(1) 4-12-36 plow-down in spring.

(2) 160 lbs. N broadcast and disked in before planting.

(3) 300 lbs. per acre banded (2" X 2")

(4) These plots were on the upper side of the field strips 6 and 7 and were very dry. Extending from these strips the moisture conditions were more favorable.

(5) On plots 17 and 18 there was excessive moisture that ruined the yield results.

Planting date - May 16

In Table 1, pop-up (starter) placement with band and different rates of broadcast placement indicate some increase in yield for a combination of band and broadcast placement over the starter. There was no injury to stand where the pop-up (starter) was used. There appeared to be no difference between the liquid and dry pop-up (starter) in yield and stand. Nitrogen was the most important single nutrient on these trials. No broadcast treatments had ever been applied on these fields so the basic fertility was about average to medium. The variations in treatments are generally the result of variable moisture and soil conditions. The planting date of May 16 was getting too late because of the continued dry weather for the remainder of May. All pop-up (starter) was applied at 3 rates of 10, 15, and 20 lbs. per acre for a total N and K. The two grades of fertilizer used was 10-30-12 (dry) and 7-21-7 (liquid).

Table 2. Broadcast, Band and Pop-up (starter) Fertilization for Corn - 1967.

Fertilizer Treatments	Yield in bu. per Acre			
	Lbs. Broadcast Placement per Acre (1)			
	Check	300 lbs. 1967	300 lbs. 1967 600 lbs. 1966	600 lbs. 1966
Check (North)	106.0	103.0	73.0	76.0
Check + N(1)	111.0	101.0	106.0	100.0
Band (2)	106.0	95.0	88.0	103.0
Band + N	137.0	130.0	134.0	136.0
Check (South)	85.0	88.0	47.0	66.0
	12-24-12 Dry Pop-up (Starter) (3)			
NK-10 lbs. + N	115.0	114.0	122.0	125.0
NK-15 lbs. + N	124.0	126.0	111.0	113.0
NK-20 lbs. + N	129.0	124.0	116.0	116.0

Field 34A
Planted May 15

(1) Nitrogen sidedressed at first cultivation at 160 lbs. of actual N per acre

(2) Band fertilizer at 300 lbs. per acre of 4-12-36

(3) Pop-up (Starter) applied with the seed at planting time of 10, 15, and 20 lbs. total N and K.

1967 broad cast fertilizer was 4-12-24 was applied to fall plowing and thoroughly disked in.

Cropping system - corn - soybeans - corn - soybeans

The purposes of the trials reported in Table 2 were to determine the residual carry-over of broadcast plow-down placement in 1966 with the broadcast plow-down made in 1967 in combination with pop-up (starter) and band placement. Here again N was the most important essential nutrient. Rates of the pop-up (starter) were 10, 15, and 20 lbs. per acre of total N and K as 12-24-12 (dry) grade. These results again reflect the variability

in moisture conditions since the planting was too late (May 15) when the remainder of May was very dry. The rate of 300 lbs. broadcast was the same rate per acre as that used in the band to see how the 2 placement methods would compare. Custom services are suggesting they apply all the basic fertilizer needs in the fall as plow-down and the farmer will then apply a small amount of starter in the spring at planting time. It would appear that the broadcast fertilizer in 1967 was as effective as the same grade and same amounts per acre placed in a band.

CORN AND SOYBEAN FERTILIZATION WITH BROADCAST, BANDED AND POP-UP (STARTER) PLACEMENT

Trials were continued in 1967 with various methods of fertilizer placement on corn and soybeans. Because of the extremely dry weather in May at planting time, some additional results were obtained on both corn and soybeans. Soybeans are not as sensitive to fertilizer salts of N and K as is generally believed but are more sensitive than corn. However, some of the better soybean producers in Minnesota are reporting excellent results from pop-up (starter) on soybeans. As the basic soil fertility is increased by use of the fall plow-down placement, the total amount of N and K can be reduced. Even under the variable moisture conditions in 1967 on some of the older fields with longer programs of fall plow-down, 15 lbs. per acre of total N and K were just as effective as the higher rates of 20 lbs. As planting dates were delayed following the first of May, all fertilizer methods of placement seem to appear less effective. Especially was this true when plantings were made after May 15th. Under that dry weather conditons with soybeans planted May 29 when both liquid and dry pop-up (starter) fertilizers were compared, the liquid fertilizer was much better as is shown by the yields given in Table 4. On this same field a comparison of two planting rates of soybeans of 60 and 45 lbs. per acre. Table 4 shows the yields were comparable which tends to bear out why some of the better

soybean producers are planting at lighter rates per acre. Tables 2 and 3 on both corn and soybeans planted May 15 indicate the difference in comparative yields from treatment to treatment placement apparently because of more favorable moisture conditons at that time of the month. On the very late planting date of soybeans on Field 37 when the liquid and dry pop-up (starter) fertilizers were compared there apparently was a greater diffusion of the injurious fertilizer salts of N and K where liquid fertilizer was used. Injury to stand from the dry fertilizer was easily visible from 1/8 of a mile away. In Field 35A, Table 3, soybeans planted on May 15, there was no injury to stand that could be determined from the use of the dry pop-up (starter) fertilizer at the rates of 10 and 15 lbs. total N and K per acre. However, there was injury to stand at the 20 lbs. total N and K rate per acre. Pop-up (starter) advanced tasseling of corn about 4 to 6 days and resulted in at least 2.0% to 3.0% less moisture in the grain at harvest time.

