PROJECT TITLE: Evaluation of Seed Boot and Furrow 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 for the production of cereal grains under varying cropping conditions and systems in northern Montana.

RESULTS:

The agronomic performance of twelve "double-shoot" opener configurations under dryland chemical fallow conditions with 'Scholar' spring wheat direct-seeded into spring wheat stubble at Havre in 2003 is presented in Table 1. Yield performance data for all air drill opener trials conducted by NARC-Agronomy since the investigations began in 1997 is presented in Table 2. A "6-Year, Comparable Average" summary for all openers evaluated in at least three of the six years (1998-2003) with spring wheat on mechanical or chemical fallow at Havre is presented in Table 3. Figures 1 through 12 comprise an opener and post-harvest photo gallery for spring wheat plots established with openers evaluated in 2003.

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 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 2001-2003 trials. Standard 165x15R radial packer tires were utilized with all openers in previous 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, Long and Stougaard 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 and Carlson are utilizing these technologies in yet a fourth collaborative effort where they are investigating 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.

FUTURE PLANS:

The Research Center plans to continue work with opener evaluations 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 mid-row fertilizer banding capability was added for the 2001 investigations.

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.

Long, Carlson 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 are 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 – the Concord air drill is currently serving three (and potentially four) separate, but related research endeavors out of the Havre station.

TABLE 1. Comparison of "Double-Shoot" Air Drill Opener Configurations on 12" Spacings under Dryland Chemical Fallow Conditions wth `Scholar' Spring Wheat Direct-Seeded into Winter Wheat Stubble at Havre. Northern Agricultural Research Center. Havre, Montana. 2003. (Exp# 03-SP08-OP)

ENTRY	STAND %	1/ ROW STYLE	2/ SEED BAND Inches	PLANTS /FT2 No.	3/ CULMS /FT2 No.	CULMS /PLANT No.	4/ HEAD DATE Julian	PLANT HEIGHT Inches	5/ GRAIN YIELD Bu/Ac	GRAIN MOIST. %	TEST WEIGHT Lbs/Bu	6/ GRAIN PROTEIN %
ATOM JET (HarvesTechnologies) Side Band	99.2	1.0	4.4	13.4	32.3	2.4	190.0	23.6	19.4	7.4	58.3	19.9
ATOM JET (HarvesTechnologies) 4" Paired Row	99.2	2.0	4.5	14.6	38.7	2.7	191.3	24.1	18.3	7.2	56.8	18.3
MORRIS Gumbo Boot	91.2	1.0	5.1	8.6	29.8	3.6	192.3	21.9	18.3	7.7	59.3	21.7
DUTCH SUPER EAGLE w/5.5" Paired Row Attachment	99.7	3.0	8.0	16.6	38.4	2.3	190.7	22.8	17.8	7.2	56.8	18.3
DUTCH SUPER EAGLE w/3.5" Paired Row Attachment	99.8	1.0	5.6	13.9	36.0	2.6	190.0	23.1	17.7	7.2	56.8	18.5
FLEXICOIL STEALTH w/Paired Row Attachment	99.5	1.0	5.3	13.5	30.3	2.3	191.3	22.5	17.4	7.4	58.1	19.5
FARMLAND LD w/Case-McKay 6" LD Swp & K3 B'kswpt Knife	99.5	1.0	7.1	15.4	40.3	2.7	189.7	22.8	17.3	7.2	56.8	17.6
FARMLAND SB1-SBS1 w/6" Nichols Knock-On Swp & K3 Knife	99.7	1.0	7.1	13.9	39.3	2.9	189.7	22.6	17.2	7.1	56.9	17.8
FARMLAND LD w/Case-McKay 11" LD Swp & K3 B'kswpt Knf	99.7	1.0	6.6	15.8	35.7	2.3	189.7	22.1	16.7	7.2	56.7	17.9
DUTCH 3.5" Paired Row w/SUPER EAGLE Tip	99.7	1.0	5.2	16.5	37.0	2.3	190.3	22.3	16.7	7.2	56.9	18.1
GEN T2x2	99.9	2.0	7.6	17.9	35.2	2.0	189.3	22.5	16.5	7.0	56.6	17.6
DUTCH SUPER EAGLE w/FARMLAND Mid-Row Bnd'g Disks	100.0	1.0	3.4	16.9	37.6	2.2	190.0	21.7	16.0	7.0	56.3	17.5
EXPERIMENTAL MEANS	98.9	1.3	6.0	14.8	35.9	2.5	190.4	22.7	17.4	7.2	57.2	18.6
LSD (0.05)	0.8	0.0	1.0	3.1	6.7	0.7	1.7	1.4	2.1	0.2	1.1	1.3
C.V. 2: (S OF MEAN/MEAN)*100	0.3	0.0	5.6	7.1	6.4	9.7	0.3	2.1	4.2	1.0	0.6	2.4

