

ALTERNATIVE CROPS AND CROPPING SYSTEMS IN SOUTHWESTERN NORTH DAKOTA

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SUMMARY

Crop production systems in the southwestern North Dakota are almost exclusively limited to small grains. Average yields for these crops sometimes are lower than those required to return an adequate profit margin to producers, if government price supports are not considered. Even when government payments are made, in some instances small grain crops cannot profitably be grown in most years.

Expanding cropping choices has been suggested as a possible strategy for profitable crop production (Jolliff, 1989). Crop diversity also can expand market opportunities, improve pest control, and enhance soil conservation (Jolliff and Snapp, 1988). In North Dakota, development of crambe points to the benefits which biological diversity in cropping systems can offer. Crambe is naturally resistant to many pests and can be used to break small grain disease cycles in rotations (Endres and Schatz, 1991). The seed oil is highly-valued by the chemical industry (Van Dyne et al., 1990), opening up new markets to primarily food and feed producers. Crambe also produces considerable amounts of residue and can be managed to protect cultivated fields from wind and water erosion.

Successful production of alternative crops in southwestern North Dakota would provide many benefits to producers. Crambe and other industrial crops could be grown and sold as high-value industrial feedstocks. Pulses like field pea

can be intercropped with cereal feed grains to enhance protein content of annual forages (Carr and Martin., 1996). Field pea also can be grown alone as high-protein feed grains as well as soil-enhancing crops. This project is directed at evaluating several alternative crops in southwestern North Dakota. This project will collect and publish information on the performance of cereal forage crops and alternative crops and crop management strategies in southwestern North Dakota.

OBJECTIVES

1. Evaluate cereals, pulses, and alfalfa alone and/or in mixtures with one another for feed and forage in southwestern North Dakota.
2. Investigate several plant species as oilseed crops.

INTRODUCTION

Corn is an important annual forage in southwestern North Dakota. According to Beard and Hamlin (1996), corn was planted on approximately 800,000 acres of cropland in 1994; this is approximately the same amount of acreage that was devoted to oat production. The importance of corn in the region supports adaptation trials of newly developed hybrids. These trials should reflect changes in corn production strategy, including increased planting rates and narrower row spacing.

Conlon and Douglas (1957) reported that corn produced larger yields per acre than any other feed crop grown at the Dickinson Research Extension Center between 1907-57. In summarizing earlier research, Conlon and Douglas (1953) concluded that a corn-wheat-oat rotation generated considerably greater returns than a fallow-wheat-oat rotation on diversified crop-livestock farm operations. The corn produced on the farm was marketed through livestock.

Corn grown as silage is an excellent forage crop. However, soybean meal generally is added to correct protein deficiencies (Goodrich and Meiske, 1976). The soybean meal added to the feed ration is an off-farm cost to producers in southwestern North Dakota, since soybean is not adapted to local growing conditions and little is grown (Beard and Hamlin, 1996). Adaptation screening trials suggest that pea may successfully be grown in western North

Dakota (Eriksmoen et al., 1995). However, much must still be learned on how to best grow pea in the dryland environment of western North Dakota. If successful pea production practices can be developed, then pea might be grown and used as a high protein supplement in selected livestock rations.

An alternative to growing corn for silage is to grow other cereals like barley or oat as haylage. While past work indicates that both these crops produce less total digestible nutrients than corn grown for either grain or silage (Smith and Stoa, 1944; Wiidakas, 1967), it may be possible to enhance the feed value of barley or oat haylage by growing these cereals together with field pea. Izaurralde et al. (1989) concluded that intercropping barley with field peas significantly increased crude protein content of the hay produced. Similarly, protein yield sometimes was increased when oats were intercropped with field peas in western North Dakota rather than grown alone (Carter and Larson, 1964). While these North Dakota researchers reported that hay yields generally were decreased when oats were intercropped with either field pea (or vetch), their data reveal several exceptions. For example, dry matter production of oat-field pea mixtures compared favorably with monocropped oat in recropped environments at Dickinson, Minot, and Williston.

Recent work indicated that dry matter yield was maintained when oats and peas were intercropped at Dickinson (Carr and Martin, 1996). The influence of intercropping on hay yield and protein content must be determined for widespread adoption of this practice in the Southwest. For this to be known, the influence of cereal to pea plant populations on intercrop performance must be established, as must be the optimum time for harvesting the mixed forage.

Alfalfa has been grown for decades in western North Dakota. Still, obstacles to successful alfalfa establishment exist for many farmers and ranchers. An important question continues to revolve around alfalfa establishment methods: should alfalfa be clear seeded or grown with a nurse crop? Work is needed to determine the best method for seeding alfalfa in western North Dakota. Research also is needed to determine optimum plant stand for maximum alfalfa hay production in western North Dakota.

Flax and crambe are industrial oilseed crops which offer advantages to crop producers if they are incorporated into crop rotations in western North Dakota. Canola is an edible oilseed crop that offers similar benefits. Adaptation screening trials are needed to identify the cultivars which are best adapted to growing conditions in this portion of

the state.

MATERIALS AND METHODS

Objective 1

Cultivar Adaptation Trials and Pea Production Trials. Field pea and lentil were evaluated in cultivar comparison trials at the Dickinson. A corn cultivar trial also was conducted. Seed of 25 field pea and 9 lentil cultivars were provided by the Carrington and North Central Research Extension Centers for testing at Dickinson. Corn seed was solicited from private seed companies. Cultural practices including tillage and seeding, fertilization, herbicide application, and harvesting followed currently acceptable agronomic procedure in implementing and maintaining cultivar comparison trials.

