pea sole crop forage was equal to the CP concentration of forage of barley sole crop and barley-pea mixtures, but greater than oat sole crop. Seeding oat with pea at a sole crop or lighter rate produced forage with a CP concentration equal to that of pea sole crop.

The CP concentration of lentil sole crop forage was greater than that of other treatments at the second harvest date (kernel milky ripe) (Table 8). The CP concentration of pea sole crop forage was greater han that of other treatments except oat/pea intercrop with each crop seeded at 50% of the sole crop rate.

The CP concentration of lentil and pea, sole crop forage was greater than that of any treatment including a cereal at the third harvest date (kernel soft dough) (Table 8). The forage CP concentration of legume sole crop treatments also was greater than that of any treatment including a cereal at the fourth harvest date (kernel hard dough). The CP concentration of barley/pea intercrop forage was greater than oat/pea intercrop forage at both the third harvest date (kernel soft dough) and the fourth harvest date (kernel hard dough), except when oat and pea were each seeded at

50% of the sole crop rate.

Summer grazing on annual forage

Pastures of annual forage produced an average of .92 animal grazing unit months per acre in 1998 (Table 9). Bred heifer performance (1 year; 1998) is presented in Table 10. Heifers averaged 2.0 lb/d from mid-June to mid-August. Typical summer grazing performance for bred heifers at Dickinson is 1.0 lb/d (Ringwall et al., 1998). Heifer live weight gain per acre (67.2 lb/ac) was comparable to average suckling calf performance (66.0 lb/acre) reported in previous years (Poland et al., 1998).

Drylot feeding of beef heifers

There were no differences in initial (*P*=.38) or final (*P*=.61) body weight, final body condition score (*P*=.67), or average daily gain (*P*=.51) (Table 11). Although heifers fed oat-pea intercrop hay consumed less feed (*P*<.03), feed efficiency (gain/feed; *P*=.74) was not different due to dietary treatment. It took approximately 12.5 lbs of feed to produce a lb of gain regardless of dietary composition.

Initial body weight (*P*=.75) and condition score (*P*=.71), final condition score, dry matter intake (*P*=.57), and feed efficiency (*P*=.25) were not affected by dietary treatment (Table 11). Although final body weight (*P*=.08) tended to be influenced by dietary treatment, average daily gain (*P*=.24) was not affected by dietary treatment. It took approximately 18 lbs of feed to produce a lb of gain in this experiment.

Objective 3

Tabulation, analyses, and interpretation of data are incomplete. However, preliminary data indicate that spring wheat yield in 1998 was not different across treatments (*P* = .064) (Table 12). These data support results of other research indicating that spring wheat yield can be maintained in intensive wheat production systems compared with wheat-summer fallow (Carr et al., a).

Conclusions/Implications of Research

This project will be completed in 1999. The following activities are planned:

Objective 1

Pea and lentil cultivars will be evaluated for both forage and seed production in 1999. Results will be published in Dickinson Research Extension Center bulletins and the annual report in paper form as well as electronically. Data will be included in the Alternative Crops Bulletin published by the NDSU Extension Service, with statewide distribution.

Objective 2

A paper which describes the feed grain potential of cereal/pea intercrop has been submitted for publication in *Agronomy Journal* (Carr et al., 19_b). Two manuscripts which describe the *cereal/pea hay forage* experiment will be written during the fall of 1999. Additional peer-reviewed manuscripts are expected.

Results of the *cereal-pea hay forage* experiment will be presented at the American Society of Agronomy's annual meeting in Salt Lake City, UT in 1999. Preliminary results of the *drylot feeding of beef heifers* experiment will be presented at the Midwest Sectional Meeting of the American Society of Animal Science in Des Moines, IA in 1999.

Objective 3

Soil and grain yield data will be collected for wheat following legumes and cereal crops. Results of this effort will be published in Dickinson Research Extension Center bulletins and the annual report. These results also will be presented to ag-industry representatives and members of other groups who have expressed a willingness to support cropping systems research at Dickinson.

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Table 1. Diet composition for oat and oat-pea hay heifer feeding studies.