1/ Row Style/Appearance: 1=solid band, 2= paired/joined bands, 3=paired/separate bands.
2/ Average `splayed' stubble width 4" above soil surface at harvest maturity.
3/ Average no.of fertile culms (stems with filled heads) per linear foot (ft2 on a 12-in. row spacing).
4/ No. of Days from January 1 (190 = July 9).
5/ Volumetric yields are based on 60 lbs/bu as the standard test weight for wheat.
6/ Protein values are adjusted to 12 percent grain moisture.

Site Resource & Management Data:										
Field	A-4-4		Init K (ppm) 0-6"	459		Init PAW (in.) 6-24"	1.34		Herbicide App. Date	6/14
Quarter	NW		Init S (ppm) 0-24"	31		Init PAW (in.) 24-36"	1.33		Herbicide Product	Bronate Adv.
Section	32		Init Na (MEQ/100g) 0-6"	0.14		Init PAW (in.) 36-48"	1.72		Herbicide Rate (/ac)	20 oz
Township	32N		SaltHaz (MMHOS/cm) 0-6"	0.64		Cropping System	NT-ChmFlw		Precip (in.) Apr1-Planting	3.53
Range	15E		SaltHaz(MMHOS/cm)6-24"	0.8		Planting Date	5/19		Precip (>.1) Apr1-Planting	3.10
Latitude			Soil Texture 0-6"	CL		Planting Depth (in.)	1.5		Precip (in.) Plnt'g-Harvest	4.02
Longitude			Soil Texture 6-24"	CL		Moist Soil Depth @Plnt'g	48+		Precip (>.1) Plnt'g-Harvest	3.53
Soil Series	Telstad CLm		Soil Texture 24-36"	CL		Dry Surf Soil (in.) @Plnt'g	0.25		Harvest Maturity Date	8/1
pH 0-6"	6.4		Soil Texture 36-48"	CL		2" Soil Temp (^{o}F) @ Plnt'g	62		Harvest Date	8/15
Org.Matter (%) 0-6"	1.2		Init Zn (ppm) 0-6"	0.6		4" Soil Temp (^{o}F) @ Plnt'g	58		Rooting Depth (in.)	31"
Init N (lbs/ac) 0-6"	34		Init Mn (ppm) 0-6"	10.6		Fertilizer Formulation	Gran.Blend		Post PAW (in.) 0-6"	0.48
Init N (lbs/ac) 6-24"	36		Init Cu (ppm) 0-6"	1.1		Fertilizer Placement	Bnd at Plntg		Post PAW (in.) 6-24"	1.34
Init N (lbs/ac) 24-36"	56		Init Fe (ppm) 0-6"	23.5		Fert. Rate (lbs/ac) N	70		Post PAW (in.) 24-36"	1.33
Init N (lbs/ac) 36-48"	64		CEC 0-6"	21.8		Fert. Rate (lbs/ac) P2O5	40		Post PAW (in.) 36-48"	1.72
Init P (ppm) Olsen 0-6"	39		Init PAW (in.) 0-6"	0.48		Fert. Rate (lbs/ac) K2O	25		Precip (>.1) Hvst-Post	1.28

Table 2. [1]YIELD MEAN SUMMARY (Bu/Ac) FOR AIR DRILL OPENER INVESTIGATIONS CONDUCTED BY NORTHERN AGRICULTURAL RESEARCH CENTER - AGRONOMY (1997-2003)

(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
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
ATOM JET (HarvesTechnologies) 4" Paired Row										36.5	18.3
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
DUTCH SUPER EAGLE w/5.5" Paired Row Attachment							37.8	28.2	28.8	38.4	17.8
DUTCH 3.5" Paired Row w/SUPER EAGLE Tip											16.7
DUTCH S.E. w/FARMLAND Mid Row Fertilizer Banding Disk									27.2	36.8	16.0
FARMLAND LD w/Case-McKay 6" LD Sweep & K3 Knife			28.2				38.7	25.6	28.5	38.1	17.3
FARMLAND LD w/Case-McKay 11" LD Sweep & K3 Knife			25.9				38.6	23.6	26.4	40.4	16.7
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
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
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
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
LSD (.05)	2.8	5.3	3.7	7.9	7.7		4.4	2.9	4.9	5.6	2.1

[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. Six-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. 1998-2003.