Cultivars were evaluated using a randomized complete block design with four replicates. Individual plot dimensions were 28 by 6 ft for all crops except corn. Corn plot dimensions were 50 by 6 ft. Variables measured in each plot varied, depending on the crop being considered.

The suitability of placing 'pop-up' N fertilizer with pea seed at planting was evaluated at Dickinson and Glen Ullin, as were alternative seeding rates for pea at Glen Ullin. Experimental design and plot dimensions were the same as those for the pea cultivar adaptation trials.

Data collected from each trial were analyzed by computer using a statistical software program.

Cereal-Pea Cutting-Date Trial, Cool and Warm-season Forage Trial, Forage Barley and Oat Trial , Alfalfa Establishment and Alfalfa Density Trials.

Dumont oat and Horsford barley were sown alone and mixed with Trapper field pea at different rates to compare forage production among alternative intercropping strategies. Other cool and warm season forages were grown, and forage yield comparisons made, with the cereal-pea mixtures. Each experiment was arranged in a randomized complete block design with four replicates. Individual plot dimensions were 28 by 6 ft. An experiment was also conducted to determine which of four cereal growth stages was optimum for forage yield and quality of cereal-pea

mixtures: late boot, milky kernel, soft dough, or hard dough.

Variables measured in each plot included plant(s) height and forage yield. Forage yield must still be determined.

Under the direction of Dwain Meyer, an alfalfa establishment experiment and an alfalfa density experiment were begun at Dickinson in 1994 and 1996, respectively. Experimental design are described elsewhere in this annual report by Dr. Meyer.

Data were analyzed by computer using a statistical software program.

Objective 2

Crambe, canola, and flax cultivar adaptation trials were established at Dickinson, along with adaptation trials for canola and flax at Glen Ullin. Cultural practices including tillage and seeding, fertilization, herbicide application, and harvesting followed currently acceptable agronomic procedure in implementing and maintaining cultivar comparison trials.

Cultivars were evaluated using a randomized complete block design with four replicates. Individual plot dimensions were 28 by 6 ft at all locations for all crops. Variables measured in each plot varied, depending on the crop being considered.

RESULTS

OBJECTIVE 1

Corn

Average silage yield for corn was 5.7 tons of dry matter per acre among the nine hybrids evaluated in 1996. Silage yield was comparable among 7 of the 9 hybrids evaluated; Pioneer corn hybrids 3963 (79 d) and 3970 (76d) produced less silage than the other hybrids developed by Pioneer and other corn seed developers that were evaluated at Dickinson.

Grain yield averaged 79 bu/acre among the nine corn hybrids evaluated; this was the first year grain had been produced since 1992 at Dickinson. The corn hybrids did not differ ($p < 0.05$) for grain yield. Test weight ranged from 50.6 lbs/bu (Dekalb 442) to 58.9 (Pioneer 3970).

The differences in silage yield were not observed among the hybrids, in part because of soil and other uncontrolled variability. Silage yield for the two hybrids included in the corn trial at Dickinson over the last three years has been around 4 tons/acre.

For the first time in three years, corn produced grain at Dickinson. Grain yield ranged from 43 bushels per acre for Pioneer 3963 to 62 bushels per acre for Pioneer 3905, though significant differences in grain yield among hybrids were not observed. Test weight was light (<56 lbs/bu), with the exception of grain produced by Cargill 1077 (58.6 lbs/bu).

Cool Season Annual Forages

The triticale cultivar '2700' produced more hay (4.2 tons/acre) than other cultivars or intercrop evaluated at Dickinson in 1996. Intercropping triticale or oat with Trapper pea reduced hay production compared to growing the cereal cultivar as a sole-crop. This was expected since the rate at which the cereal was sown was reduced in cereal-pea intercrop compared to cereal sole-crop (Carr and Martin, 1996). Intercropping 'Whitestone' oat with semi-leafless pea cultivar 'Carneval' did not affect hay production compared to intercropping Whitestone with Trapper pea.

Forage Barley and Oat Cultivars

'Bay' (forage-type) oat, 'Chopper' (forage-type) barley, 'Haybet' (forage-type), and Dumont (grain-type) oat produced the most hay among the 10 cereal cultivars and two oat-pea intercrops that were evaluated in 1996. Over the past two years, Haybet barley has produced the most hay among the cultivars and intercrops evaluated. Dumont oat-Trapper pea mixtures produced less hay than Dumont oat sole-crop, even when Dumont oat was seeded at a sole-crop rate in the mixture and Trapper pea was seeded at 1.5x the sole-crop rate. Horsford barley, perhaps the most widely grown forage-type barley grown in western North Dakota, has produced less hay than Haybet barley in both years the two cultivars have been compared for hay production. Paul oat was included in this experiment for the first

time in 1996; hay production by Paul oat was less than for five other cultivars (Bay, Dumont, Chopper, Haybet, and the barley cultivar B 7518) included in the experiment.

Cereal/Pea Cutting Dates

Hay yield generally increased for oat sole-crop, oat-pea intercrop, and oat-lentil intercrop as the cutting date was delayed from early heading to the kernel hard dough stage. This general trend also existed for barley sole-crop and barley-pea intercrop, except when cutting was delayed from kernel soft dough to hard dough stages. In this instance, hay yield was reduced, probably because of leaf senescence of barley and oat plants.

Alfalfa Establishment and Density Evaluations

Establishing alfalfa with an oat nurse crop enabled an oat hay crop (1.8 tons/acre) to be produced in 1996; too little hay was produced when alfalfa was clear seeded in a no-tillage seedbed for any forage to be harvested in 1996. No difference in hay yield was measured between second and third year alfalfa stands between plots where alfalfa had been established with an oat nurse crop, and in plots where alfalfa had been clear seeded in a no-tillage seedbed.

