PROJECT TITLE: Evaluation of Seed and Fertilizer Opener Configurations for Optimizing Seed and Fertilizer Placement in Simultaneous, Single-Pass Operations with Air Drills under Differing Cropping Systems.

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OBJECTIVES:

It is the objective of this project to evaluate air drill openers and systems for the production of cereal grains under varying cropping conditions and systems in northern Montana.

RESULTS:

The results of new investigations featuring four seed and fertilizer placement configurations under dryland chemical fallow conditions with `Choteau' spring wheat direct seeded into spring wheat stubble at Havre in 2005 are presented in Table 1. These limited, first-season results represent the beginning of a new and expanded series of seed and fertilizer placement investigations made possible through manufacturer loan and dealer support of additional state-of-the-art air drill equipment being made available to the research center. These preliminary results are tempered by the fact that planting date was later than optimal due to procedures associated with our becoming familiar with new equipment and getting it appropriately integrated with existing tractor equipment so far as proper installation of computer controllers, etc. was concerned. With exception of Seed Band Width there were no statistically significant differences among treatments for the response variables measured. The separate evaluation of various "double-shoot" air drill opener configurations conducted by the research center since 1997 was continued in 2005, but an intermittent mechanical equipment malfunction associated with precise metering of seed and fertilizer materials resulted in non-uniform seed and fertilizer delivery volumes within treatments. Although reasonable stands and yields were still achieved, non-treatment-related variability rendered these data unusable for any meaningful addition to long-term performance databases. Thus, the performance data for twelve opener configurations evaluated in 2005 are not presented. However, yield performance data for all pre-2005 air drill opener trials conducted by NARC-Agronomy since the investigations began in 1997 is presented in Table 2. A "7-Year, Comparable Average" summary for all openers evaluated in at least three of the seven years (1998-2004) with spring wheat on mechanical or chemical fallow at Havre is presented in Table 3. An opener and post-harvest photo gallery for spring wheat plots established with openers evaluated in 2004 was presented in the 2004 version of this report to MWBC and is available there for reference.

SUMMARY:

Producers contemplating purchase of an air drill logically base their decisions on a number of variables to include manufacturer, dealer support, features, availability, price, etc. Prior to the past several years, limited attention was given to the type and style of interchangeable openers supplied with a new or used air drill. In some situations, dealers want to encourage a prospective buyer to consider a particular type of opener thought to be most appropriate for the grower's own conditions and needs, but are reluctant to do so if less sophisticated and less costly openers being selected on a competitor's machine would result in loss of a sale. Due to the cost associated with outfitting a machine of average width with openers, producers prefer to limit their on-farm inventory to one or perhaps two differing scenarios to cover nearly all planting needs. Openers range widely in cost, but it is not uncommon for producers to spend an average of $100 per shank which amounts to $4000-$5000 for a typical air drill. Thus, few producers can

afford to make very many selection mistakes in a "trial and error" approach before finding the opener most appropriate for them. Approximately 70% of the dryland wheat and barley in major producing areas of Montana is sown with air drills. Thus, producers are keenly interested in unbiased evaluation of air drill opener options.

Our involvement with air drill opener investigations began in 1997 when Northern Agricultural Research Center hosted the third Montana "Fields of Tomorrow" show sponsored by Monsanto Company and KMON Country Radio with trade show support of numerous other vendors of agricultural supplies, equipment and technology. Part of NARC's contract for hosting the show included on-site evaluation of air drill openers. The use of a research-scale 'Concord' air drill was provided to Northern Agricultural Research Center by the manufacturer in cooperation with area dealer, Northern Ag Services of Malta. At the same time, a research-scale 'Conserva-Pak' air drill was purchased by MSU for use in conducting a series of large-scale cropping systems projects in Montana funded by USDA's Special Grant Program. Initially the MSU unit was available for inclusion in the opener evaluation studies at Havre and Moccasin. Heavy use schedules within the projects for which it was purchased have limited the use of the Conserva-Pak in recent seed and fertilizer placement investigations. Carlson has conducted air drill opener investigations each year since 1997 with the Concord machine. Manufacturers and/or dealers provide all opener hardware at no cost to the Research Center.

