TECHNOLOGY EVALUATION AND DEVELOPMENT SUB-PROGRAM

REPORT ON "TYE-DRILL" MODIFICATIONS FOR SOWING SOYBEANS ON COMMERCIAL FARMS UNDER NO-TILL CONDITIONS

FINAL REPORT

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2. Ecological Services for Planning, TED-subprogram Manager, Guelph, Ontario.
3. Anne Marie Hedrick and Angela Myslik, technical staff, without whose assistance this study would not have been possible.

Executive Summary

In 1988, a study was initiated by a group of farmers in Rondeau Bay area of Kent County. The goal of the study was determine if more aggressive and better matched coulter/presswheelcombinations would improve the performance of the Tye drill for narrow row planting of soybeans in a no-till system. Experiments with the Tye drill in previous years had shown a tendency for poor seed establishment due to non-uniform seed depth, resulting in theexposure and desiccation of the seed.

ln year one of the study, side by side comparisons of crop performance were made for fields planted with the Tye drill and with conventional planting units. The Tye drill was outfitted on one side with a bubble coulter and two V-presswheels with 8" rows,and on the other side with a fluted coulter and a single presswheel.

The results of the first year of research were inconclusive, due in part to the drought of 1988. While plant populations at two of the five sites were significantly higher on fields planted with the Tye drill compared to the conventional planter, the differencesin yields were not significant.

The study continued in 1989 using the same comparisons as inYear 1, with some additional treatments. The Tye drill equipped with 1" fluted coulters across the front was outfitted on the left half portion of the drill rows with single presswheels while the other half had standard V-type (double) presswheels. On demand, a rake could be dropped behind the full width of the drill. It was hoped that one of these combinations would provide a more favourable seedbed environment, which would translate into greater emergence and yields.

The results of the 1989 field season were not encouraging for any of the Tye drill treatments. At all of the sites, plants seeded with conventional planters experienced more rapid and vigorous emergence when compared to all other treatments. At all but one of the sites, the yield on the plot that was planted with the conventional planter was greater than any of the corresponding yields from the Tye drill treatments.

The results of two years of experiments with the Tye drill were not conclusive. The farmers who were involved in the study are still interested in making minor adjustments to the coulters ofthe Tye drill in an effort to improve the seed placement. They would also like to evaluate the performance of the Tye drill on afield scale. There was some feeling amongst the farmers involved in the research, that the plot scale research may have introduced errors and biased the results in favour of the planters.

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1.1 Introduction

One of the goals of the Technology Evaluation and Development(TED) subprogram of SWEEP is to involve the farming community in the process of developing technologies and management systems. This results of such research will be directly applicable to the needs of farmers in their quest for improved soil conservation practices. Widespread adoption of these technologies is essential if SWEEP is to reach its phosphorus reduction goals within the specified time frame.

it is desirable to hasten the adoption process, for soybean growers especially. Thus, the expertise of progressive, innovative farmers was utilized on a number of re[p]resentative soils in this region which are subject to sediment and phosphorus movement.

The Rondeau Bay group of farmers in Kent County has expressed concern about the unsatisfactory performance of the conventionally equipped Tye drill for close planting of soybeans in a reduced tillage system. The problem is perceived by farmers to be inadequate seed coverage, due to uneven depth placement of seed resulting in seed exposure and desiccation. Several farmers have made various adjustments to the equipment but have not improved its performance to a satisfactory level.

In 1988 (Year 1) this group of farmers attempted to obtain a solution to the problem through close comparisons of various coulter press wheel combinations at different plant spacings. In 1989 (Year 2), further studies on the coulter wheel combinations were conducted, with additional treatments added to investigate the effect of a trailed rake or harrow behind the drill.

1.2 Field Study Objectives

The demonstration/research plots were located on the properties of five farmer cooperators in both years of the study. The objective of the Year 1 study was to determine whether the use of more aggressive and better matched coulter/packing wheel combinations for narrow spacings would improve the performance of the Tye drill for planting soybeans in a no-till system. At the same time it was intended to measure the performance of the Tye drill against conventional corn planting units, which are limited to wide row spacings.

The Year 2 study objectives were the same as those of Year 1, with some additional objectives aimed at fine-tuning the system. The study participants wished to determine if single or double V presswheels, in combination with a rake, could effectively level the seed bed and/or part the corn trash, concurrently facilitating and improving coverage of the drill row.

2.0 Materials and Methods

Location: The field plots of the grower/cooperators were located in the Township of Harwich, County of Kent (Figure 1). Cooperators 1, 2, 4, and 5 listed below participated in field tests in both 1988 and 1989. Cooperator 6 participated in the 1988 research season and was replaced by cooperator 3 in the 1989 season.

1. Jack Rigby, principal manager	Con. 3, Lot 17 (1988); Lot 16 (1989)
2. Henry DeBrouwer	Con. 3, Lot 22
3. Groenewegen Bros.	Con. 2, Lot 22 (1989 only)
4. Dan Myslik	Con. 5, Lot 16
5. Peter Cumming	Con. 3, Lot 14
6. Arthur Huffman	Con. 3, Lot 14 (1988 only)

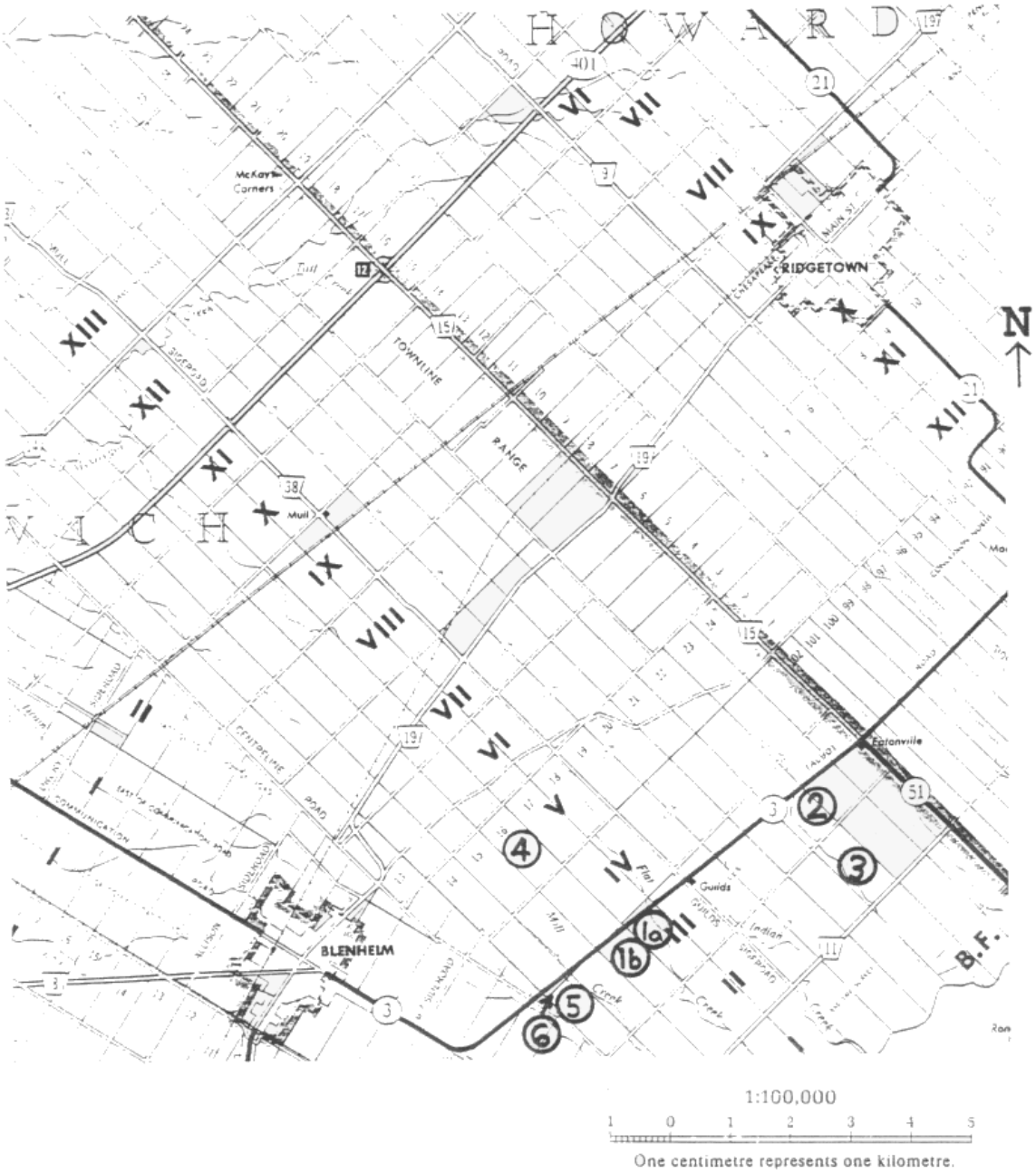

Figure 1. Location of the field plots for the 1988 and 1989 Tye drill experiments

Farmer Cooperators
1a = Jack Rigby (1988)
1b = Jack Rigby (1989)
2 = Henry DeBrouwer
3 = Groenewegen Brothers (1989 only)
4 = Dan Myslik
5 = Peter Cumming
6 = Arthur Huffman (1988 only)

2.1 Soil Types

The farms of cooperators 1,2,5 and 6 are located on a Haldimand loam soil. The farm of cooperator 3 is located on a Haldimand clay loam, while cooperator 4 is situated on a somewhat sloping Fox gravelly loam.