Less than a ton of hay (avg. 0.6 tons/acre) was produced across seeding rates in the alfalfa density trial established at Dickinson in 1996. Increasing the alfalfa seeding rate from 1 lbs PLS/acre to 4 lbs PLS/acre did increase hay yield from 0.7 to 0.8 tons/acre. Increasing the seeding rate from 4 lbs PLS/acre to 16 PLS/acre did not increase hay yield, and yield was reduced as the seeding rate was increased to 32 lbs PLS/acre.

Hay yield was increased as alfalfa plants were arranged in a hexagonal, equidistant pattern and plant stand density was increased from 10 to 30 plants/m². Further increases in plant stand density did not affect hay yield.

Warm Season Annual Forages

German millet and the sorghum x sudan cross 'Sudax ST6E) produced more hay (avg. = 4.7 tons/acre) than the other millet, sudangrass, sorghum x sudan, and forage legume cultivars evaluated. Least amount of hay was produced by foxtail dalea (1.6 tons/acre), a forage legume which may have some potential in western North Dakota as a green fallow cover crop. Overall yield of the 7 cultivars evaluated was 3.6 tons/acre.

Field Pea - Seeding Rate

More peas were established as the pea seeding rate was increased from 300 000 (100 lbs/acre) to 400 000 (130 lbs/acre) PLS/acre at Glen Ullin. However, altering the seeding rate within this range failed to affect pea seed yield. However, pea plots seemed easier to harvest mechanically as more peas were planted.

Field Pea - Cultivar Evaluations

Seed yield of the 25 pea cultivars evaluated at Dickinson averaged 1722 lbs/acre (29 bu/acre) in a field where rye had been plowed down in 1995. At Glen Ullin in a field where hard red spring wheat was grown in 1995, seed yield for the 12 pea cultivars averaged 2823 lbs/acre (47 bu/acre). These data suggest that field pea is adapted to western North Dakota conditions; total annual and growing season precipitation was less than the 30-year average in 1996.

Trapper probably remains the most widely grown pea in western North Dakota. However, the cultivar trials at Dickinson and Glen Ullin suggest that other pea cultivars exist which will produce more seed than Trapper in western North Dakota. For example, seed yield for Trapper is the lowest of the 4 cultivars that have been evaluated at Dickinson over the past three years: 'Profi' (2024 lbs/acre), 'Express' (2008 lbs/acre), 'Century' (1916 lbs/acre), and Trapper (1837 lbs/acre).

Field Pea - N Pop-Up Evaluations

Applying N as urea with pea seed reduced pea plant stand at both the 5 lbs N/acre and 10 lbs N/acre rates at both Dickinson and Glen Ullin. Across both sites, pea plant stand was reduced an average of around 15% for each 5 lbs N/acre increment that was placed with the seed. However, this reduction in pea plant stand failed to affect seed yield, test weight, or seed weight. These data indicate that there is no benefit to applying small amounts of urea with pea seed in western North Dakota under dryland conditions.

Lentil - Cultivar Evaluations

Seed yield of the 9 cultivars evaluated at Dickinson averaged around 950 lbs/acre, while that of the 6 cultivars evaluated at Glen Ullin averaged about 1400 lbs/acre. Seed yield of the cultivars developed in Canada ('CDC Matador', 'CDC Redwing', 'CDC Richlea') were the highest yielding cultivars at Dickinson; yield was comparable among the cultivars evaluated at Glen Ullin except for that of 'Chilean' and 'Laird', which was less.

'Crimson' produced less seed (810 lbs/acre) than several other cultivars evaluated at Dickinson in 1996. In past years, Crimson has generally been among the highest yielding cultivars evaluated. It is unclear why Crimson lentil was a relatively poor yielding cultivar in 1996; this cultivar was developed and released for dry regions at northern latitudes by USDA-ARS scientists located at Pullman, WA.

Objective 2

Canola - Cultivar Evaluations

Canola yield averaged around 900 lbs/acre among the 7 commercial cultivars evaluated at Dickinson in 1996, and almost 1100 lbs/acre among the 4 cultivars evaluated at Glen Ullin. Damage from blister beetles to late maturing cultivars at Dickinson reduced the amount of seed harvested from plots of 'Bullet', 'Ebony', 'Jewel', 'OAC Springfield', and 'Pearl'. This damage also increased seed yield variability within replicates since feeding by the beetles was not uniform across the experiment or across the plots of any cultivar evaluated. As a result, a high coefficient of variation (20.9%) occurred for seed yield when data were analyzed at Dickinson and cultivars could not be ranked by mean comparison methods. At Glen

Ullin, 'Hyola 308' produced more seed than the other three cultivars evaluated ('Crusher', 'Cyclone', and 'Reward').

Crambe - Cultivar Evaluation

Seed yield of the 5 commercial cultivars evaluated at Dickinson in 1996 averaged about 1750 lbs/acre. 'Meyer' crambe produced less seed than any of the other cultivars evaluated. 'Belann' crambe produced the most seed (2126 lbs/acre), although this amount was comparable to that produced by the cultivars 'Indy' (1840) and 'Prophet' (2109 lbs/acre).

Flax - Cultivar Evaluation

Seed yield of the 5 flax cultivars evaluated at Glen Ullin in a field where hard red spring wheat was grown in 1995 averaged around 35 bu/acre. 'Linora' flax produced the most seed (37.6 bu/acre), although comparable amounts were also produced by the cultivars 'Neché', 'Omega' (yellow seeded), and 'Verne'. The data indicate that flax can be productive when grown in selected environments in western North Dakota.