	1997		1998			
	OAT[a]	O/P	OAT	O/P	ALF	PEA
Ingredients						

Oat hay	43.5	-	37.0	-	35.8	37.2
Oat-pea hay		54.9	-	37.5	-	-
Mixed hay	11.9	-	-	-	14.6	-
Grass hay	-	-	37.8	37.8	30.0	38.0
Corn silage	31.1	31.2	-	-	-	-
Corn grain	10.4	10.6	18.9	19.1	18.6	10.7
Soybean meal	-	-	5.3	4.6	-	-
Pea grain	-	-	-	-	-	13.1
Supplement[b]	2.5	2.6	.6	.6	.6	.6
Salt	0.6	0.6	.4	.4	.4	.4
Composition						
Crude protein, %DM	10.4	10.3				

[a] OAT, O/P, ALF and PEA indicate dietary treatments that contained oat, oat/pea intercropped or mixed (primarily alfalfa) hay or field pea grain, respectively.
[b] In 1997; Vigortone Feedlot No. 411B, Vigortone Ag Products, Inc., Cedar Rapids, IA. In 1998; limestone.

Table 2. Dickinson lentil cultivar adaptation trial in - 1997 and 1998 forage production and crude protein (CP) concentration.

		DM Basis

Variety	Harvest Moisture			Yield			CP		
	1997	1998	avg	1997	1998	avg	1997	1998	avg
	%			Tons/ac			%		
Crimson	--	73	--	--	0.7	--	--	20.4	--
CDC Richlea	66	73	70	1.8	1.2	1.5	16.3	20.2	18.2
Indianhead	70	75	73	2.0	1.2	1.6	18.2	21.7	20.0
CDC Milestone	64	70	67	1.2	1.2	1.2	16.0	17.2	16.6
Mean	66	73	70	1.7	1.1	1.4	16.8	19.9	18.3
C.V. %	3.0	0.9	--	15.7	14.4	--	7.5	5.0	--
LSD .05	3	1	--	NS	0.2	--	1.9	1.9	--

Table 3. Dickinson lentil cultivar adaptation trial - 1997 and 1998 acid detergent fiber (ADF), neutral detergent fiber (NDF), and relative feed value (RFV) of forage.

Variety	DM Basis								
	ADF			NDF			RFV		
	1997	1998	avg	1997	1998	avg	1997	1998	avg
	%								

Crimson	--	22	--	--	31	--	--	216	--
CDC Richlea	34	23	29	40	34	37	144	197	171
Indianhead	36	25	31	42	35	39	136	185	161
CDC Milestone	33	25	29	39	34	37	152	189	171
Mean	34	24	29	40	34	38	144	197	167
C.V. %	10.9	9.7	--	7.6	5.4	--	10.9	7.4	--
LSD .05	NS	NS	--	NS	NS	--	NS	NS	--

Table 4. Dickinson pea cultivar adaptation trial in - 1997 and 1998 forage production and crude protein (CP) concentration.

Variety	Harvest Moisture			DM Basis					
				Yield			CP		
	1997	1998	avg	1997	1998	avg	1997	1998	avg
	%			Tons/ac			%		
Algera	79	72	76	1.4	2.7	2.1	17.5	15.5	16.5
Carneval	80	70	75	1.2	2.8	2.0	17.0	11.8	14.4
Grande	82	75	79	1.4	2.8	2.1	18.8	16.2	17.5
SW Bravo	--	69	--	--	2.7	--	--	13.9	--

Motazz	81	70	76	0.9	1.8	1.4	19.8	12.5	16.2
Pro 2100	79	70	75	1.2	2.3	1.8	16.9	15.2	16.1
Trapper	--	78	--	--	2.5	--	--	19.1	--
Nutrigreen	84	79	82	1.2	2.2	1.7	20.3	19.9	20.1
Hors/Carneval[1]	--	66	--	--	2.5	--	--	11.8	--
Yorkton	80	73	77	1.2	2.9	2.1	17.7	18.5	18.1
Highlite	81	--	--	1.0	--	--	18.6	--	--
Precourse	80	--	--	1.2	--	--	18.1	--	--
Quintessa	79	--	--	1.0	--	--	17.3	--	--
Quayessa	82	--	--	1.2	--	--	17.2	--	--
Totem	82	--	--	0.7	--	--	20.0	--	--
Mean	81	72	76	1.1	2.3	1.9	18.3	15.4	17.0
C.V. %	1.8	2.4	--	15.7	9.1	--	9.0	13.5	--
LSD .05	2	3	--	NS	0.3	--	2.4	1.8	--
[1]Hors/Carneval: Horsford barley and Carneval pea mix									

Table 5. Dickinson lentil cultivar adaptation trial - 1996, 1997, and 1998 seed production.