2.2 Equipment and Machinery

The same Tye drill was used by all of the cooperators. It had a coulter/caddy front bar set for 22 rows at an 8" row spacings and a trailing hoistable rake in two sections attached to the frame. The Tye drill arrangements used in the 1988 and 1989 field experiments are shown in Figures 2, 3 and 4.

The following planters (check) were used for comparisons with the Tye drill at the five locations:

1	Rigby	John Deere-7000 Maximerge		12 rows	Fig. 5
2	DeBrouwer	John Deere-7000 Maximerge		12 rows	Fig. 5
3	Groenewegen	New Idea-Kinze		5 rows	Fig. 7
4	Cumming	New Idea-Kinze	Year 1	7 rows	Fig. 6
			Year 2	9 rows	
5	Myslik	New Idea-Kinze	Year 1	7 rows	Fig. 6
			Year 2	9 rows	
6	Huffman	New Idea-Kinze		7 rows	Fig. 6

The planter configurations are shown in Figures 5, 6 and 7.

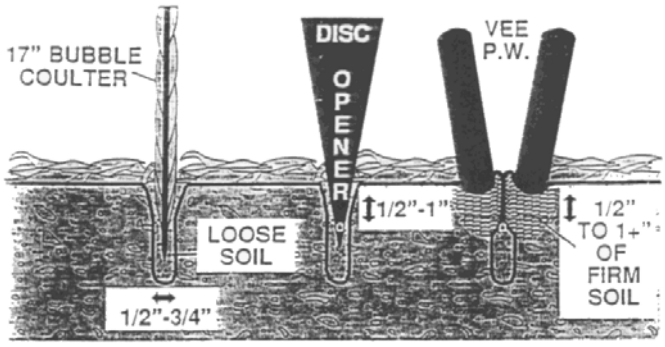

Figure 2. Tye drill - Bubble Coulter and Standard V-type Presswheel Arrangement

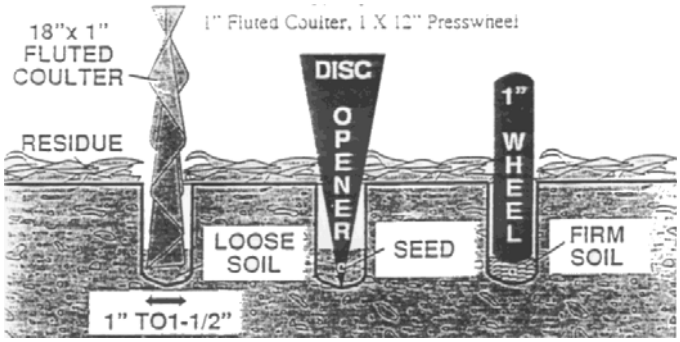

Figure 3. Tye drill - Fluted Coulter and Single Presswheel Arrangement

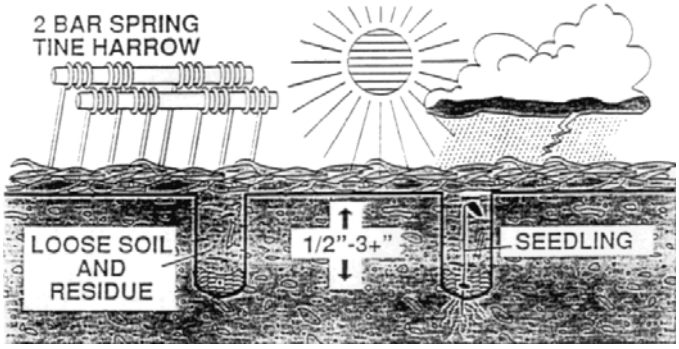

Figure 4. Tye drill - Trailing Rake/Harrow Option
(the above figures obtained from promotional materials published by the Tye Company, P.O. Box 218, Lockney, Texas 79241)

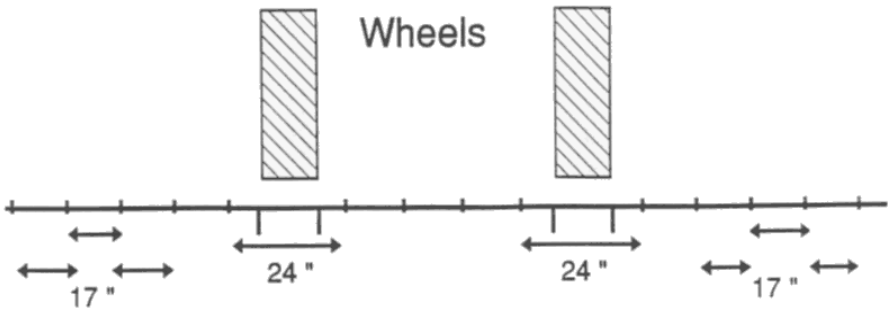

Figure 5. John Deere - 7000 Maximerge Planter Arrangement

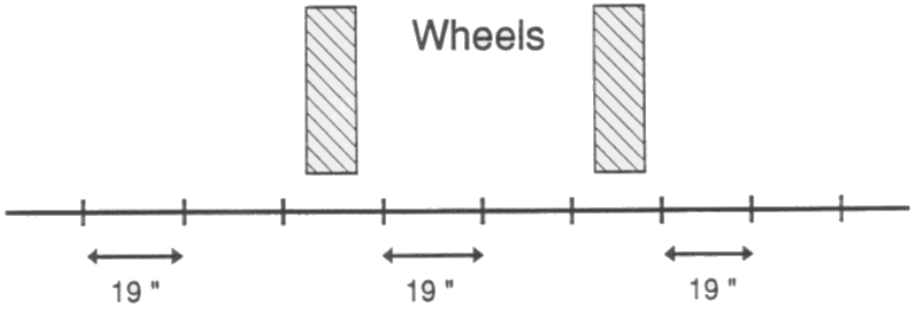

Figure 6. New Idea - Kinze Planter Arrangement

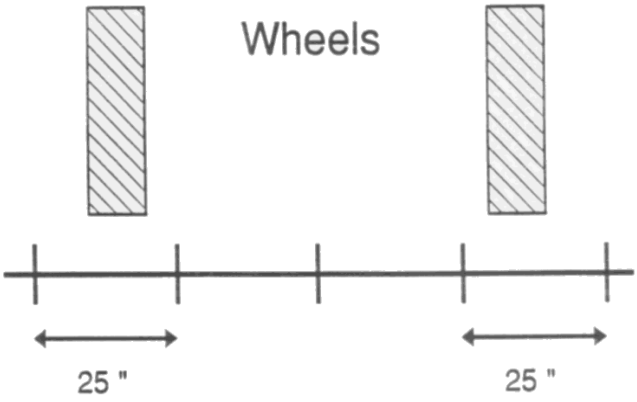

Figure 7. New Idea - Kinze (double frame) Planter Arrangement

2.3 Treatments (Year 1) (planter/coulter/presswheel arrangements)

1. Tye drill with bubble coulter and V-presswheels (2) with 8" rows (Figure 2).
2. Tye drill with 18" x 1" fluted coulter (Tye #555-318) and E-Z adjust single presswheel (Tye #204-303) with 8" rows (Figure 3).
3. John Deere planter with two 1" fluted coulters and standard V-type presswheels with 17" rows.
4. New Idea planter with two 2" fluted coulters and standard V-type presswheels with 19" rows.

(see photos in Appendix C)

The changes in the coulter/presswheel combination on the Tye drill were always made in the centre portion of the planter unit. Details about the planter arrangement and agronomic practices at each of the sites in Year 1 are presented in Table 1.

2.4 Plot Layout (Year 1)

On each location and approximately in the centre of the field, at least one planting round was executed with the Tye drill next to the conventional planter. In several instances, half the field was planted with each particular planter. For every treatment, four replications of 15 metres (50 feet) were selected at random from the field-length strips and flagged for subsequent measurements.

Soybeans were planted from May 12 to May 24, 1988 into unincorporated corn stalks from the previous year, except for cooperator Art Huffman who planted into soybean stubble. Harvest was started October 1 and completed during the last week of October.

TABLE 1. Field Conditions for the 1988 Tye drill Soybean Experiment					
Cooperator	Rigby	DeBrouwer	Myslik	Cumming	Huffman
Previous Crop	Corn	Corn	Corn	Corn	Soybeans
Planter(for comparison)	John Deere - Maximerge 12 row	John Deere-Maximerge 12 row	New Idea-Kinze 7 row	New Idea-Kinze 7 row	New Idea-Kinze 7 row
Planter Row Width	17in.	17in.	19in.	19in.	19in.
Soybean Cultivar	Jewel	Elgin	P.9202	Jewel	Jewel
Planting Date	May 14,1988	May 12,1988	May 14,1988	May 21,1988	May 24,1988
Herbicide	2-4-D Dual Senicor	Roundup-Pre-Dual Lexone (.4 Kg/ha)	Roundup-Pre Sencore Poast Basagran	Dual + Ambien	Dual Lexone (.5 Kg/ha, 2.5 oz 2-4-D)

2.5 **Treatments (Year 2)** (planter/coulter/presswheel arrangements)

1. The Tye drill equipped with 1" fluted coulters across the front was outfitted on the left half portion of the drill rows with single presswheels while the other half had standard V-type (double) presswheels. On demand, a rake could be dropped behind the full width of the drill (Figure 4).
2. The configurations of the planters used for comparison with the Tye drill are shown in Figures 5 to 7. The John Deere Maximerge planter (Figure 5) was equipped with two 1" fluted coulters and standard V-type presswheels (double). Both of the New Idea-Kinze planters (Figures 6 and 7) were equipped with two 2" fluted coulters and standard V-type presswheels (double).