1996 Hybrid Corn - Recrop Dickinson										
Brand	Hybri	RM days	Grain bu/a	Tst Wt lb/bu	Harvest Moisture %	Silage Yield				
						70%	1996	1995	1994	3 year
						Tons/acre				
Dekalb	343	84	79	54.8	57	19.6	5.9	5.5	3.6	5.0
Dekalb	385	85	70	52.4	64	18.3	5.5	6.5	--	--
Dekalb	412	91	71	51.0	61	19.1	5.7	--	--	--
Dekalb	442	94	72	50.6	60	19.4	5.8	--	--	--
Pioneer	3878	90	70	52.2	62	19.7	5.9	--	--	--
Pioneer	3893	89	99	54.0	61	20.4	6.1	--	--	--
Pioneer	3963	79	88	55.6	60	16.7	5.0	5.7	3.7	4.8
Pioneer	3970	76	82	58.9	59	16.8	5.0	--	--	--
Pioneer	3979	76	83	56.6	53	20.8	6.2	--	--	--
Mean			79	54	60	19.0	5.7			
C.V. %			16.2	2.3	7.0	14.7	14.6			

LSD .05			NS	1.8	6.1	4.1	1.2		
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Planting Date: May 29
 Harvest Date: Sept 11 for corn silage; Sept 17 for corn grain
 Previous crop: Oat hay; Soil test results 12 lbs N, 9 ppm P - Applied 250 lbs Urea and 50 lbs DAP per acre Applied 1pt Roundup + 1pt Class Act per acre May 29; Applied .66oz Accent + 1qt Scoil per acre June 12
 Bushel per acre and Test weight are at 12% moisture.

1996 Cool Season Annual Forages - Recrop Dickinson							
Crop	Variety	Harvest Moistur %	Hay Yield				
			12%	DM Basis			
				1996	1995	1994	2 year
			Tons/acre				
barley	Azure	65	3.2	2.8	4.4	--	3.6
triticale	2700	52	4.7	4.2	--	--	--
triticale/pea	2700/Trapper	54	3.9	3.4	--	--	--
triticale	Frank	56	4.0	3.5	3.2	--	3.4
triticale/pea	Frank/Trapper	54	3.5	3.0	2.7	--	2.8
oat	Paul	66	2.6	2.2	--	--	--
oat/pea	Paul/Trapper	67	2.4	2.1	--	--	--
oat	Whitestone	64	3.1	2.7	3.3	--	3.0

oat/pea	Whitestone/Trapper	66	2.9	2.6	2.6	--	2.6
oat/pea	Whitestone/Carneval	65	3.0	2.7	--	--	--
oat/pea	CLOL 1	67	2.8	2.4	--	--	--
oat/pea	CLOL 2	66	2.8	2.4	--	--	--
pea	Arika	67	2.7	2.4	--	--	--
Mean		62	3.2	2.8			
C.V.%		2.6	9.2	9.2			
LSD .05		2.0	0.4	0.4			

Planting Date: May 14; planted at 100 lbs (Azure), 75 lbs (Frank), 130 lbs (Frank[50] + Trapper[80]), 65 lbs (Whitestone), 115 lbs (Whitestone[35] + Trapper[80]), 115 lbs (Whitestone[35] + Carneval[80]), 70 lbs (Paul), 105 lbs (Paul[45] + Trapper[60]), 75 lbs (2700), 130 lbs (2700[50] + Trapper[80]), 100 lbs (Arika), 110 lbs both (CLOL 1 & 2).

Harvest Date: Azure harvested July 11, Frank, Trical/Trapper, Trical 2700, Frank/Trapper, harvested Aug 8, other entries harvested July 24.

Previous crop: Black lentil (plow down); Soil test results 70 lbs N, 12 ppm P - no fertilizer applied.

1996 Forage Barley and Oat - Recrop Dickinson							
Crop	Variety	Harvest Moisture %	Hay Yield				
			12%	DM Basis			
				1996	1995	1994	3 year
			Tons/acre				
oat	Bay	63	3.6	3.2	3.3	--	--

oat	Dumont	64	3.8	3.3	3.2	2.4	3.0
oat	Mammoth	67	3.3	2.9	3.4	--	--
oat	Paul	67	2.9	2.5	--	--	--
oat/pea	Dumont/Trap 5/5 ¹	70	2.7	2.4	2.9	2.2	2.5
oat/pea	Dumont/Trap 10/15 ²	65	3.1	2.8	3.4	2.5	2.9
barley	B 7518	64	3.8	3.3	3.8	--	--
barley	Chopper	56	4.1	3.6	3.4	--	--
barley	Haybet	60	3.7	3.3	4.0	--	--
barley	Horsford	62	3.0	2.7	3.2	4.6	3.5
barley	Stark	64	3.2	2.8	3.7	--	--
barley	Weal	67	2.4	2.2	3.3	--	--
Mean		64	3.3	2.9			
C.V. %		4.6	11.6	11.6			
LSD .05		4.0	0.6	0.5			

Planting Date: May 14

Planted at 800,000 Pure Live Seed (PLS) per acre, except for the oat/pea mixtures which were sown at 750,000 oat plus 487,000 pea PLS per acre⁽²⁾ and 375,000 oat plus 162,500 PLS per acre⁽¹⁾; no herbicide was applied.

Previous crop: Black lentil (plow down); Soil test results: 70 lbs N, 12 ppm P - no fertilizer was applied.