Variety	Type	Days to Flower	Seeds per Pound	Plant Height in	Test Weight lbs/bu	--- Grain Yield ----			Average Yield	
						1996	1997	1998	2 Year	3 Year
						-------lbs/ac-------			----lbs/ac----	
Brewer	C	54	9,585	12	61.3	815	1232	1726	1479	1258
CDC Richlea	C	63	10,359	13	62.0	1285	1197	1809	1503	1430
Crimson	R	63	16,526	12	63.6	810	1187	1629	1408	1209
Eston	P	63	17,005	13	64.4	1025	1316	1752	1534	1364
Laird	C	70	6,835	14	59.5	945	947	1496	1221	1129
Mason	C	55	8,467	12	62.5	--	--	1729	--	--
Red Chief	R	57	10,495	11	61.5	--	--	1676	--	--
Mean	--	61	1,324	12	62.1	976	1176	1688	--	--
C.V. %	--	1	4.8	4.0	0.8	14.8	14.0	7.4	--	--
LSD .05	--	1	803	1	0.7	205	250	NS	--	--
Type: C=Chilean, R=Red, P=Persian										

Table 6. Dickinson pea cultivar adaptation trial - 1996, 1997, and 1998 seed production.

Variety	Type	Days to Flower	Flower Duration	Seeds per Pound	Lodging Score	Test Weight	Grain Yield			Average Yield	
							1996	1997	1998	2 Year	3 Year
					0-9	lbs/bu	lbs/ac			lbs/ac	
Adagio	G	59	19	1,744	3.5	63.3	--	--	2739	--	--
Atomic	G	60	19	1,421	0.0	64.3	--	--	3355	--	--
Grande	Y	62	18	1,864	4.0	62.3	2381	2309	2749	2529	2480
Highlight	Y	59	20	2,340	0.5	65.1	--	1759	3264	2511	--
Mp 1373	Y	61	18	1,787	0.3	64.1	--	--	3994	--	--
Phantom	G	56	19	1,581	0.8	64.6	--	--	3200	--	--
Scuba	G	56	22	1,850	0.5	64.9	--	--	3007	--	--
Totem	G	61	18	1,890	5.8	63.1	--	1914	3051	2483	--
Mean	--	59	19	1,810	1.9	64.0	--	1994	3170	--	--
C.V. %	--	0.9	4.2	4.4	84.6	1.5	--	13.8	8.4	--	--
LSD .05	--	1	1	117	2.4	1.4	--	321	394	--	--

Type: Y=Yellow, G=Green
Lodging: 0=No lodging, 9=Completely flat

Table 7. Dickinson Cereal/Pea 1998 Cutting Date Trial - forage yield.

Variety	Seeding rate		Yield DM Basis				
	Cereal	Pea/Lentil	1st cut	2nd cut	3rd cut	4th cut	Regrowth
			Tons/ac				
Horsford/Trapper	1,125,000	487,000	2.0	2.8	3.3	3.8	0.7
Horsford/Trapper	750,000	325,000	1.7	2.5	3.3	3.5	0.6
Horsford/Trapper	375,000	162,500	1.3	2.4	3.1	3.0	0.8
Horsford barley	750,000	--	1.9	2.8	3.2	3.3	0.8
Dumont/Trapper	1,125,000	487,000	2.3	2.7	3.6	2.9	0.6
Dumont/Trapper	750,000	325,000	1.8	2.5	3.6	3.5	0.5
Dumont/Trapper	375,000	162,500	1.3	2.2	3.2	3.1	0.6
Dumont oat	750,000	--	1.5	2.7	4.0	3.3	0.6
Dumont/Indianhead	750,000	278,000	2.0	2.6	3.9	3.1	0.6
Indianhead lentil	--	278,000	0.1	0.7	1.4	2.0	0.8
Trapper pea	--	325,000	0.8	1.5	2.4	3.4	0.3
Mean			1.5	2.3	3.2	3.2	0.6
CV %			25.0	10.5	14.0	12.7	37.2
LSD .05			NS	0.4	0.6	0.6	NS

Table 8. Dickinson 1998 Cereal/Pea Cutting Date Trial - crude protein concentration.