Details about the planter arrangement and agronomic practices at each of the sites in Year 2 are presented in Table 2.

TABLE 2. Field Conditions for the 1989 Tye drill Soybean Experiment					
Cooperator	Rigby	DeBrouwer	Groenewegen	Myslik	Cumming
Previous Crop	Corn	Corn	Corn	Corn	Corn
Planter (for comparison)	John Deere-Maximerge 12 row	John Deere-Maximerge 12 row	New Idea-Kinze 5 row	New Idea-Kinze 9 row	New Idea-Kinze 9 row
Planter Row Width	17in.	17in.	25in.	19in.	19in.
Soybean Cultivar	Jewel	Jewel	Jewel	Jewel	Jewel
Planting Date	May 28,1989	May 29,1989	May 30,1989	June 11,1989	June 10, 1989
Harvest Date	Oct.12-13, 1989	Oct.13,1989	Oct.16,1989	Nov.13,1989	Oct.
Fertilizer	none	16/A 0-0-90	none	16/A 10-57.5-45	none
Herbicide	pre/roundup dual/poast senicor	pre/roundup dual lexone	pre/roundup dual lexone	pre/roundup senicor poast	dual roundup ambien

2.6 Plot Layout (Year 2)

Near the centre of the soybean field at each location, at least two planting rounds were executed with the Tye drill in order to have each half portion repeated side by side and thereby doubling the specific treatment in either case, i.e. twice eleven(11) rows with single presswheel units next to twice eleven (11) rows with double V-type presswheel units. Approximately halfway through the length of each field plot, the rakes were dropped, superimposing an additional seed covering treatment on the experiment (Figure 4). In each location the Tye drill treatments were "framed" and placed next to rows sown with a conventional corn/soybean planter. For every treatment at each location, four replications of 25 m (50 feet) were selected at random from the large field-length strips and flagged for subsequent measurements during the field season.

Soybeans were planted from May 28 to June 11, 1989 (Table 2) into unincorporated corn stalks left on the surface of the ground from the previous crop. Harvest was started on

October 12 and completed on November 13. The crop harvested on November 13 also had the latest planting date (June 11) and had been hit by an early frost on September 24, hastening the maturation process.

3.0 Recording Data

1. Emergence: Year 1 emergence data were collected on the following schedule:

    3x daily after first showing followed by

    3x every second day, then

    3x every fourth day (last count = final stand)

In Year 2, the emergence data collection schedule was modified as follows:

    5 sites, 2 x daily after first break through, then

    5 sites, 2 x every record day 3 sites, 1 x after 3 days

    3 sites, 1 x after 4 days

    4 sites, 1 x after 5 days (last count = final stand)

    In general, counts were taken whenever emergence patterns warranted a seedling count.

2. Yields: On both Year 1 and Year 2, bean yields were obtained using a "Hegie" plot combine, with a 1 m (40") cutting head. Whole plot yields were bagged, to be cleaned and weighed and grain moisture determined at a later date. Grain moisture was estimated using a Dickey-john GAC II moisture meter.

3. The following additional physiological data were obtained approximately 3 days before harvest on Year 2 of the experiment only:

    a) plant population - plants/m^2

    b) pod count - number of axils with 3 pods or more

c) root rot - diseased plants/m^2

4. Rainfall: Recorded at each site by the cooperator. Daily rainfall accumulations in Year 1 are shown on Table 3, while the Year 2 rainfall accumulations are shown in Table 4. In Year 2, Myslik's rainfall data were unavailable after August 1st.

TABLE 3. 1988 Rainfall Data (mm)

Cooperator		Rigby	DeBrouwer	Myslik	Cumming	Huffman
May	15	23.0	23.0	23.0		
	22	2.5				
Jun	1	6.4	15.2	7.6	7.6	7.6
	3		2.5	2.5		
Jul	10	7.6	4.0	7.6	7.6	7.6
	16	30.5	37.0	33.0	33.0	33.0
	18	22.9	12.0	16.5	22.9	22.9
	27	12.7	5.0	10.0	9.0	9.0
Aug	5	17.8	18.0	15.0	12.5	:2.5
	11	2.5	1.0	7.6	4.5	4.5
	14	5.0	4.0	7.6	7.0	7.0
	23	3.8	6.0		5.0	5.0
	24		5.0			
	28	12.7	12.0		12.5	12.5
Sep	4	33.0	39.0		33.0	33.0
	12		10.0			
	19		8.0			
Totals		180.4	201.7	130.4	154.6	154.6

TABLE 4. 1989 Rainfall Data (mm)

Co-operator		Rigby	DeBrouwe	Groeneweg	Myslik	Cumming
May	30	25	24	23	0	very wet field
	31	15	25	1	25	very wet field
Jun	2	5	7	0	25	very wet field
	4	15	14	5	15	very wet field
	9	3	3	11	0	vary wet field
	12	6	11	1	15	6
	13	3	0	12	0	3
	15	0	4	1	0	0
	17	8	9	0	9	8
	20	36	11	8	6	36
	22	8	3	11	8	8
	26	13	21	3	13	13
	27	3	1	13	3	3
Jul	3	13	5	5	15	13
	4	0	1	0	0	0
	9	0	2	1	5	0
	19	8	4	3	13	8
	20	13	12	11	20	13
	26	5	4	0	46	5
	27	0	2	6	0	0
Aug	15	5	3	4	n/a	5
	20	0	2	0	n/a	0
	22	18	32	25	n/a	18
	23	3	8	8	n/a	3
	29	28	26	25	n/a	28
Sep	1	10	12	11	n/a	10
	6	15	10	8	n/a	15
	7	3	2	0	n/a	2
	8	5	4	5	n/a	5
	10	0	3	5	n/a	0
	14	17	17	15	n/a	15
	16	5	7	5	n/a	5
Totals		288	294	226	218	222

4.0 Results and Discussion (Year 1)

The five cooperators used one of the soybean cultivars Jewel, Elgin or P9202 for all treatments within the comparison plantings (Table 1).

4.1 Plant Populations

The plant populations achieved by each grower appeared to be different when compared to their neighbours even where the same drill and coulter assemblies were used (Table 5).

TABLE 5. 1988 (Year 1) Soybean Populations(Number of Plants/m^2)

Cooperator	Variety	Tye Drill Bubble Coulter Double V Presswheels	Tye Drill Fluted Coulter Single Presswheel	Check Planter	F Value
Rigby	Jewel	22	20	25	N.S.
DeBrouwer	Elgin	34	38	34	N.S.
Myslik	P9202	31	24	19	N.S.
Cumming	Jewel	52	51	36	6.23*
Huffman	Jewel	73	75	54	12.96**

* Significant P = 0.05

** Significant P = 0.01

In the case of both Cumming and Huffman, the plant populations achieved with the planter in 19-inch rows were significantly lower than obtained with the Tye drill. It is not clear whether these differences were the result of individual machine adjustment because there are no data on the number of seeds planted.

4.2 Yields

The only instances where plant stand affected final grain yield were with Cumming (r=0.724) and Myslik (r=0.521). Myslik's poor initial stand, a victim of the severe consequences of the 1988 drought, was obviously reflected in his lower yields (Table 6).

TABLE 6. 1988 (Year 1) Soybean Yields (Bu/acre @14% m.c.)

Cooperator	Variety	Tye Drill Bubble Coulter Double V Presswheels	Tye Drill Fluted Coulter Single Presswheel	Check Planter	F Value
Rigby	Jewel	60.6	52.7	56.1	N.S.
DeBrouwer	Elgin	64.4	59.8	50.4	6.42*
Myslik	29202	53.1	57.3	23.8**	N.S.
Cumming	Jewel	59.4	56.3	43.5	N.S.
Huffman	Jewel	53.2	49.0	40.9	N.S.

* Significant P = 0.05

** This site was poorly chosen;situated on sloping gravelly loam soil with southerly exposure, explaining the low value for the check plot.

It appears that the high plant populations obtained by Huffman may have been rather detrimental to yields. The field notes indicated a heavy seeding rate. With the other cooperators, no relationships could be established between plant numbers/unit area and crop yields. For future comparisons, emphasis should be placed on more exact calibration of seeding rates, at least within each farm location; better still would be a standardized seeding rate for all cooperators in the project, against which would have to be measured the extra cost in time and effort to obtain uniformity across all locations.

From the yield summary in Table 6 it becomes apparent that the bubble coulter-1" V-presswheel combination was superior in all, except in one location. This difference, ranging from 4.5 to 15.9 Bu/acre (disregarding the Myslik site) was a surprising and unexpected revelation to all parties concerned. One hopes that 1989 experiments will show similar results under less extreme weather conditions.