Table 3. Broadcast, Band and Pop-up (starter) Fertilization for Soybeans - 1967

Fertilizer Treatments	Yield in bu. per acre			
	Lbs. Broadcast Placement per Acre (1)			
	Check	300 lbs. 1967	300 lbs. 1967 600 lbs. 1966	600 lbs. 1966
Check	26.6	26.6	28.3	26.6
Band (2)	26.6	28.3	28.3	28.3
NK-10 lbs. (3)	30.0	25.0	31.6	30.0
NK-15 lbs. (3)	31.6	28.3	31.6	28.3
NK-20 lbs. (3)	26.6	28.3	26.6	28.3

Field 35A

Planted May 15.

(1) Broadcast fertilizer was 4-12-24 in 1966 (plow-down) and 4-12-24 in 1967 (Disked in thoroughly).

(2) Band placement was 4-12-36 at 300 lbs. per acre.

(3) Pop-up (starter) was applied at 10, 15, and 20 lbs. per acre total N and K in contact with the seed at planting time. (12-24-12-dry).

Variety - Merit

Weed Spray - Banded with Randax.

Cropping system -- Soybeans - Corn - Soybeans - Corn.

Table 4. Liquid vs. Dry Pop-up (starter) Fertilizer for Soybeans at Two Planting Rates - 1967.

Fertilizer Treatments	Yield in bu. per Acre							
	60 lbs. planting rate/acre				45 lbs. planting rate/acre			
	Dry (1)		Liquid (2)		Dry		Liquid	
	No Broad-cast	(3) Broad-cast	No Broad-cast	Broad-cast	No Broad-cast	Broad-cast	No Broad-cast	Broad-cast
Check	28.3	28.3	28.3	28.3	23.3	25.0	23.3	25.0
Band (4)	25.0	25.0	25.0	25.0	31.6	30.0	31.6	30.0
NK-10 lbs. (5)	20.0	20.0	26.6	26.6	25.0	21.6	30.0	23.3
NK-10 lbs. + Band	20.0	28.3	23.3	26.6	21.6	21.6	28.3	26.6
NK-15 lbs.	18.3	23.3	28.3	26.6	21.6	15.0	30.0	25.0
NK-15 lbs. + Band	23.3	21.6	30.0	28.3	26.6	15.0	28.3	26.6
NK-20 lbs.	13.3	15.0	28.3	21.6	18.3	13.3	28.3	23.3
NK-20 lbs. + Band	20.0	16.6	28.3	26.6	16.6	13.3	25.0	26.6

Field 37

(1) Dry fertilizer was 10-30-12

(2) Liquid fertilizer was 7-21-7

(3) Broadcast fertilizer was plow-down of 800 lbs. per acre 4-12-24 in spring of 1966.

(4) Band fertilizer was 4-12-36 at 300 lbs. per acre.

(5) Pop-up (starter) was applied at 10, 15, and 20 lbs. per acre total N and K in contact with the seed at planting time.

Variety - Merit

Weed Spray - Jaeflan

Planted May 29 (very dry)

BROADCAST PLOW-DOWN FERTILIZER PLACEMENT WITH BAND AND BAND PLUS SIDEDRESSED NITROGEN ON CONTINUOUS CORN AND CORN IN A CROP ROTATION SYSTEM

Trials were continued in 1967 where a basic broadcast plow-down placement of fertilizer has been made every three years regardless of the crop that appeared in that particular year of the rotation. The grade of fertilizer applied was based on soil test and applied at two rates of 300 and 600 lbs. per acre. This study was started in 1959 using 0-20-20 but because the levels of potash remained at a medium range the grade was changed in 1966 to 4-12-24 and to 4-12-36 in 1967. Additional treatments of band and sidedressing with N were made each year on continuous corn and on corn in three different crop rotation systems based on soil type topography and the degree of erosion. Less row crop was included in the more rolling and eroded soils. The rotations included were corn-oats-alfalfa hay (2 years), corn-soybeans-oats-alfalfa hay (1 year), and corn-soybeans-grain (alfalfa, green manure)-corn-oats-alfalfa hay (1 year). In 1966 the oats were discontinued because of their shattering at combining time that resulted in a volunteer growth in the fall that injured the stand and yield of the alfalfa hay crop the following year. Instead of the oats crop the fields are sprayed for grassy weed control in the spring and the alfalfa is then seeded in June. As a result of this practice the alfalfa hay yields have increased by at least 35 percent over the practice of seeding with a companion crop of oats. The yields of corn given in Tables 5 and 6 show the advantage of a crop rotation as compared to continuous corn. Yields increased from 68.4 bu. per acre for continuous corn to 77.0 bu. per acre for corn in the rotation. No fertilizer has ever been applied to these check areas. The big increase in yield when comparing the two cropping systems is the increase in response to nitrogen on the continuous corn. Yields can be comparable on