Square-wall, 6-inch wide 'Titan' packer tires were utilized with all openers in 2001-2004 trials with the Concord machine. Standard 165x15R radial packer tires were utilized with all openers in previous Concord trials. The wider Titan packer tires afford more appropriate packing with opener scenarios featuring wider seed bands, but may be less appropriate than narrower packer tires for packing narrow seed band scenarios. Interchanging packer wheels/tires for different openers within a single trial is not feasible in view of the time and effort required.

The Concord unit is also integral to other research investigations conducted by Stougaard and Carlson involving the use of widened seed bands and increased rates of seeding for reduction of wild oat competition in the production of spring wheat. Carlson, Lamb, Stougaard and Whitmus are further involved in developing other crop and crop pest management strategies utilizing Variable Rate Technology (VRT) equipment added to the Concord with funds provided in part by the Montana Wheat and Barley Committee, Northern Agricultural Research Center and Northern Ag Services. Boss, Carlson and Lamb utilized these technologies in yet a fourth collaborative effort where they investigated the effects of barley class, variable seed band widths, variable seeding rates, and variable harvest end points on both forage and grain end use parameters.

The Bourgault equipment consisting of the center section of a commercial-scale Bourgault 5710 Air Hoe Drill equipped with Series 25 Mid Row Banders and a three-compartment Bourgault 5350 leading air cart was delivered to the research center on loan for research purposes by Bourgault Industries Ltd at Minot, ND with local dealer support provided by Tilleman Motor Company of Havre.

FUTURE PLANS:

The Research Center plans to continue work with traditional opener evaluations using the Concord unit in response to continued interest expressed by Montana producers. New opener configurations have been incorporated into the trials during each of the past four years, and after-market mid-row fertilizer banding capability was added in 2001 for investigations with this unit. The Concord drill lends itself to easier head-to-head comparison of numerous sets of primarily "double-shoot" openers since changeovers involve only ten shanks and replicated plots can be established within a relatively small research area.

The new three-product compartment Bourgault equipment will afford opportunity to expand evaluations relative to nutrient delivery and placement. Primary initial emphasis will be placed on replicated comparison of low disturbance seed placement and fertilizer placement via mid banding versus seed and fertilizer placement with leading "double-shoot" opener systems. And, given the steep increases in cost of fertilizer materials, effort will be made to address comparison of low disturbance seed and fertilizer placement systems versus single-shoot seeding coupled with broadcast fertilization.

Stougaard and Carlson completed the third of three years of field research in 2001 evaluating the effects of seeding rate and placement patterns on spring wheat's ability to compete with wild oats. It was difficult to secure extramural funding support for the pilot studies in this effort. With positive results from the pilot studies in hand, the next phase will

logically involve replicated, commercial field-scale application of the technology in the presence of ‘already-established’ wild oat populations. It will not be possible to carry out the next phase of this research without an appropriate level of extramural funding from some yet unsecured source. The general expense and time investment required cannot be absorbed by existing resources. The researchers will continue to pursue potential sources of funding.

Carlson, Lamb and Whitmus will continue other existing investigations underway with VRT-equipped air drills in site-specific placement of nitrogen for optimized yield and protein relationships in wheat.

Boss, Carlson and Lamb completed the third of three years of field research in 2003 on, “Increasing Yield and Management Options for Producers who Traditionally Plant Barley for Forage or Grain Production.” The second and third years of this work were supported by a grant with the Montana Board of Research and Commercialization Technology.

Thus, although originally put to work at Havre solely for the purpose of evaluating opener configurations, air drills are currently serving multiple research endeavors out of the Havre station.

Arrangements are currently pending for acquisition of an auxiliary set of exchangeable packer gangs for the Bourgault unit to provide 5-1/2” `Titan’ rubber packers for use with more appropriate evaluation of “wide seed band” opener configurations.