4.3 General Observations (Year 1)

Three of the sites experienced a downpour of over 20 mm shortly after planting which resulted in severe crusting, and caused erratic and uneven emergence. The rainfall data (see Table 3) appear to support the somewhat higher yields of DeBrouwer; however, it should also be taken into account that this farmer rotates his land with clover, uses pig manure on occasion and generally has a higher organic matter content on this portion of the farm.

The emergence pattern within the row with the check-planter inmost locations appeared more uniform to the eye although not necessarily providing higher plant populations as has been noted. The overall yields with the Tye drill using the modification of the 1" fluted coulter with a single 1" presswheel (diameter 10") were generally lower than expected. The original-equipment bubble coulter was extremely hard to align properly with the planting unit; at the same time the smeared, compressed edges formed by this type of coulter often resulted in seed-placement above the bottom of the seed-furrow causing desiccation.

Despite the unusual weather extremes experienced in 1988, valuable information was collected. Plans for the 1989 trials should take into consideration the problems encountered during the previous season, and should incorporate the necessary changes and improvements, eventually resulting in definite recommendations for the planting of soybeans in narrow row-spacings in a no-till system.

5.0 Results and Discussion (Year 2)

In the first year of the study, three different soybean cultivars were used and each farmer cooperator used their planter at its usual seeding rate. In an effort to achieve greater uniformity in the second year of the study, all five cooperators used the Jewel soybean cultivar, at a seeding rate of 80 lb. per acre on all treatments. Using a mechanical balance for the soybeans, each type of planter was calibrated to achieve a seeding rate of approximately 56.5 seeds/m^2 (228,615 seeds/acre), to compare as closely as possible to the intended seeding rate of the Tye drill.

The uniformity from planter to planter as well as from field to field was fairly satisfactory from the farmer's point of view. However, Table 7 reveals that several of the Tye drill treatments and all but one of the planter treatments had total emergence values greater than 57 plants/m^2, indicating an inconsistent degree of control over the seeding rate. Although the same soybean cultivar was used at all of the sites, differences in soybean seed weights resulted in some variation in the actual seeding rate. Some plots may have received less seeds than intended while others, such as the plots at the Myslik site, probably received more seeds than intended.

Table 7. TYE DRILL MODIFICATIONS 1989

TOTAL EMERGENCE / m^2

COOPERATOR	TREATMENTS					
	1 RAKE SINGLE	2 RAKE DOUBLE	3 NO-RAKE SINGLE	4 NO-RAKE DOUBLE	5 PLANTER	6 F VALUE
Rigby	41.3 b	34.6 a	25.0 a	28.4 a	65.7 c	9.6
DeBrouwer	56.3 b	49.9 a	54.9 a	48.7 a	73.5 c	6.47
Groenewegen	45.9 a	55.6 b	60.0 c	57.6 b	66.9 d	3.72
Myslik	74.6 b	61.2 a	60.0 a	63.1 a	75.6 b	6.54
Cumming	46.7 c	31.6 a	40.6 b	41.2 b	54.6 d	5.28

Values in the same row with different letters are significantly different at the 0.05 probability level

5.1 Populations and Emergence

Plant populations at harvest were influenced very little by treatments but differed overall from location to location (Table 8). Similar patterns were evident from emergence counts (Table 7).

Table 8. TYE DRILL MODIFICATIONS 1989

HARVEST POPULATION - PLANTS/m^2

COOPERATOR	TREATMENTS					
	1 SINGLE RAKE	2 DOUBLE RAKE	3 NO-RAKE SINGLE	4 NO-RAKE DOUBLE	5 PLANTER	F VALUE
Rigby	31.6 a	31.6 a	33.0 a	27.5 a	51.5 b	10.19
DeBrouwer	44.7 d	41.0 b	43.5 c	36.9 a	53.3 e	1.02
Groenewegen	46.7 a	43.9 a	50.0 b	51.8 c	53.5 b	4.23
Myslik	69.7 e	61.6 c	52.9 b	47.6 a	64.3 d	2.54
Cumming	n/a	n/a	n/a	n/a	n/a	n/a

Values in the same row with different letters are significantly different at the 0.05 probability level

In almost every instance except for single rake treatment at Myslik's and the no-rake double coulter treatment at Groenewegen's, planter populations were higher than Tye drill populations. Although variations within each field plot and between the different treatments were observed in some locations, no clear pattern developed within any of the cooperator's fields.

Plant emergence counts taken anywhere from four to six times per location gave first evidence that the planters gave more rapid and more vigorous emergence when compared to all other treatments (Tables 9 - 13). From Groenewegen's emergence data (Table 11) one would suspect that the single presswheel/rake combination is the least desirable, but data from the other locations did not support this observation. The pattern at Myslik's differed from the other fields due to the later planting date, which resulted in improved speeds of emergence. This site also showed the least differences between treatments, possibly due to an improvement in climatic conditions favouring more uniform germination/emergence (Table 12).

Table 9. SOYBEAN EMERGENCE (PL. COUNT/m^2)

RIGBY		TREATMENTS					
		1	2	3	4	5	F
		RAKE	RAKE	NO-RAKE	NO-RAKE	PLANTER	VALUE
PLANTED: MAY 28		SINGLE	DOUBLE	SINGLE	DOUBLE		
June 7	DAY 10	0.68	0	0.13	0	0.96	N.S 3.13
June 8	DAY 11	1.2	0.95	0.68	0.68	5.7	N.S. 4.53
June 10	DAY 13	3.2 a	3.0 a	1.6 a	2.3 a	22.1 b	15.75
June 13	DAY 16	12.9 a	7.3 a	5.4 a	6.5 a	45.4 b	26.15
June 16	DAY 19	28.3 a	21.8 a	17.7 a	18.0 a	65.4 b	11.67
June 21	DAY 24	41.3 a	34.6 a	25.0 a	28.4 a	65.7 b	9.60

Values in the same row with different letters are significantly different at the 0.05 probability level

Table 10. SOYBEAN EMERGENCE (PL. COUNT/m^2)

DEBROUWER		TREATMENTS					
		1	2	3	4	5	
PLANTED: MAY 29		RAKE SINGLE	RAKE DOUBLE	NO-RAKE SINGLE	NO-RAKE DOUBLE	PLANTER	F VALUE
JUNE 7	DAY 9	13.5 b	11.8 a	17.5 c	10.4 a	26.2 d	1.46
JUNE 8	DAY 10	19.5 a	23.2 b	25.2 c	19.8 a	38.6 d	1.74
JUNE 10	DAY 12	29.1 a	33.9 b	33.9 b	29.5 a	50.3 c	1.99
JUNE 13	DAY 15	37.4 a	39.7 a	40.1 a	38.8 a	65.2 b	4.05
JUNE 16	DAY 19	51.5 b	47.2 a	52.2 b	45.1 a	71.8 c	4.60
JUNE 21	DAY 23	56.3 b	49.9 a	54.9 a	48.7 a	73.5 c	6.47

Values in the same row with different letters are significantly different at the 0.05 probability level

Table 11. SOYBEAN EMERGENCE (PL. COUNT/m^2)

GROENEWEGEN		TREATMENTS					
		1	2	3	4	5	
PLANTED: MAY 30		RAKE SINGLE	RAKE DOUBLE	NO-RAKE SINGLE	NO-RAKE DOUBLE	PLANTER	F VALUE
JUNE 7	DAY 8	2.3 a	8.6 a	10.6 a	17.0 a	21.7 b	8.75
JUNE 8	DAY 9	5.4 a	17.6 b	18.1 b	25.2 b	35.3 c	8.60
JUNE 10	DAY 11	9.6 a	29.8 b	31.2 b	34.3 b	47.8 b	13.5
JUNE 13	DAY 14	22.5 a	43.4 b	42.3 b	43.9 b	58.8 c	12.7
JUNE 16	DAY 19	41.1 a	54.0 b	56.8 b	55.7 b	66.3 c	5.33
JUNE 22	DAY 23	45.9 a	55.6 b	60.0 c	57.6 b	66.9 d	3.72

Values in the same row with different letters are significantly different at the 0.05 probability level

Table 12. SOYBEAN EMERGENCE (PL. COUNT/m^2)

MYSLIK		**TREATMENTS**					
PLANTED: JUNE 11		1 SINGLE RAKE	2 DOUBLE RAKE	3 NO-RAKE SINGLE	4 NO-RAKE DOUBLE	5 PLANTER	F VALUE
JUNE 19	DAY 8	42.4 b	26.5 a	22.1 a	25.9 a	42.8 b	6.41
JUNE 20	DAY 9	67.1 c	55.5 b	47.4 a	49.0 a	68.3 c	3.95
JUNE 22	DAY 11	73.5 b	60.0 a	58.5 a	58.8 a	75.8 b	8.26
JUNE 27	DAY 16	74.6 b	61.2 a	60.0 a	63.1 a	75.6 b	6.54

Values in the same row with different letters are significantly different at the 0.05 probability level

Table 13 SOYBEAN EMERGENCE (PL. COUNT/m^2)

CUMMING		TREATMENTS					
PLANTED: JUNE 10		1 SINGLE RAKE	2 DOUBLE RAKE	3 NO-RAKE SINGLE	4 NO-RAKE DOUBLE	5 PLANTER	F VALUE
JUNE 19	DAY 9	11.0 b	7.4 a	8.5 a	13.5 c	16.0 d	1.80
JUNE 20	DAY 10	21.8 b	15.1 a	16.2 a	19.4 b	33.3 c	3.27
JUNE 22	DAY 12	37.8 c	24.5 a	32.4 b	33.3 bc	47.9 d	4.53
JUNE 27	DAY 17	46.7 c	31.6 a	40.6 b	41.2 b	54.5 d	5.28

Values in the same row with different letters are significantly different at the 0.05 probability level

5.2 Plant Height

While it was anticipated that some of the treatments might influence plant height, this expectation was not substantiated (Table 14). In two out of four locations, plants from the check (planter) treatment were significantly taller than the rest. At Myslik's, both of the "rake" treatments were about 10 cm. taller than the rest, while at DeBrouwer's, the check plants were the shortest. No clear interpretation can be offered.