Harvest Date: reps 1 and 4 of Stark and Weal were harvested on July 11; reps 1 and 4 of Horsford,

Chopper, and Haybet were harvested on July 16; all other plots were harvested on July 22.

1996 Cereal/Pea Cutting Date Trial - Recrop Dickinson								
Crop	Variety	Seeding Rate		Harvest Moisture				
		Cereal	Pea	1st cut	2nd	3rd cut	4th cut	5th cut
barley/pe	Horsford/Trapper	1125000	487000	73	66	62	44	63
barley/pe	Horsford/Trapper	750000	325000	75	67	62	45	64
barley/pe	Horsford/Trapper	375000	162500	74	68	65	43	64
barley	Horsford	750000	0	74	65	62	43	65
oat/pea	Dumont/Trapper	1125000	487000	72	69	65	48	--
oat/pea	Dumont/Trapper	750000	325000	72	68	65	49	--
oat/pea	Dumont/Trapper	375000	162500	73	70	68	54	--
oat	Dumont	750000	0	74	68	67	54	--
oat/lentil	Dumont/Indian	750000	350000	71	68	66	49	--
lentil	Indian head	0	350000	73	70	72	66	--
Mean				73	68	65	49	64
CV(%)				3.6	2.6	2.6	8.6	2.6
LSD .05				3.8	2.6	2.4	6.2	2.7

Variety	Seeding Rate		Yield DM Basis tons/acre				
	Cereal	Pea	1st cut	2nd	3rd cut	4th cut	5th cut
Horsford/Trapper	1125000	487000	1.8	2.6	2.9	1.9	0.7
Horsford/Trapper	750000	325000	1.5	2.4	2.8	2.5	0.7
Horsford/Trapper	375000	162500	1.4	2.2	2.5	2.4	0.6
Horsford	750000	0	1.6	2.7	2.9	2.6	0.7
Dumont/Trapper	1125000	487000	2.2	2.6	2.8	2.9	--
Dumont/Trapper	750000	325000	2.1	2.4	2.8	2.6	--
Dumont/Trapper	375000	162500	1.9	2.2	2.3	2.7	--
Dumont	750000	0	2.0	2.4	2.6	2.9	--
Dumont/Indian head	750000	350000	2.0	2.4	2.6	2.9	--
Indian head	0	350000	0.4	0.9	1.2	2.1	--
Mean			1.7	2.3	2.5	2.6	0.7
CV(%)			11.1	7.1	10.9	15.0	12.0
LSD .05			0.3	0.2	0.4	0.6	0.1

Planting date: May 14

Previous crop: Sweet clover; soil test results 47 lbs N, 15 lbs P - no fertilizer applied

Harvest date: all the plots were harvested 4 times; each time at a different growth stage; 1st cut was on July 11 at the early heading stage, 2nd cut was on July 16 at the milk stage, 3rd cut was on July 22 at the soft dough stage, 4th cut was on Aug 8 at the hard dough stage; the 5th cut was a cut of

the regrowth from cut 1 of the barley/pea plots.

1996 Alfalfa Establishment Trial - Recrop Dickinson					
Year	Establishment method	Plant Count		Yield DM Basis	
		Oat	Alfalfa	1st cut	2nd cut
1	Clear seeded into notill	--	--	1.2	--
	With an oat nurse crop	--	--	1.1	--
Mean		--	--	1.1	--
CV(%)		--	--	9.0	--
LSD .05		--	--	NS	--
2	Clear seeded into notill	--	--	1.2	--
	With an oat nurse crop	--	--	1.1	--
Mean		--	--	1.1	--
CV(%)		--	--	21.2	--
LSD .05		--	--	NS	--
3	Clear seeded into notill	--	523 591	--	--
	With an oat nurse crop	610 711	692 604	1.8	--
Mean		--	608 097	--	--
CV(%)		--	51.2	--	--

LSD .05		--	700 886	--	--
<p>Planting date: April 17; 10 lbs PLS/acre of alfalfa with a John Deere 750 drill; Harvest date: June 26 for year 1 & year 2 alfalfa; July 11 for year 3 with nurse crop; Year 1 established 1994, year 2 established 1995, year 3 established 1996.</p> <p>Previous crop: Black lentil (plow down); Soil test results 20 lbs N, 6 ppm P - Applied 100 lbs 0-44-0; Herbicide: Applied 1.25pt Post + 1qt Scoil + 1.5qt Am.Sulfate in 1996 notill plots on June 27; applied 1.5lbs/acre of Kerb 50W on Oct 9 to year 1 and 2 seedings.</p>					

1996 Alfalfa Plant Density Trial- Fallow Dickinson				
Seeds per acre	PPA	Harvest Moisture %	Hay Yield	
			12%	--- DM basis---
			---- Tons/ac----	
4 lbs PLS/ac	60708	68	1.0	0.8
Hand planted @ 2 plants /ft ²	--	70	0.5	0.4
Hand planted @ 3 plants /ft ²	--	70	0.6	0.5
Hand planted @ 1 plant /ft ²	--	70	0.3	0.3
32 lbs PLS/ac	302568	66	0.8	0.7
16 lbs PLS/ac	207917	68	0.9	0.8

Hand planted @ 4 plants /ft ²	--	70	0.6	0.5
0.58 lbs PLS/ac	102661	67	0.9	0.8
1 lbs PLS/ac	15732	70	0.8	0.7
2 lbs PLS/ac	34417	67	0.9	0.8
Mean	120667	69	0.7	0.6
C.V. %	13.0	2.5	13.9	13.9
LSD .05	23608.0	NS	0.1	0.1
Planting Date: May 21; Previous crop: fallow; Harvest Date: Aug 2nd; Hebicide applied: 1pt Poust + 2pt Scoil on June 20; 4oz Pursuit + 2pt Scoil June 20.				