TABLE 1. Comparison of Differing Seed and Fertilizer Placement Configurations with a `Bourgault' Air Drill System Under No-Till Dryland Fallow Conditions in a Wheat Stem Sawfly Environment with Late-Seeded `Choteau' Solid-Stemmed Spring Wheat. Northern Agricultural Research Center. Havre, Montana. 2005. (Exp# 05-SP14-OP)

ID	1/ ENTRY DESCRIPTION	STAND %	2/ ROW STYLE	3/ SEED BAND Inches	PLANTS /FT2 No.	4/ CULMS /FT2 No.	CULMS /PLANT No.	5/ HEAD DATE Julian	PLANT HEIGHT Inches	6/ GRAIN YIELD Bu/Ac	GRAIN MOIST. %	TEST WEIGHT Lbs/Bu	KERNEL WEIGHT g/1000	7/ GRAIN PROTEIN %	8/ SAWFLY RATING %
03	Bourgault Exp Dbl-Shoot Opnr Config #1	100.0	1.0	4.3	14.0	24.4	1.7	188.8	23.2	23.9	7.2	54.4	15.5	17.8	5.0
04	Bourgault Exp Dbl-Shoot Opnr Config #2	100.0	1.0	4.2	16.0	23.2	1.5	188.3	23.6	23.3	7.1	53.6	14.6	18.0	5.0
01	Bourgault Sgl-Sht Opnr w/MRB Config #1	100.0	1.0	2.4	15.3	29.7	1.9	189.0	21.9	23.0	7.2	54.3	15.2	17.6	5.0
02	Bourgault Sgl-Sht Opnr w/MRB Config #2	100.0	1.0	2.7	15.5	27.2	1.8	188.5	22.1	22.7	7.2	53.6	14.9	18.0	5.0
EXPERIMENTAL MEANS		100.0	1.0	3.4	15.2	26.1	1.7	188.6	22.7	23.2	7.2	54.0	15.1	17.8	5.0
LSD (0.05)		0.0	0.0	0.8	2.4	8.4	0.6	0.7	3.5	2.6	0.1	0.8	0.7	0.3	0.0
C.V. 2: (S OF MEAN/MEAN)*100		0.0	0.0	7.3	4.8	10.0	10.2	0.1	4.8	3.5	0.6	0.5	1.5	0.6	0.0

1/ Treatment Description Detail: ("Overall" Applied Fertilizer Nutrient was Constant at 70#N, 40#P_2O_5, and 0#K_2O per Acre via Granular 46-0-0 and 11-52-0 Fertilizer Products)
Base Equipment = Bourgault 5710 Air Hoe Drill with 9.8" Row Spacing, 3-1/2" Steel Packers, Series 25 Mid Row Banders and Bourgault 5350 Leading 3-Compartment Air Cart.

ID 01 = Bourgault Industries Ltd Series 25 Mid Row Banders & BTT 200-4010 Single-Shoot (SS) Seed Opnr+200-0801 Tip w/Entire 70-40-0 Delivered via the Mid Row Banders
ID 02 = Bourgault Industries Ltd Series 25 Mid Row Banders & BTT 200-4010 Single-Shoot (SS) Seed Opnr+200-0801 Tip w/8.5-40-0 Deliv'd w/Seed + 61.5-0-0 Deliv'd via MRBs
ID 03 = Bourgault Tillage Tools Prototype Dbl-Shoot (DS), Paired Seed Row Opener System w/Entire 70-40-0 Delivered to Fertilizer Band Between & Below Seed Band
ID 04 = Bourgault Tillage Tools Prototype Dbl-Shoot (DS), Paired Seed Row Opener System w/8.5-40-0 Starter Delivered w/Seed + 61.5-0-0 Delivered to Separate Fertilizer Band

2/ Row Style/Appearance: 1=solid band, 2= paired/joined bands, 3=paired/separate bands.
3/ Average `splayed' stubble width 4" above soil surface at harvest maturity.
4/ Average no. of fertile culms (stems w/filled heads) per ft^2 (14.7" linear row w/9.8" row spacing).
5/ No. of Days from January 1 (189 = July 8).
6/ Volumetric yields are based on 60 lbs/bu as the standard test weight for wheat.
7/ Protein values are adjusted to 12 percent grain moisture.
8/ Percent stem cutting.