Table 14. TYE DRILL MODIFICATIONS 1989

PLANT HEIGHT cm

COOPERATOR	TREATMENTS 1 SINGLE RAKE	2 DOUBLE RAKE	3 NO-RAKE SINGLE	4 NO-RAKE DOUBLE	5 PLANTER	F VALUE
Rigby	68.0 a	65.0 a	63.6 a	62.1 a	78.3 b	5.55
DeBrouwer	73.6 a	75.4 a	73.9 a	77.4 b	81.5 c	1.85
Groenewegen	70.9 a	76.4 b	75.8 b	86.5 c	87.5 c	4.04
Myslik	64.5 b	65.8 b	54.3 a	56.3 a	56.0 a	2.40
Cumming	n/a	n/a	n/a	n/a	n/a	n/a

Values in the same row with different letters are significantly different at the 0.05 probability level

5.3 Pod count and Plant Disease

It was thought that treatments might influence the number of axils setting three or more pods which would affect yields significantly (Table 15).

Table 15 . TYE DRILL MODIFICATIONS 1989

POD COUNT/m^2
(axils with 3 pods or more)

COOPERATOR	TREATMENTS 1 SINGLE RAKE	2 DOUBLE RAKE	3 NO-RAKE SINGLE	4 NO-RAKE DOUBLE	5 PLANTER	F VALUE
Rigby	45.8 b	52.7 e	49.0 c	49.8 d	45.1 a	0.20
DeBrouwer	55.8 b	72.8 d	52.9 a	66.4 c	52.4 c	2.23
Groenewegen	61.4 c	63.4 c	47.6 b	46.8 b	42.7 a	3.84
Myslik	30.5 c	37.5 e	35.9 d	28.5 b	24.9 a	1.06
Cumming	n/a	n/a	n/a	n/a	n/a	n/a

Values in the same row with different letters are significantly different at the 0.05 probability level

In every location pod counts were highest with the rake treatments - which again is extremely hard to interpret and should be deemed inconclusive.

There was little evidence of root rot except at the Groenewegen plots, where a noticeable number of plants were affected, resulting in stunted growth and arrested pod development (Table 16). At this site, the planter treatment, with a row width of 25 inches (64 cm), had significantly less disease incidence than any of the other treatments.

Table 16. TYE DRILL MODIFICATIONS 1989

ROOT ROT - DISEASED PLANTS / m^2

	TREATMENTS					
COOPERATOR	1 RAKE SINGLE	2 RAKE DOUBLE	3 NO-RAKE SINGLE	4 NO-RAKE DOUBLE	5 PLANTER	F VALUE
Groenewegen	2.45 b	2.80 b	2.45 b	3.28 b	0.40 a	1.95
Myslik	0.4	0	0.825	0	0.575	N.S. 0.49

Values in the same row with different letters are significantly different at the 0.05 probability level

5.4 Yields

The 1989 yield data do not allow specific conclusions. In three out of five sites, the planter (check) yields were significantly greater than any of the other four treatments cooperator (Table 17). There was no consistent yield difference that could be related to one of the four Tye drill treatments.

Single degree of freedom comparisons, such as rake versus no-rake, single versus double presswheel, do not support definite conclusions with respect to method of soybean planting using the Tye drill.

Table 17. TYE DRILL MODIFICATIONS 1989

YIELDS - BU/A

	TREATMENTS					
COOPERATOR	1 RAKE SINGLE	2 RAKE DOUBLE	3 NO-RAKE SINGLE	4 NO-RAKE DOUBLE	5 PLANTER	F VALUE
Rigby	43.2 b	41.9 b	31.1 a	36.0 a	51.8 b	9.45
DeBrouwer	49.5 a	48.3 a	48.4 a	45.5 a	54.8 b	4.67
Groenewegen	46.8 a	49.4 b	51.9 c	51.7 c	50.0 b	1.17
Myslik	28.8 b	30.6 c	26.4 a	29.5 b	33.0 d	1.18
Cumming	44.4 a	43.5 a	42.3 a	41.0 a	50.7 b	4.96

Values in the same row with different letters are significantly different at the 0.05 probability level

5.5 General Observations (Year 2)

The season was relatively "normal", compared to the drought of 1988, but was fairly dry during July, August and September (Table 4). Only 30 mm of precipitation fell in July, while about 50 mm fell in August and 60 mm in September. We suspect that with these dry conditions, our fields offered plants little moisture reserves to draw on.

Four out of five sites were planted in quite good time. Myslik's plot went in late, but caught up fairly well only to be hit by an early frost, which reduced the yields to about 60% of the yields at the other sites. The other sites had individual minor problems, as could be expected, but not any which would negate the results.

6.0 Conclusions and Recommendations

As mentioned previously on several occasions - it is impossible to draw any definite conclusions from the 1989 data. Consistent patterns or trends useful in evaluating the treatments were absent. The Hegie small plot combine had difficulty in picking up all available beans and possibly resulted in some yield losses. It is not certain that such losses were consistent between plots.

Despite apparent visual and physical differences caused by either coulter arrangements, rakes or packer wheels which appeared to change the seedbed environment in a positive fashion, none of the differences were significant on the small plots used in this experiment.

We have learned that seed placement is of utmost importance and minor adjustments to the coulters are suggested. Better seed placement and coverage could be achieved by a combination of improved balance between the front and rear of the Tye drill and/or more pressure up front, achieved by either spring action or weight. Under no circumstances should seeding occur under improper soil conditions; i.e. too wet (moist) a seedbed would destroy any coulter or rake action the machinery was set-up to achieve.

It is suggested that the farm group repeat the 1989 treatments with the minor adjustments suggested above on a limited commercial field scale, using a standard bean combine and weigh wagon in orderto better emulate farm practice and to search for treatment differences. Each of the cooperators is in full agreement with these conclusions and would support such an experiment in 1990.

6.1 The Farmers' Report

We were disappointed with the results of this study. We had hoped to make the no-till drill perform to our satisfaction so that we could eliminate the need for two separate planters; one to plant soybeans and one to plant small grains. The no-till drill did not perform to our expectations.

The results shown in this report may not reflect an accurate picture of our experience. The yields from the first year may have been biassed toward the grain drill because we found it difficult to keep border row beans out of our sample. In year 2, we corrected this problem by harvesting the border rows first. The no-till drill was inconsistent in its performance across the field, tending to plant too deep as we crested over a hill, causing a reduction in stand in these locations. We positioned our plots in the flat areas of the field to try and reduce our variables, therefore the report doesn't reflect this problem.

This has been a good learning experience for the farmers involved in this project; we now have a better appreciation for the work researchers do.

More work needs to be done and we have ideas that could be pursued. However, we decided it would not be a wise expenditure of funds to carry on this project for a third year.

7.0 Appendices

Appendix A Data Files (Year 1)

Appendix B Data Files (Year 2)

Appendix C Photographs of the equipment used in the research

APPENDIX A

Data Files (Year 1)

Data file: **RIGBY 4**

Title: **TYE DRILL MODIFICATIONS**

Function: PRLIST

Data case no. 1 to 57

Without selection

LIST OF VARIABLES

VA R	TYPE	NAME/DESCRIPTION
1	text 7	FARMER
2	numeric	REPNO.
3	numeric	TREAT NO.
4	numeric	YIELD BU/A 14%
5	numeric	D0 - PLANTING DAY
6	numeric	D1 - DAYS
7	numeric	D1 - PLANTS/M^2
8	numeric	D2 - DAYS
9	numeric	D2 - PLANTS/M^2
10	numeric	D3 - DAYS
11	numeric	D3 - PLANTS/M^2
12	numeric	D4 - DAYS
13	numeric	D4 - PLANTS/M^2
14	numeric	D5 - DAYS
15	numeric	D5 - PLANTS/M^2
16	numeric	D6 - DAYS
17	numeric	D6 - PLANTS/M^2
18	numeric	D7 - DAYS
19	numeric	D7 - PLANTS/M^2
20	numeric	D8 - DAY
21	numeric	D8 - PLANTS/M^2