1996 Warm Season Annual Forages Dickinson							
Crop	Variety	Harvest Moisture %	12%	Forage Yield DM Basis			
				1996	1995	1992	3 Year
				Tons/acre			
millet	German	56	5.4	4.8	4.3	4.7	4.6
millet	Siberian	64	4.1	3.6	2.9	4.3	3.6
sudangrass	Piper	52	3.1	2.8	2.9	--	--
foxtail	Dalea	60	1.8	1.6	--	--	--

sorghum x sudan	Sudax ST6E	65	5.2	4.6	--	--	--
sorghum x sudan	Greentreat 3	60	4.5	4.0	--	--	--
millet	Millex 32	62	4.0	3.5	--	--	--
Mean		60	4.0	3.6			
C.V. %		3.0	12.6	12.6			
LSD .05		2.6	0.8	0.7			

Planting Date: May 28
Harvest Date: Aug 29
Previous crop: Black lentil (plow down); Soil test results 70 lbs N, 12 ppm P - no fertilizer applied.
Planted at 20 lbs (millets) and 25 lbs (Sudangrass and Sorghum x Sudan cross); no herbicide applied.

Field Pea Seeding Rate - Recrop Glen Ullin					
Variety	Seeding Rate	Plant Stand	Seeds lbs	Test Weight lbs/bu	Grain Yield lbs/ac
Trapper	300000	186779	3154	63.8	2903.1
Trapper	350000	181554	3082	63.1	3011.4
Trapper	400000	227270	3074	63.6	2925.8
Mean		198643	3103	63.5	2946.8
C.V. %		11.1	2.2	0.4	2.5

LSD .05		37981	NS	0.5	NS
Planting Date: May 28; Harvest Date: August 21; Previous crop: Spring wheat; Applied 130lbs Urea and 25lbs DAP per acre; Applied 1.5pt Poast+2pt COC per acre on June 17.					

Field Pea - Green Fallow Dickinson							
Variety	Type	Flower Duration	Days to Flowe	Days to Maturity	Plant Height in	Lodging Score 0-9	Seeds lbs
ARVIKA	FG	7	51	79	15.3	7.8	2698
ASTINA	G	13	44	75	17.1	0.8	1860
AUSTRIAN WINTER	G	11	51	--	12.5	7.8	3795
CARNEVAL	Y	10	47	78	20.0	1.3	1844
CENTURY	Y	9	49	79	14.6	7.0	1984
COLUMBIAN	G	19	35	70	10.2	8.0	2379
DELTA	Y	11	46	77	16.3	1.0	1941
ESPACE	G	11	46	77	19.2	0.0	1884
EXPRESS	Y	10	48	78	13.7	5.3	1752
GRANDE	Y	9	49	78	20.1	2.0	1668
HM2648	Y	13	44	76	16.3	2.8	1549
MAGDA	FG	8	49	79	13.7	7.3	2576

MAJORET	G	10	46	79	20.5	0.5	1786
MIKO	Y	10	46	78	19.1	1.8	1725
PROFI	Y	12	46	76	18.4	2.3	1841
PROMAR	MF	15	41	79	16.2	1.0	1443
RADLEY	G	11	46	77	11.3	6.0	2468
RICHMOND	Y	12	45	76	10.1	7.0	2098
SIRIUS	FD	9	47	74	13.2	7.5	1704
SWING	Y	13	44	75	19.5	1.5	1991
TENOR	FD	13	44	76	16.7	4.8	1763
TRAPPER	Y	11	50	79	13.3	7.8	3358
VOYAGEUR	Y	11	47	78	17.1	0.5	2334
WHERO	M	7	52	80	8.2	9.0	1864
YORKTON	Y	10	48	79	17.2	1.3	1900
Mean		8	46	77	15.6	4.1	2088
C.V. %		11	2	2	13.6	22.9	6
LSD .05		1	1	2	3.0	1.3	168

Planting Date: May 13

Harvest Date: August 19 (except for Arvika, Trapper, Century, Austrian Winter, Whero, which were harvested on August 5)

Type: FG=Forage, MF=Marrowfat, FD=Feed, M=Maple, G=Green, Y=Yellow

Field Pea - Green Fallow Dickinson						
Variety	Test Weight lbs/bu	Yield			Average Yield	
		1994	1995	1996	2 Year	3 Year
		----- lbs/ac -----				
ARVIKA	61.4	--	--	1811.6	--	--
ASTINA	62.9	--	--	1792.4	--	--
AUSTRIAN WINTER	63.9	--	--	1559.1	--	--
CARNEVAL	63.0	--	2816.8	1723.4	2270.1	--
CENTURY	62.6	1678.1	2719.4	1349.8	2034.6	1915.8
COLUMBIAN	61.8	--	1273.5	1156.2	1214.9	--
DELTA	64.1	--	--	1914.9	--	--
ESPACE	63.3	--	--	2117.8	--	--
EXPRESS	62.8	1611.1	2586.4	1827.9	2207.2	2008.5
GRANDE	63.3	--	--	2381.2	--	--
HM2648	62.4	--	--	1658.6	--	--
MAGDA	61.0	--	--	1853.6	--	--
MAJORET	63.6	--	2619.7	1745.2	2182.4	--