Site Resource & Management Data: (Exp# 05-SP14-OP)									
Field	B-5-2		Init K (ppm) 0-6"	220		Init PAW (in.) 24-36"	0.92		Herbicide App. Date	6/21
Quarter	NW		Init S (ppm) 0-24"	17		Init PAW (in.) 36-48"	1.42		Herbicide Product	Bronate Adv.
Section	32		Init Na (MEQ/100g) 0-6"	0.06		Init PAW (in.) 0-48"	3.77		Herbicide Rate (/ac)	18 oz
Township	32N		SaltHaz (MMHOS/cm) 0-6"	0.35		Cropping System	NT-ChmFlw		Precip (in.) Apr1-Planting	0.79
Range	15E		SaltHaz(MMHOS/cm)6-24"	0.32		Previous Crop	Spr Wheat		Precip (>.1) Apr1-Planting	0.50
Latitude	N48 29.631'		Soil Texture 0-6"	CL		Planting Date	5/16		Precip (in.) Plnt'g-Harvest	6.75
Longitude	W109 48.173'		Soil Texture 6-24"	CL		Planting Depth (in.)	1.5		Precip (>.1) Plnt'g-Harvest	6.39
Soil Series	Telstad CLm		Soil Texture 24-36"	CL+		Moist Soil Depth @Plnt'g	48+		Harvest Maturity Date	8/8
pH 0-6"	8.1		Soil Texture 36-48"	CL+		Dry Surf Soil (in.) @Plnt'g	1.25		Harvest Date	8/22
Org.Matter (%) 0-6"	1.6		Init Zn (ppm) 0-6"	0.3		2" Soil Temp (^{o}F) @ Plnt'g	69		Rooting Depth (in.)	36"
Init N (lbs/ac) 0-6"	16		Init Mn (ppm) 0-6"	9.9		4" Soil Temp (^{o}F) @ Plnt'g	67		Post PAW (in.) 0-6"	0.14
Init N (lbs/ac) 6-24"	54		Init Cu (ppm) 0-6"	1.1		Fertilizer Formulation	Gran.Blend		Post PAW (in.) 6-24"	1.30
Init N (lbs/ac) 24-36"	84		Init Fe (ppm) 0-6"	5		Fertilizer Placement	Bnd at Plntg		Post PAW (in.) 24-36"	0.92
Init N (lbs/ac) 36-48"	80		CEC 0-6"	21.8		Fert. Rate (lbs/ac) N	70		Post PAW (in.) 36-48"	1.42
Init N (lbs/ac) 0-48"	234		Init PAW (in.) 0-6"	0.14		Fert. Rate (lbs/ac) P2O5	40		Post PAW (in.) 0-48"	3.77
Init P (ppm) Olsen 0-6"	12		Init PAW (in.) 6-24"	1.30		Fert. Rate (lbs/ac) K2O	0		Precip (>.1) Hvst-Post	0.71

Table 2. [1]YIELD MEAN SUMMARY (Bu/Ac) FOR AIR DRILL OPENER INVESTIGATIONS CONDUCTED BY NORTHERN AGRICULTURAL RESEARCH CENTER - AGRONOMY (1997-2004)

(See Reports for Individual Investigations for Additional Performance Parameters, Site & Climatic Specifics, and Project Management Details)