Data file **RIGBY4**

Title: **TYE DRILL MODIFICATIONS**

CASE No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	2
1	CUMMING	1	1		141	152	36.7	153	38.3	154	44.4	156	44.4	158	56.1	160	58.9	162	60.0	169	57.2
2	CUMMING	1	2	55.4	141	152	21.7	153	23.3	154	28.9	156	33.9	158	37.8	160	38.9	162	40.6	169	40.6
3	CUMMING	1	3	48.6	141	152	13.3	153	18.9	154	30.2	156	33.7	158	35.1	160	37.2	162	37.9	169	37.9
4	CUMMING	2	1	53.6	141	152	48.3	153	48.3	154	51.1	156	52.8	158	53.9	160	54.4	162	53.3	169	55.0
5	CUMMING	2	2	69.5	141	152	46.7	153	52.2	154	52.8	156	56.7	158	56.7	160	51.1	162	57.7	169	56.7
6	CUMMING	2	3	44.2	141	152	28.1	153	31.6	154	30.9	156	33.0	158	34.4	160	35.1	162	35.9	169	35.9
7	CUMMING	3	1	57.2	141	152	25.0	153	30.0	154	36.7	156	41.1	158	43.9	160	42.2	162	40.0	169	45.0
8	CUMMING	3	2	39.3	141	152	26.1	153	33.3	154	36.7	156	38.3	158	42.2	160	45.0	162	46.7	169	46.7
9	CUMMING	3	3	39.4	141	152	18.2	153	22.4	154	26.7	156	31.6	158	35.9	160	37.2	162	38.6	169	38.6
10	CUMMING	4	1	65.4	141	152	20.6	153	26.7	154	36.1	156	46.1	158	48.9	160	50.6	162	49.4	169	51.7
11	CUMMING	4	2	60.9	141	152	41.1	153	52.2	154	55.6	156	60.0	158	61.7	160	63.3	162	62.8	169	61.7
12	CUMMING	4	3	41.7	141	152	12.6	153	17.5	154	23.9	156	26.7	158	29.5	160	31.6	162	32.3	169	31.6
13	HENRY	1	1	58.9	132	142	2.8	143	14.4	144	22.2	146	26.7	148	32.8	151	40.6	153	41.7	169	45.6
14	HENRY	1	2	65.1	132	142	3.9	143	9.4	144	22.8	146	16.1	148	33.9	151	37.8	153	37.8	169	41.1
15	HENRY	1	3	47.8	132	142	8.6	143	16.5	144	30.6	146	34.5	148	36.9	151	40.0	153	41.6	169	41.6
16	HENRY	2	1	68.0	132	142	3.9	143	5.6	144	8.9	146	10.6	148	21.7	151	30.6	153	32.8	169	31.7
17	HENRY	2	2	59.6	132	142	2.8	143	6.7	144	12.8	146	13.9	148	23.3	151	30.0	153	32.2	169	37.2
18	HENRY	2	3	47.0	132	142	10.2	143	14.1	144	17.3	146	17.3	148	20.4	151	22.0	153	21.2	169	22.0
19	HENRY	3	1	61.3	132	142	3.9	143	3.9	144	8.9	146	8.9	148	16.1	151	18.9	153	18.9	169	25.6
20	HENRY	3	2	60.4	132	142	5.0	143	8.9	144	11.1	146	12.8	148	18.3	151	24.4	153	31.1	169	25.6
21	HENRY	3	3	50.7	132	142	7.8	143	13.3	144	21.2	146	20.4	148	31.4	151	32.9	153	30.6	169	33.7
22	HENRY	4	1	61.5	132	142	3.9	143	6.7	144	17.8	146	21.1	148	28.3	151	30.6	153	32.8	169	33.3
23	HENRY	4	2	54.3	132	142	3.9	143	10.6	144	22.2	146	23.3	148	33.3	151	42.2	153	43.9	169	46.7
24	HENRY	4	3	55.9	132	142	11.0	143	14.9	144	28.2	146	32.2	148	40.8	151	42.4	153	43.1	169	39.2
25	HUFFMAN	1	1	59.7	144	152	43.3	153	48.9	154	56.1	156	66.1	158	70.0	160	71.1	162	70.0	169	70.6
26	HUFFMAN	1	2	60.0	144	152	36.7	153	45.6	154	51.7	156	56.7	158	62.8	160	63.3	162	63.3	169	63.9
27	HUFFMAN	1	3	38.2	144	152	48.4	153	50.5	154	50.5	156	52.6	158	54.0	160	54.7	162	55.4	169	54.0
28	HUFFMAN	2	1	48.2	144	152	46.1	153	61.7	154	72.8	156	81.7	158	83.9	160	87.8	162	87.8	169	87.8
29	HUFFMAN	2	2	40.8	144	152	55.6	153	63.3	154	67.2	156	72.2	158	74.4	160	79.4	162	81.1	169	81.1
30	HUFFMAN	2	3	41.1	144	152	45.6	153	51.2	154	54.7	156	56.1	158	56.1	160	56.1	162	56.1	169	55.4
31	HUFFMAN	3	1	49.2	144	152	31.7	153	36.7	154	48.3	156	58.9	158	66.7	160	66.7	162	67.8	169	68.3
32	HUFFMAN	3	2	51.9	144	152	53.3	153	55.6	154	62.8	156	71.7	158	73.3	160	73.9	162	74.4	169	73.9
33	HUFFMAN	3	3	42.7	144	152	45.6	153	51.2	154	38.6	156	54.7	158	55.4	160	54.0	162	54.0	169	51.9
34	HUFFMAN	4	1	55.9	144	152	41.7	153	48.9	154	53.9	156	61.1	158	61.1	160	66.7	162	68.9	169	65.0
35	HUFFMAN	4	2	43.1	144	152	57.8	153	65.0	154	68.9	156	81.1	158	83.9	160	83.3	162	82.2	169	79.4
36	HUFFMAN	4	3	41.6	144	152	27.4	153	35.1	154	44.2	156	45.6	158	52.6	160	53.3	162	53.3	169	54.0
37	MYSLIK	1	1	63.2	134	145	4.4	147	17.8	149	27.2	151	27.8	153	30.0	155	29.4	162	30.6	169	28.9
38	MYSLIK	1	2	56.1	134	145	0.6	147	2.8	149	8.3	151	13.3	153	18.3	155	21.1	162	23.3	169	24.4
39	MYSLIK	1	3	31.1	134	145	4.2	147	7.7	149	21.8	151	23.2	153	23.9	155	24.6	162	23.9	169	22.5
40	MYSLIK	2	1	43.8	134	145	12.2	147	15.6	149	23.9	151	21.7	153	23.3	155	22.8	162	23.9	169	24.4
41	MYSLIK	2	2	85.8	134	145	9.4	147	12.2	149	20.6	151	22.8	153	23.3	155	25.6	162	25.6	169	25.0
42	MYSLIK	2	3	26.7	134	145	0.0	147	0.0	149	6.3	151	9.8	153	16.1	155	16.1	162	16.8	169	18.2
43	MYSLIK	3	1	52.3	134	145	16.1	147	34.4	149	38.3	151	41.1	153	41.7	155	41.7	162	41.1	169	40.6
44	MYSLIK	3	2	30.0	134	145	2.2	147	5.0	149	15.0	151	18.9	153	22.2	155	22.8	162	23.3	169	23.9
45	MYSLIK	3	3	13.6	134	145	0.0	147	1.4	149	4.2	151	7.7	153	15.4	155	16.1	162	17.5	169	15.4
46	RIGBY	1	1	60.4	134	145	8.3	147	16.7	149	27.8	151	20.0	153	17.8	155	20.0	162	22.2	169	21.7
47	RIGBY	1	2	46.5	134	145	3.3	147	4.4	149	15.0	151	23.3	153	17.2	155	20.0	162	20.0	169	21.1
48	RIGBY	1	3	70.6	134	145	6.3	147	11.8	149	23.5	151	22.0	153	22.0	155	22.0	162	22.0	169	22.0
49	RIGBY	2	1	62.7	134	145	7.2	147	14.4	149	18.3	151	17.2	153	19.4	155	20.6	162	23.9	169	27.2
50	RIGBY	2	2	57.6	134	145	3.9	147	5.6	149	7.8	151	8.3	153	12.8	155	13.3	162	12.2	169	11.7
51	RIGBY	2	3	35.6	134	145	1.6	147	7.1	149	14.1	151	13.3	153	19.6	155	21.2	162	21.2	169	22.7
52	RIGBY	3	1	57.6	134	145	5.0	147	7.8	149	11.7	151	15.5	153	17.2	155	17.8	162	18.3	169	17.8
53	RIGBY	3	2	56.6	134	145	7.8	147	11.1	149	14.4	151	13.9	153	19.4	155	22.2	162	21.7	169	21.1
54	RIGBY	3	3	56.7	134	145	3.1	147	7.1	149	20.4	151	23.5	153	24.3	155	23.5	162	24.3	169	23.5

Data file: RIGBY 4
Title: TYE DRILL MODIFICATIONS

CASE No.	1	2	3	4	5	6	7	3	9	10	11	12	13	14	15	16	17	18	19	20	21
55	RIGBY	4	1	61.7	134	145	5.6	147	8.3	149	11.1	151	15.6	153	17.8	155	18.9	162	21.1	169	21.1
56	RIGBY	4	2	49.9	134	145	5.0	147	7.8	149	19.4	151	18.3	153	23.3	155	25.0	162	27.2	169	26.7
57	RIGBY	4	3	51.4	134	145	5.5	147	13.3	149	30.6	151	34.5	153	33.7	155	33.7	162	33.7	169	32.9