MIKO	63.0	--	2489.1	1951.5	2220.3	--
PROFI	62.1	1699.0	2646.8	1726.9	2186.8	2024.2
PROMAR	61.9	--	--	1434.6	--	--
RADLEY	62.5	--	1607.6	1415.1	1511.3	--
RICHMOND	61.9	--	--	1498.1	--	--
SIRIUS	61.8	--	--	1726.7	--	--
SWING	64.0	--	--	1923.9	--	--
TENOR	64.3	--	--	1875.0	--	--
TRAPPER	63.1	1429.8	2214.8	1866.8	2040.8	1837.1
VOYAGEUR	63.6	--	--	1737.2	--	--
WHEREO	62.0	--	--	1293.8	--	--
YORKTON	63.0	--	--	1715.7	--	--
					-	
Mean	62.8			1722.3		
C.V. %	1.6			17.1		
LSD .05	1.4			NS		

Previous crop: Rye (plow down); Soil test results 29 lbs N and 19 ppm P - No fertilizer applied;
Applied 2.5 pt Sonolan per acre on April 23; Applied 2 oz Pursuit + 2 pt Scoil per acre on June 10.

Field Pea - Recrop Glen Ullin

Variety	Cotyledon Color	Seeds lbs	Test Weight lbs/b	Grain Yield lbs/ac
Arika	Green	2421	61.5	2828.5
Carneval	Yellow	2042	63.9	2815.5
Century	Yellow	1876	63.4	2762.6
Columbian	Green	2143	63.6	1850.5
Express	Yellow	1918	62.9	3072.6
Grande	Yellow	1726	64.6	3551.9
Magda	Green	2600	62.8	2809.2
Majoret	Green	1801	64.3	2595.5
Profi	Yellow	1931	63.6	2886.7
Radley	Green	2322	63.3	2878.3
Sirius	Green	1914	62.9	3168.4
Trapper	Yellow	3189	63.5	2655.9
Mean		2157	63.3	2823.0
C.V. %		14.0	1.3	9.5
LSD .05		435	1.2	385.1

Planting Date: May 28

Harvest Date: August 21

Previous crop: Spring wheat; Applied 130lbs Urea and 25lbs DAP per acre; Applied 1.5pt Poast+2pt COC per acre on June 17.

Field Pea Pop-up Fertilizer Trial - Recrop Glen Ullin

Variety	N Fertilizer Rate lbs/ac	Plant Stand	Seeds lbs	Test Weight lbs/bu	GrainYield lbs/ac
Trapper	0	190698	3167	63.1	2786.9
Trapper	10	146289	3183	62.8	2665.4
Trapper	5	156738	3135	63.1	2751.4
Mean		164357	3162	63.0	2734.6
C.V. %		14.0	6.3	1.2	8.8
LSD .05		39872	NS	NS	NS

Planting Date: May 28
 Harvest Date: August 21
 Previous crop: Spring wheat; Applied 130lbs Urea and 25lbs DAP per acre; Applied 1.5pt Poast+2pt COC per acre on June 17.

Field Pea Pop-up Fertilizer Trial - Recrop Dickinson

Variety	N Fertilizer Rate lbs/ac	Plant Stand	Seeds lbs	Test Weight lbs/bu	Grain Yield lbs/ac
Trapper	0	288985	2887	61.1	1664.2
Trapper	10	195922	2920	60.5	1578.9
Trapper	5	253066	2680	61.5	1610.7
Mean		245991	2829	61.0	1617.9
C.V. %		9.8	11.7	1.1	7.9
LSD .05		41900	NS	NS	NS
Planting Date: May 13; Previous crop: Rye (plow down); Soil test results 29lbs N and 19ppm P - No fertilizer applied; Applied 2.5pt Sonolan per acre on April 23; Applied 2oz Pursuit+2pt Scoil per acre on June 10.					

Lentils - Green Fallow Dickinson							
Variety	Type	Flower Duration	Days to Flower	Days to Maturity	Plant Height in	Lodging Score 0-9	Seeds lbs
Brewer	C	14	43	76	9.7	5.0	6900
CDC Matador	SB	12	48	80	10.5	4.0	14568
CDC	R	14	46	78	11.1	2.3	10993

Redwing							
CDC Richlea	C	13	46	80	10.8	4.3	8207
Crimson	R	13	48	77	6.9	7.8	11794
Eston	P	12	45	78	10.3	2.5	12318
Laird	C	14	51	85	14.1	1.8	6655
Pardina	SB	12	44	76	8.3	6.0	10036
Red Chief	R	13	44	77	9.4	4.5	7620
Mean		13	46	78	10.1	4.2	9899
C.V. %		10	2	2	8.8	17.1	4
LSD .05		2	1	2	1.3	1.1	572

Variety	Test Weight lbs/bu	Yield			Average Yield	
		1994	1995	1996	2 year	3 year
		lbs/ac				
Brewer	57.0	652.0	1448.0	815.0	1131.5	971.7
CDC Matador	59.9	--	--	1132.4	--	--
CDC Redwing	59.9	--	--	1128.7	--	--

CDC Richlea	57.3	846.0	2108.2	1285.1	1696.7	1413.1
Crimson	60.6	1106.0	2009.2	810.3	1409.8	1308.5
Eston	60.3	701.0	1826.6	1024.7	1425.7	1184.1
Laird	56.6	545.0	1693.2	945.4	1319.3	1061.2
Pardina	60.1	--	--	652.0	--	--
Red Chief	56.8	--	--	740.4	--	--
Mean	58.7	--	--	948.2	--	--
C.V. %	2.5	--	--	14.8	--	--
LSD .05	2.1	--	--	205.0	--	--
<p>Planting Date: May 13; Harvest Date: August 8 (Brewer, CDC Matador, CDC Redwing, Crimson, Eston, Pardina, Red Chief) August 19 (Laird); Type: C=Chilean, R=Red, P=Persian, SB=Spanish Brown; Previous crop: Rye (plow down); Soil test results 29 lbs N and 19 ppm P - No fertilizer applied; Applied 2.5 pt Sonolan per acre on April 23.</p>						