Variety	Seeding rate		Crude protein concentration				
	Cereal	Pea/Lentil	1st cut	2nd cut	3rd cut	4th cut	Regrowth
			%				
Horsford/Trapper	1,125,000	487,000	19.8	13.6	11.2	9.9	15.2
Horsford/Trapper	750,000	325,000	19.3	12.0	11.7	9.5	14.2
Horsford/Trapper	375,000	162,500	20.3	12.8	11.1	9.4	13.7
Horsford barley	750,000	--	20.0	12.9	9.9	8.5	12.2
Dumont/Trapper	1,125,000	487,000	17.2	14.3	7.6	6.1	14.9
Dumont/Trapper	750,000	325,000	19.0	14.7	8.3	6.3	15.8
Dumont/Trapper	375,000	162,500	21.3	16.4	9.6	8.3	15.1
Dumont oat	750,000	--	17.9	12.4	8.2	5.4	14.4
Dumont/Indianhead	750,000	278,000	17.6	11.9	6.5	4.7	15.2
Indianhead lentil	--	278,000	26.4	23.4	20.1	14.0	17.6
Trapper pea	--	325,000	20.3	17.7	15.6	12.8	19.7

Mean			19.9	14.7	11.0	8.6	15.3
CV %			7.5	10.6	15.5	15.4	11.0
LSD .05			2.2	2.3	2.4	1.9	2.4

Table 9. Seeding and grazing dates and stocking rates for beef cattle grazing annual forages at the Dickinson Research Extension Center.

Year/Forage Type	Seeding date	Grazing dates	Days	AUM[a]/acre
1998		15June - 15August	61	.92
Oat and Pea Barley and Lentil	27April 04June	15June - 20July 22July - 17August	35 26	1.05 .78

[a] Animal unit month or the equivalent of one cow-calf pair grazing for one month. Bred heifer were considered to be .75 animal unit.

[b] Stocking rates were .9 animal units per acre in 1998.

[c] Grazing in pastures of sole lentil was not initiated until 05 August giving only 12 days of grazing and .36 AUM/acre.

Table 10. Cattle performance while grazing annual forages at Dickinson Research Extension Center.

Year/Forage Type	Average daily gain lb/d	SE[a]	Gain per acre lb/ac	SE
	Bred heifer performance			

1998	2.02	--[c]	67.2	--
Oat	1.21	.32[g]	51.3	10.0[g]
Pea	1.68		71.4	
OP intercrop	1.45		61.4	
Barley	3.02		95.3	
Lentil	1.69		24.6	
BL intercrop	3.14		99.0	

[a] Standard error of mean

[b] Stocking rates were.9 animal units per acre in 1998. One animal unit equating to a cow-calf pair or 1.2 bred heifers.

[c] Not applicable or not reported.

[d] OP and BL refer to oat-pea and barley-lentil intercrops.

[g] Standard error is average for all forage types within year.

Table 11. Animal performance for oat and oat-pea hay heifer feeding studies.

	1997			1998				
	OAT[a]	O/P	SE	OAT	O/P	ALF	PEA	SE
Weights, lb								
Initial	651.4	663.7	7.7	792.0	801.2	800.4	793.5	7.3
Final[b]	806.8	810.2	4.0	887.1[w]	902.0[x]	897.8[w x]	901.8[x]	3.6
Daily gain	2.47	2.33	.13	1.13	1.20	1.16	1.29	.05
Body condition								

Initial	-	-	-	6.5	6.5	6.5	6.4	.08
Final	6.6	6.8	.2	6.6	6.8	6.8	6.8	.06
DMI[bc], lb/d	29.6[y]	30.5[z]	.11	19.1	19.1	19.3	19.1	.09
Efficiency								
Gain/feed	.08	.08	.004	.06	.06	.06	.07	.003
Feed/gain	12.9	13.4	-	18.0	16.7	20.2	17.1	-

[a] See note in table 3.
[b] Final weight tends to differ between treatments in Exp 2 (P=.08). [w,x] Means lacking common superscript differ (P<.05).
[c] Dry matter intake.
[d] DMI differs between treatments in 1997 (P<.03).
[y,z] Means lacking common superscript differ (P<.03).

Table 12. Grain yield of hard red spring wheat following selected crops and fallow at Dickinson, ND, in 1998.

Previous crop	Grain yield
	-------- bu/acre --------
corn	59
millet	66
none (fallow)	55
oat	51

pinto bean	57
pea	55
wheat	53
Mean	57
CV (%)	7.6
LSD .05	NS

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