APPENDIX B

Data Files (Year 2)

Data File: **RIGBY 189**
Title: **TYEDRILL MODIFICATIONS**

Function: **PRLIST**
Data Case No. 1 to 20
Without selection

LIST OF VARIABLES

VAR	TYPE	NAME/ DESCRIPTION
1	text 7	FARMER
2	numeric	REP NO.
3	numeric	TREAT NO.
4	numeric	YIELD BU/A 14%
5	numeric	D0 - PLANTING DAY
6	numeric	D1 - DAYS
7	numeric	D1 - PLANTS/M^2
8	numeric	D2 - DAYS
9	numeric	D2 - PLANTS/M^2
10	numeric	D3 - DAYS
11	numeric	D3 - PLANTS/M^2
12	numeric	D4 - DAYS
13	numeric	D4 - PLANTS/M^2
14	numeric	D5 - DAYS
15	numeric	D5 - PLANTS/M^2
16	numeric	D6 - DAYS
17	numeric	D6 - PLANTS/M^2
18	numeric	HEIGHT CM
19	numeric	POPULATION PLANTS/M^2
20	numeric	ROOT ROT DISEASED PLTS/M^2
21	numeric	PODS NO./M^2
22	numeric	SEED WEIGHTS(100 SEEDS) GRAMS

AEE No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	RIGBY	1	1	0.0	149	158	1.1	159	1.6	161	7.5	164	26.9	167	44.7	172	51.1	62.7	32.8	0.0	43.5	15.61
2	RIGBY	1	2	0.0	149	158	0.0	159	0.0	161	1.1	164	9.1	167	21.0	172	31.2	66.7	31.1	0.0	49.2	15.33
3	RIGBY	1	3	0.0	149	158	0.5	159	1.1	161	2.7	164	8.1	167	24.8	172	34.4	67.7	29.5	0.0	31.2	15.79
4	RIGBY	1	4	0.0	149	158	0.0	159	2.2	161	6.7	164	15.1	167	31.2	172	36.6	64.7	32.8	0.0	50.0	15.10
5	RIGBY	1	5	0.0	149	158	0.0	159	3.8	161	21.3	164	44.8	167	71.4	172	68.4	66.0	48.6	0.0	28.9	16.17
6	RIGBY	2	1	42.1	149	158	1.1	159	1.6	161	1.6	164	16.1	167	38.8	172	50.6	70.3	23.0	0.0	38.6	15.74
7	RIGBY	2	2	36.2	149	158	0.0	159	0.0	161	0.5	164	2.2	167	12.4	172	33.4	63.7	29.5	0.0	52.5	14.73
8	RIGBY	2	3	35.9	149	158	0.0	159	1.6	161	3.8	164	9.7	167	26.4	172	35.5	58.3	31.1	0.0	49.2	15.45
9	RIGBY	2	4	29.9	149	158	0.0	159	0.0	161	0.0	154	0.5	167	6.5	172	19.9	60.0	26.2	0.0	41.0	15.07
10	RIGBY	2	5	46.5	149	158	2.3	159	11.4	161	32.7	164	51.7	167	63.1	172	62.3	87.0	53.2	0.0	70.6	14.76
11	RIGBY	2	1	43.9	149	158	0.0	159	0.0	161	0.5	164	0.5	167	5.4	172	22.6	70.0	31.1	0.0	55.0	15.27
12	RIGBY	3	2	44.0	149	158	0.0	159	2.2	161	8.1	164	12.9	167	32.3	172	38.8	62.0	42.6	0.0	43.5	16.08
13	RIGBY	3	3	31.0	149	158	0.0	159	0.0	161	0.0	164	2.7	167	5.9	172	9.7	64.0	41.9	0.0	49.2	16.07
14	RIGBY	3	4	40.9	149	158	0.0	159	0.5	161	2.2	164	9.7	167	29.9	172	39.8	66.0	32.8	0.0	62.3	15.37
15	RIGBY	3	5	58.2	149	158	0.8	159	5.3	161	19.8	164	50.2	167	72.2	172	75.2	80.0	50.9	0.0	56.7	17.49
16	RIGBY	4	1	43.7	149	158	0.5	159	1.6	161	3.2	164	8.1	167	24.2	172	40.9	69.0	39.3	0.0	45.9	15.82
17	RIGBY	4	2	45.4	149	158	0.0	159	1.6	161	2.2	164	4.8	167	21.5	172	35.0	67.7	41.0	0.0	65.6	15.19
18	RIGBY	4	3	26.3	149	158	0.0	159	0.0	161	0.0	164	1.1	167	13.5	172	20.5	64.3	29.5	0.0	66.4	15.88
19	RIGBY	4	4	37.3	149	158	0.0	159	0.0	161	0.0	164	0.5	167	4.3	172	17.2	57.7	18.0	0.0	45.9	14.86
20	RIGBY	4	5	50.6	149	158	0.8	159	2.3	161	14.4	164	35.0	167	54.7	172	57.0	80.0	53.2	2.3	24.3	16.28

Data File: **RIGBY 189**
Title: **TYE DRILL MODIFICATIONS**
Function: **PRLIST**
Data case no. **21 to 70**
Without selection