Lentil - Recrop Glen Ullin			
Variety	Seeds lbs	Test Weight lbs/bu	Grain Yield lbs/ac
Brewer	7204	58.9	1466.6
Chilean	8972	54.6	1274.6
Eston	13579	62.1	1514.0

Laird	7279	55.6	1072.0
Red Chief	8031	57.1	1450.8
Rose	10049	59.8	1617.7
Mean	9185	58.0	1399.3
C.V. %	3.1	2.6	10.6
LSD .05	432	2.2	224.1
Planting Date: May 28 Harvest Date: August 21 (Brewer, Chilean, Eston, Red Chief, Rose); August 27 (Laird) previous crop: Durum; Applied 130lbs Urea and 25lbs DAP per acre; Applied 1.5pt Poast+2pt COC per acre on June 17.			

Canola - Green Fallow Dickinson									
Variety	Days to Flower	Flower Period	Days to Harvest	Plant Height in	Lodging Score 0-9	Seeds Lb	Oil %	Test Weight lbs/bu	Grain Yield lbs/ac
BULLET	48	17	92	25.0	1.0	125889	43.1	47.1	627.0
EBONY	54	12	---	26.6	0.0	117466	45.0	42.6	891.5
JEWEL	50	14	93	24.5	0.0	124650	44.3	46.1	1006.2
OAC	49	14	93	23.8	0.0	100370	43.8	47.0	762.2
PEARL	53	14	94	26.1	0.0	132286	42.7	46.1	776.5

REWARD	42	20	83	23.2	1.5	213715	41.9	49.4	709.2
TOBIN	41	21	82	24.1	1.8	210884	40.8	51.1	797.3
Mean	50	15	91	26	0	132661		46.2	895.7
C.V. %	2	7	1	6	233	13		2.4	20.9
LSD .05	1	1	NS	2.2	0.9	23785		1.6	NS

Planting Date: May 1

Harvest Date: July 26 (Reward and Tobin); August 6 (BC 94-123, Bullet, Jewel, LG 3260, LG 3300, LG 3310, LG 3369, OAC Springfield, Pearl, PSL 121); August 7 (PSL 124); August 8 (Ebony); August 9 (PSL 9603).

Lodging: 0=Upright, 9=Completely flat

Previous crop: Sweet clover (plow down); Soil test results: 54 lbs N, 18 ppm P - Applied 210 lbs Urea per acre; Applied 1 pt Treflan per acre on April 26; Applied 2 oz Malathion per acre on July 13 (Blister beetle control).

Canola - Recrop Glen Ullin				
Variety	Seeds lbs	Oil %	Test Weight lbs/bu	Grain Yield lbs/ac
Crusher	137882	41.2	50.4	738.6
Cyclone	140244	41.9	50.1	833.3
Hyola 308	135554	42.7	50.1	1625.4
Reward	149803	43.4	51.0	1088.8

Mean	140871	--	50.4	1071.5
C.V. %	7.4	--	1.0	8.1
LSD .05	NS	--	0.8	139.3

Planting Date: May 28

Harvest Date: August 21 (Cyclone and Reward), August 27 (Hyola 308 and Crusher)

Previous crop: Oats; Applied 130lbs Urea and 25lbs DAP per acre; Applied 1.5pt Poast+2pt COC per acre on June 17.

Crambe - Green Fallow Dickinson

Variety	Days to Flower	Flower Duration	Days to Maturity	Plant Height in	Lodging Score 0-9	Seeds Lb	Oil %	Test Weight lbs/bu	Grain Yield lbs/ac
Belann	55	13	87	28	3	75592	34.1	29.1	2126.5
Belenzian	54	14	87	28	4	62539	34.3	28.9	1807.0
Indy	54	13	86	28	2	68880	34.2	29.0	1839.8
Meyer	54	12	85	27	1	70927	35.2	29.9	1482.8
Prophet	54	15	87	28	3	55363	35.4	27.1	2109.0
Mean	52	14	86	28	2	69767	34.9	29.3	1751.4
C.V. %	2	9	1	4	49	10	2.4	2.9	11.8

LSD .05	2	2	1	1	2	9755	1.2	1.2	295.6
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Planting Date: May 1 (No-Till)
 Harvest Date: July 31
 Lodging: 0=Upright, 9=Completely flat
 Previous crop: Black lentil (burn down); Soil test results: 31 lbs N, 12 ppm P - Applied 250 lbs Urea and 25 lbs DAP per acre; Applied .75pt Roundup+1pt Class Act+.25pt 2,4-D ester per acre on April 23.

Flax - Recrop Glen Ullin			
Variety	Seeds lbs	Test Weight lbs/bu	Grain Yield bu/ac
Linora	80031	53.4	37.6
Nече	80337	52.9	35.9
Omega	78685	53.6	35.4
Prompt	81944	54.1	31.8
Verne	85326	54.1	33.6
Mean	81265	53.6	34.9
C.V. %	4.4	1.6	9.5
LSD .05	5555	1.3	5.1
Planting Date: May 28; Harvest Date: August 27; Previous crop: Oats; Applied 130lbs Urea and 25lbs DAP per acre; Applied 1.5pt Poast+2pt COC per acre on June 17.			

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