(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	AVERAGE for YEARS TESTED	% of CHECK YIELD 1/	6-YEAR COMP. AVERAGE YIELD 2/
DUTCH SUPER EAGLE w/3.5" Paired Row Attachment	5		38.9	30.8	30.6	40.1	17.7	31.6	107.5	**30.7**
ATOM JET (HarvesTechnologies) Side Band	4			27.9	31.1	37.9	19.4	29.1	104.3	**29.7**
FARMLAND LD w/Case-McKay 6" LD Sweep & K3 Knife	6	28.2	38.7	25.6	28.5	38.1	17.3	29.4	103.0	**29.4**
DUTCH SUPER EAGLE w/5.5" Paired Row Attachment	5		37.8	28.2	28.8	38.4	17.8	30.2	102.6	**29.3**
GEN T2x2	6	26.3	37.0	27.1	28.1	38.9	16.5	29.0	101.6	**29.0**
ANDERSON (Case-Concord) Triple Shooter	5	27.4	35.9	26.7	26.6	38.1		30.9	100.4	**28.7**
FARMLAND LD w/Case-McKay 11" LD Sweep & K3 Knife	6	25.9	38.6	23.6	26.4	40.4	16.7	28.6	100.3	**28.6**
FARMLAND SB1-SBS1 w/6" Knock-On Sweep & K3 Knife	6	24.0	35.7	28.1	27.4	38.8	17.2	28.5	100.0	**28.5**
FARMLAND SB1-SBS1 w/4" Knock-On Sweep & K3 Knife	4	25.6	35.4	26.6	27.4			28.7	99.8	**28.5**
FLEXICOIL STEALTH w/Paired Row Attachment	6	25.7	27.8	27.9	27.5	40.4	17.4	27.8	97.4	**27.8**
MORRIS Gumbo Boot	3			24.3	27.8		18.3	23.5	96.8	**27.6**
DUTCH S.E. w/FARMLAND Mid-Row Fertilizer Banding Disk	3				27.2	36.8	16.0	26.7	96.0	**27.4**
ENTRY MEANS (For Entries Included in this Summary)		26.2	36.2	27.0	28.1	38.8	17.4			28.8
SITE MEANS (For All Entries Included in Original Trial)		25.5	35.6	26.9	28.1	38.6	17.4			
LSD (.05) (For All Entries Included in Original Trial)		3.7	4.4	2.9	4.9	5.6	2.1			

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] 6-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 = 6-Yr average yield for the Check Entry

Figure 1a. ATOM JET (HarvesTechnologies) Side Band

Figure 1b. Post-Harvest, Solid, Seed Band Width = 4.4 Inches

Figure 2a. ATOM JET (HarvesTechnologies) 4” Paired Row

Figure 2b. Post-Harvest, Paired-Joined, Seed Band Width = 6.5 Inches

Figure 3a. DUTCH SUPER EAGLE w/3.5” Paired Row Attachment

Figure 3b. Post-Harvest, Solid, Seed Band Width = 5.6 Inches

Figure 4a. DUTCH SUPER EAGLE w/5.5” Paired Row Attachment

Figure 4b. Post-Harvest, Paired-Separate, Seed Band Width = 8.0 Inches

Figure 5a. DUTCH 3.5” Paired Row w/SUPER EAGLE Tip

Figure 5b. Post-Harvest, Solid, Seed Band Width = 5.2 Inches

Figure 6a. DUTCH SUPER EAGLE w/FARMLAND Mid-Row Fertilizer Banding Disk

Figure 6b. Post-Harvest, Solid, Seed Band Width = 3.4 Inches

Figure 7a. FARMLAND LOW DISTURBANCE (LD) w/Case-McKay 6” LD Sweep & K3 Backswept Knife

Figure 7b. Post-Harvest, Solid, Seed Band Width = 7.1 Inches

Figure 8a. FARMLAND LOW DISTURBANCE (LD) w/Case-McKay 11” LD Sweep & K3 Backswept Knife

Figure 8b. Post-Harvest, Solid, Seed Band Width = 6.6 Inches

Figure 9a. FARMLAND SB1-SBS1 w/6” Knock-On Sweep & K3 Backswept Knife

Figure 9b. Post-Harvest, Solid, Seed Band Width = 7.1 Inches

Figure 10a. FLEXICOIL STEALTH w/Paired Row Attachment

Figure 10b. Post-Harvest, Solid, Seed Band Width = 5.3 Inches

Figure 11a. GEN T2x2

Figure 11b. Post-Harvest, Paired-Joined, Seed Band Width = 7.6 Inches

Figure 12a. MORRIS Gumbo Boot

Figure 12b. Post-Harvest, Solid, Seed Band Width = 5.1 Inches