CASE NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
21	DEBROUW	1	1	41.7	149	158	23.7	159	30.7	161	43.1	164	51.7	167	64.0	172	63.0	81.0	54.1	0.0	95.2	16.98
22	DEBROUW	1	2	47.9	149	158	14.0	159	28.0	161	35.5	164	40.4	167	47.9	172	51.1	73.7	37.7	0.0	117.3	16.41
23	DEBROUW	1	3	46.7	149	158	3.2	159	7.0	161	17.8	164	30.1	167	47.9	172	50.1	82.0	47.5	0.0	91.9	15.78
24	DEBROUW	1	4	44.1	149	158	6.5	159	18.8	161	24.8	164	33.9	167	47.4	172	52.7	90.0	41.0	0.0	94.3	17.64
25	DEBROUW	1	5	56.3	149	158	2.3	159	16.7	161	29.6	164	64.6	167	81.3	172	81.3	85.0	39.4	2.3	61.3	17.00
26	DEBROUW	2	1	54.3	149	158	2.7	159	8.1	161	16.7	164	26.9	167	45.2	172	53.8	93.7	39.3	1.6	52.5	15.96
27	DEBROUW	2	2	50.9	149	158	12.9	159	22.1	161	33.9	164	41.4	167	46.8	172	50.1	87.7	36.1	0.0	48.4	18.54
28	DEBROUW	2	3	47.4	149	158	32.8	159	40.9	161	50.1	164	54.4	167	57.1	172	57.6	90.0	41.0	0.0	52.5	20.70
29	DEBROUW	2	4	49.4	149	158	11.9	159	17.8	161	28.5	164	36.1	167	39.3	172	40.9	83.7	31.1	0.0	64.8	16.40
30	DEBROUW	2	5	55.3	149	158	42.6	159	59.3	161	75.2	164	88.1	167	91.9	172	89.7	90.0	74.1	0.0	61.3	16.41
31	DEBROUW	3	1	44.4	149	158	14.5	159	21.5	161	30.1	164	43.1	167	54.4	172	58.1	66.7	52.5	0.0	28.7	18.49
32	DEBROUW	3	2	46.1	149	158	10.2	159	23.7	101	31.8	164	37.7	167	47.4	172	50.1	73.3	45.9	0.0	64.8	16.99
33	DEBROUW	3	3	51.1	149	158	11.3	159	19.9	161	27.4	164	29.1	167	49.5	172	54.9	60.7	27.9	0.0	25.4	16.88
34	DEBROUW	3	4	43.0	149	158	12.9	159	24.8	161	36.1	164	46.3	167	50.6	172	52.2	66.0	27.9	0.0	50.0	17.76
35	DEBROUW	3	5	52.4	149	158	30.4	159	40.3	161	51.7	164	60.0	167	66.1	172	67.6	78.0	53.2	0.0	33.6	16.74
36	DEBROUW	4	1	0.0	149	158	12.9	159	17.8	161	26.4	164	28.0	167	42.5	172	50.1	63.0	32.8	0.0	46.8	17.14
37	DEBROUW	4	2	0.0	149	158	10.2	159	18.8	161	34.4	164	39.3	167	46.8	172	48.4	66.7	44.3	0.0	60.7	17.31
38	DEBROUW	4	3	0.0	149	158	22.6	159	32.8	161	40.1	164	46.8	167	54.4	172	57.1	63.0	57.4	3.3	41.8	17.78
39	DEBROUW	4	4	0.0	149	158	10.2	159	17.8	161	28.5	164	38.8	167	43.1	172	49.0	70.0	47.5	0.0	56.6	17.26
40	DEBROUW	4	5	0.0	149	158	29.6	159	38.0	161	44.8	164	47.9	167	47.9	172	55.5	73.0	46.3	0.0	53.2	16.71
41	GROENEW	1	1	47.3	150	158	3.2	159	4.8	161	8.6	164	25.8	167	49.0	173	55.4	78.7	50.8	3.3	61.5	18.41
42	GROENEW	1	2	52.3	150	158	21.0	159	34.4	161	39.3	164	57.1	167	67.3	173	68.9	78.7	55.7	3.3	59.1	17.78
43	GROENEW	1	3	49.2	150	158	14.5	159	21.0	161	36.6	164	50.1	167	63.5	173	65.7	72.3	65.6	4.9	39.4	18.46
44	GROENEW	1	4	51.6	150	158	20.5	159	24.8	161	36.6	164	45.2	167	60.8	173	67.8	76.0	63.9	4.9	46.8	17.98
45	GROENEW	1	5	50.1	150	158	17.1	159	27.9	161	38.8	164	55.8	167	64.1	173	65.1	83.0	56.7	0.0	44.1	17.12
46	GROENEW	2	1	51.3	150	158	1.6	159	5.4	161	8.6	164	20.5	167	45.7	173	51.7	90.0	60.7	4.9	56.6	17.90
47	GROENEW	2	2	50.8	150	158	7.5	159	14.5	161	31.8	164	40.4	167	52.7	173	54.4	76.7	54.1	1.6	66.4	16.65
48	GROENEW	2	3	41.3	150	158	3.8	159	4.3	161	16.7	164	31.2	167	49.5	173	56.0	65.0	54.1	3.3	31.2	16.93
49	GROENEW	2	4	31.5	150	158	13.5	159	20.5	151	25.3	164	37.7	167	51.5	173	52.7	82.0	62.3	4.9	52.5	17.83
50	GROENEW	2	5	55.2	150	158	18.1	159	32.6	161	40.3	164	51.7	167	57.4	173	57.9	80.0	56.7	0.0	32.3	18.06
51	GROENEW	3	1	44.7	150	158	0.0	159	0.0	161	2.7	164	12.9	167	24.8	123	29.6	73.0	34.4	0.0	60.7	17.72
52	GROENEW	3	2	49.6	150	158	2.2	159	7.5	161	21.0	164	38.2	167	46.3	173	49.5	71.7	29.5	3.0	55.8	18.09
53	GROENEW	3	3	49.0	150	158	9.7	159	17.8	161	25.8	164	32.3	167	54.4	173	58.1	79.3	42.6	0.0	50.0	17.66
54	GROENEW	3	4	51.5	150	158	11.8	159	24.8	161	32.8	164	41.4	167	53.8	173	53.8	91.7	49.2	0.0	50.0	17.55
55	GROENEW	3	5	48.5	150	158	20.2	159	31.5	151	53.7	164	66.7	167	79.1	173	80.6	70.0	47.2	1.6	55.1	17.88
56	GROENEW	4	1	43.9	150	158	4.3	159	11.3	161	18.3	164	30.7	167	44.7	173	46.8	61.7	41.0	1.5	78.8	19.16
57	GROENEW	4	2	44.8	150	158	3.8	159	14.0	151	26.9	164	37.7	167	49.5	173	49.5	78.3	36.1	3.3	72.2	13.14
58	GROENEW	4	3	59.9	150	158	14.5	159	29.1	161	45.5	164	55.4	167	59.7	173	60.3	86.7	37.7	1.6	69.7	17.05
59	GROENEW	4	4	52.0	150	158	22.1	159	30.7	161	42.5	164	51.1	167	56.5	173	56.0	96.3	55.7	3.3	37.7	18.26
60	GROENEW	4	5	46.1	150	158	31.5	159	49.1	161	58.4	164	61.0	167	64.6	173	64.1	96.0	53.5	0.0	39.4	17.67
61	MYSLIK	1	1	28.4	162	170	50.6	171	68.9	173	74.8	178	77.0					73.0	62.3	0.0	45.1	20.37
62	MYSLIK	1	2	36.3	162	170	28.5	171	56.0	173	57.6	178	59.2					78.7	72.0	0.0	52.5	21.13
63	MYSLIK	1	3	18.7	162	170	10.8	171	33.9	173	60.3	178	60.3					50.0	75.4	0.0	47.6	19.06
64	MYSLIK	1	4	34.9	162	170	29.1	171	64.0	173	65.1	178	70.5					60.3	44.3	0.0	28.7	18.51
65	MYSLIK	1	5	29.9	162	170	38.1	171	63.2	173	79.5	178	79.5					56.0	76.6	0.0	10.4	20.15
66	MYSLIK	2	1	27.6	162	170	33.9	171	60.8	173	71.6	178	72.1					73.3	54.1	0.0	33.6	20.32
67	MYSLIK	2	2	28.1	162	170	29.1	171	54.9	173	61.9	178	63.5					63.0	57.4	0.0	33.6	22.31
68	MYSLIK	2	3	28.5	162	170	26.4	171	54.9	173	60.3	178	60.8					53.7	34.4	0.0	32.0	20.37
69	MYSLIK	2	4	20.0	162	170	33.4	171	59.7	173	65.1	178	67.3					52.7	54.1	0.0	33.6	19.83
70	MYSLIK	2	5	29.5	162	170	44.9	171	76.1	173	84.3	178	84.3					50.0	58.0	0.0	20.7	19.01

Data File: **RIGBY 189**
Title: **TYE DRILL MODIFICATIONS**
Function: **PRLIST**
Data case no. **71 to 100**
Without selection

CASE No.	1	2	3	4	5	6	7	3	9	10	11	12	13	14	15	16	17	18	19	20	21	22
71	MYSLIK	3	1	33.5	162	170	43.6	171	69.4	173	72.1	178	72.7					62.0	68.9	0.0	22.1	20.89
72	MYSLIK	3	2	32.6	162	170	18.8	171	56.5	173	64.0	178	64.0					60.0	54.5	0.0	35.3	19.48
73	MYSLIK	3	3	31.8	162	170	19.9	171	48.4	173	49.5	178	51.7					59.3	49.2	0.0	40.2	19.81
74	MYSLIK	3	4	34.7	162	170	28.0	171	38.8	173	46.3	178	51.1					58.7	41.0	0.0	34.5	20.63
75	MYSLIK	3	5	37.6	162	170	39.4	171	56.4	173	59.8	178	59.1					63.0	62.1	0.0	34.2	19.20
76	MYSLIK	4	1	25.7	162	170	41.4	171	69.4	173	75.3	178	76.4					49.7	93.4	0.0	21.3	22.27
75	MYSLIK	4	2	25.2	162	170	29.6	17!	54.4	173	56.5	179	58.1					61.3	62.3	0.0	28.7	20.95
78	MYSLIK	4	3	26.4	162	170	31.2	171	52.2	173	64.0	178	67.3					54.3	52.5	0.0	23.8	21.71
79	MYSLIK	4	4	28.3	162	170	12.9	171	33.4	173	58.7	178	63.5					53.3	50.8	0.0	17.2	21.74
80	MYSLIK	4	5	35.1	162	170	48.9	171	77.5	173	79.5	178	79.5					55.0	60.4	0.0	34.2	19.54
81	CUMMING	1	1	40.5	162	170	17.2	171	33.4	173	45.2	178	50.1									16.00
82	CUMMING	1	2	46.9	162	170	9.1	171	17.3	173	29.6	173	37.7									15.99
83	CUMMING	1	3	47.3	162	170	14.5	171	23.7	173	40.4	178	45.2									16.91
84	CUMMING	1	4	38.1	162	170	18.3	171	23.7	173	37.1	178	45.2									15.61
85	CUMMING	1	5	48.0	162	170	19.7	171	34.0	173	38.7	178	50.3									15.87
86	CUMMING	2	1	50.6	162	170	4.3	171	12.4	173	36.1	178	48.9									16.66
87	CUMMING	2	2	46.4	162	170	11.3	171	17.2	173	23.1	178	31.2									16.34
88	CUMMING	2	3	41.7	162	170	4.3	171	8.6	173	27.4	173	36.6									15.43
89	CUMMING	2	4	45.1	162	170	10.8	171	17.8	173	36.1	178	46.8									16.78
90	CUMMING	2	5	54.4	162	170	14.3	171	27.9	173	52.3	178	61.2									16.86
91	CUMMING	3	1	41.9	162	170	11.8	171	17.8	173	28.5	178	40.4									15.46
92	CUMMING	3	2	44.5	162	170	7.5	171	17.8	173	29.6	178	35.5									16.27
93	CUMMING	3	3	41.7	162	170	0.5	171	12.4	173	27.9	178	34.4									15.13
94	CUMMING	3	4	43.9	162	170	16.1	171	25.8	173	40.9	178	49.0									15.23
95	CUMMING	3	5	52.0	162	170	23.1	171	53.0	173	59.8	178	59.8									16.13
96	CUMMING	4	1	44.4	162	170	10.8	171	23.7	173	41.4	172	47.4									17.91
97	CUMMING	4	2	36.2	162	170	1.6	171	7.5	173	15.8	178	22.1									17.42
98	CUMMING	4	3	38.4	162	170	14.5	171	19.9	173	33.9	178	46.3									16.32
99	CUMMING	4	4	36.8	162	170	8.6	171	10.2	173	19.4	178	23.7									16.97
109	CUMMING	4	5	48.4	162	170	6.8	171	18.4	173	40.8	178	46.9									16.28