	[2]NO-TILL RECROP SW-1997 (>BLY) HAVRE	CHM+TILL FALLOW WW-1998 (>BLY) HAVRE	CHM+TILL FALLOW SW-1998 (>BLY) HAVRE	[2]NO-TILL FALLOW WW-1998 (>WW) MOCC	[2]NO-TILL RECROP WW-1998 (>SW) MOCC	[2]NO-TILL RECROP WW-1998 [3](>BLY) MOCC	NO-TILL FALLOW SW-1999 (>BLY) HAVRE	NO-TILL FALLOW SW-2000 (>WW) HAVRE	NO-TILL FALLOW SW-2001 (>SW) HAVRE	NO-TILL FALLOW SW-2002 (>WW) HAVRE	NO-TILL FALLOW SW-2003 (>BLY) HAVRE	NO-TILL FALLOW SW-2004 (>WW) HAVRE
ANDERSON (Case-Concord) Triple Shooter		39.3	27.4	69.5	37.6	47.6	35.9	26.7	26.6	38.1		
ATOM JET (HarvesTechnologies) Side Band								27.9	31.1	37.9	19.4	33.6
ATOM JET (HarvesTechnologies) 4" Paired Row										36.5	18.3	34.0
ATOM JET CB-15 w/TECHNOTILL Precision Packer												32.8
CONCORD LD w/Case-McKay 6" LD Sweep & K3 Knife		38.1		75.8	44.6	66.3						
CONCORD LD w/Case-McKay 11" LD Sweep & K3 Knife		35.3		69.6	40.9	63.7						
CONSERVA PAK System	22.4	36.7	27.2	73.5	43.9	80.0						
DUTCH SUPER EAGLE w/3.5" Paired Row Attachment							38.9	30.8	30.6	40.1	17.7	32.6
DUTCH SUPER EAGLE w/5.5" Paired Row Attachment							37.8	28.2	28.8	38.4	17.8	34.3
DUTCH 3.5" Paired Row w/SUPER EAGLE Tip											16.7	35.0
DUTCH S.E. w/FARMLAND Mid Row Fertilizer Banding Disk									27.2	36.8	16.0	34.5
FARMLAND LD w/Case-McKay 6" LD Sweep & K3 Knife			28.2				38.7	25.6	28.5	38.1	17.3	35.0
FARMLAND LD w/Case-McKay 11" LD Sweep & K3 Knife			25.9				38.6	23.6	26.4	40.4	16.7	33.4
FARMLAND SB1-SBS1 w/3" Knock-On Spoon & K3 Knife		35.4	21.2	70.6	37.1	46.6						
FARMLAND SB1-SBS1 w/4" Chrome Sweep & K3 Knife	19.5			75.1	47.6	64.2						
FARMLAND SB1-SBS1 w/4" Knock-On Sweep & K3 Knife		40.0	25.6	74.5	47.1	62.8	35.4	26.6	27.4			
FARMLAND SB1-SBS1 w/6" Knock-On Sweep & K3 Knife	23.9	41.0	24.0	70.3	48.1	58.9	35.7	28.1	27.4	38.8	17.2	32.2
FARMLAND SB1-SBS1 w/10" Knock-On Sweep & K3 Knife			23.5				35.2					
FLEXICOIL STEALTH w/Single Side Band Attachment	23.5	42.2	25.3	65.9	39.7	48.1	30.7					
FLEXICOIL STEALTH w/Paired Row Attachment	23.4	31.2	25.7	68.6	36.5	46.2	27.8	27.9	27.5	40.4	17.4	34.5
GEN T2	23.4											
GEN T2x2		41.1	26.3	71.9	45.7	58.5	37.0	27.1	28.1	38.9	16.5	33.1
MORRIS Gumbo Boot								24.3	27.8		18.3	
SWEDE	22.5	36.8		63.8	42.0	60.9		26.3				
SITE MEANS	22.4	37.9	25.5	71.0	42.4	58.6	35.6	26.9	28.1	38.6	17.4	33.8
LSD (.05)	2.8	5.3	3.7	7.9	7.7		4.4	2.9	4.9	5.6	2.1	2.8

[1]G.R. Carlson, Northern Agricultural Research Center, Havre - Moccasin trials conducted in cooperation with D.M. Wichman, Central Agricultural Research Center, Moccasin. All openers are "double-shoot" configurations with seeding rate at 60#/ac and fertilizer at 70#N, 40#P_2O_5, and 25#K_2O via blended granular fertilizer at 251#/ac.

[2]Trials conducted in conjunction with "Fields of Tomorrow" shows in 1997 and 1998.

[3]This trial had heavy volunteer barley pressure. Certain opener systems affording minimal surface soil disturbance produced higher wheat yields due to less competition with volunteer barley.

Table 3. Seven-Year Yield Summary on Selected Entries from Dryland Fallow Evaluation of Double-Shoot Air Drill Openers with Spring Wheat. Northern Agricultural Research Center. Havre, Montana. 1998-2004.

(See Reports for Individual Investigations for Additional Performance Parameters, Site & Climatic Specifics, and Project Management Details)

	No. of YEARS TESTED	CHEM+TILL FALLOW SW-1998 (>BLY) HAVRE	NO-TILL FALLOW SW-1999 (>BLY) HAVRE	NO-TILL FALLOW SW-2000 (>WW) HAVRE	NO-TILL FALLOW SW-2001 (>SW) HAVRE	NO-TILL FALLOW SW-2002 (>WW) HAVRE	NO-TILL FALLOW SW-2003 (>BLY) HAVRE	NO-TILL FALLOW SW-2004 (>WW) HAVRE	AVERAGE for YEARS TESTED	% of CHECK YIELD 1/	7-YEAR COMP. AVERAGE YIELD 2/
DUTCH SUPER EAGLE w/3.5" Paired Row Attachment	6		38.9	30.8	30.6	40.1	17.7	32.6	31.8	106.3	**30.9**
ATOM JET (HarvesTechnologies) Side Band	5			27.9	31.1	37.9	19.4	33.6	30.0	104.3	**30.3**
FARMLAND LD w/Case-McKay 6" LD Sweep & K3 Knife	7	28.2	38.7	25.6	28.5	38.1	17.3	35.0	30.2	104.0	**30.2**
DUTCH SUPER EAGLE w/5.5" Paired Row Attachment	6		37.8	28.2	28.8	38.4	17.8	34.3	30.9	103.3	**30.0**
GEN T2x2	7	26.3	37.0	27.1	28.1	38.9	16.5	33.1	29.6	101.8	**29.6**
FARMLAND LD w/Case-McKay 11" LD Sweep & K3 Knife	7	25.9	38.6	23.6	26.4	40.4	16.7	33.4	29.3	100.8	**29.3**
ATOM JET (HarvesTechnologies) 4" Paired Row	3					36.5	18.3	34.0	29.6	100.7	**29.3**
ANDERSON (Case-Concord) Triple Shooter	5	27.4	35.9	26.7	26.6	38.1			30.9	100.4	**29.2**
FARMLAND SB1-SBS1 w/6" Knock-On Sweep & K3 Knife	7	24.0	35.7	28.1	27.4	38.8	17.2	32.2	29.1	100.0	**29.1**
FARMLAND SB1-SBS1 w/4" Knock-On Sweep & K3 Knife	4	25.6	35.4	26.6	27.4				28.7	99.8	**29.0**
DUTCH S.E. w/FARMLAND Mid-Row Fertilizer Banding Disk	4				27.2	36.8	16.0	34.5	28.6	99.1	**28.8**
FLEXICOIL STEALTH w/Paired Row Attachment	7	25.7	27.8	27.9	27.5	40.4	17.4	34.5	28.7	98.9	**28.7**
MORRIS Gumbo Boot	3			24.3	27.8		18.3		23.5	96.8	**28.1**
ENTRY MEANS (For Entries Included in this Summary)		26.2	36.2	27.0	28.1	38.6	17.5	33.7			29.4
SITE MEANS (For All Entries Included in Original Trial)		25.5	35.6	26.9	28.1	38.6	17.4	33.8			
LSD (.05) (For All Entries Included in Original Trial)		3.7	4.4	2.9	4.9	5.6	2.1	2.8			

Check Entry is (FARMLAND SB1-SBS1 w/6" Knock-On Sweep & K3 Backswept Knife).

[1] Percent of check entry yield performance for the same data years as those in which a given entry was tested.

[2] 7-Yr Comparable Average Yield = (x/y)*z where x = average yield of a given entry for years tested, y = average yield for the Check Entry for the same years, and z = 7-Yr average yield for the Check Entry.