continuous corn if sufficient nitrogen is applied to make up for what is not supplied by the legume crop in the rotation. Difference over the years in favor of the rotation on the rolling and eroded soils have generally averaged above 20.0 bu. per acre in favor of the crop rotation system. There appears to be very little difference between the 300 and 600 lbs. rate of broadcast fertilizer. The band plus nitrogen about off-sets the band plus broadcast plus N. In Table 6 where the cropping system was continuous corn since 1956 the yields are generally much lower than the corn yields in a crop rotation system with the same fertilizer treatments and placement. In Table 7 similiar yields without broadcast fertilizer placements were obtained under the continuous corn cropping systems. These soils are not subject to erosion and have been cropped to continuous corn since 1952 except for fields 19A and 24A that have been in continuous corn since 1959. The check yield of 68.4 bu. per acre reflect the need for fertilizer or show the reduced level of fertility in terms of yields where no fertility and organic matter is added except from the corn stalk residue.

Table 5. Fertilized Corn Yields in a Crop Rotation System with Broadcast and Band Fertilizer Placement - 1967

Fertilizer Treatments	Yield in bu. per acre						
	Check	1959 1962 1965		1960 1963 1966		1961 1964 1967	
		300	600	300	600	300	600
Check	77.0	86.7	85.7	88.2	84.2	87.0	91.2
Band (1)	123.0	117.7	117.2	120.5	118.0	120.2	123.2
Band + N (2)	127.0	131.7	129.7	130.0	133.7	136.7	134.5

Yields includes first and second corn follow alfalfa hay and corn follow a green manure crop of alfalfa.

Fields 19-26-32-36

(1) Banded fertilizer 4-12-36 at 300 lbs. per acre.

(2) Nitrogen sidedressed at first cultivation with 100 lbs. of actual N per acre. (Ammonium Nitrate)

Table 6. Fertilized Corn Yields in a Continuous Corn Cropping System with Broadcast and Band Fertilizer Placement - 1967.

Fertilizer Treatments	Yield in bu. per acre						
	Check	1959 1964 1966		1960 1964 1967		1961 1964 1967	
		300	600	300	600	300	600
Check	70.0	64.5	78.0	79.0	76.5	84.5	94.5
Band (1)	103.7	107.5	111.5	110.0	116.5	116.0	120.0
Band + N (2)	125.0	125.0	134.0	125.5	132.0	125.5	123.0

Fields 10 and 31

(1) Banded fertilizer 4-12-36 at 300 lbs. per acre

(2) Nitrogen sidedressed at first cultivation with 160 lbs. of actual N per acre. (Ammonium Nitrate)

Table 7. Fertilized Corn Yields in a Continuous Corn Cropping System with Band Fertilizer Placement - 1967.

Fertilizer Treatments	Yield in bu. per acre
Check	68.4
Band (1)	102.5
Band + N(2)	127.2

Fields 17W-18-18A-19A-24A

Fields 17W-18-18A have been in continuous corn since 1952 --- 19A and 24A since 1959.

(1) Band --- 4-12-36 at 300 lbs. per acre.

(2) Nitrogen sidedressed at first cultivation at 160 lbs. per acre of actual N.

LIME AND MANURE ON CONTINUOUS CORN - 1967

On field 48 that has been in continuous corn since 1952, limed at 3 tons per acre in the fall of 1961 and has received 10 tons of manure per acre, per year trials were continued to compare lime and no lime for corn.

Many of the plots were drowned out in June following the dry month of May so the yield results are not complete for 1967. The results are shown in the following table.

Soil Treatments	Yields in bu. per acre
Check	69.0
Manure	116.0
Manure-lime	126.0
Band (1)-manure-lime	128.0 (Too wet)

Planted May 9

(1) Band --- 6-24-12 at 175 lbs. per acre.

Weed Control --- Atrazine broadcast after planting and disked in.

As soil fertility levels improve, high plant populations are used and larger amounts of fertilizer are applied . Corn is continuing to show more

response to the application of agricultural limestone.

FERTILIZED ALFALFA YIELDS

Trials were continued on alfalfa production in the various crop rotation systems of land use on crop land. Broadcast plow-down was made every three years regardless of the crop that appeared in that particular year of the rotation. The basic broadcast fertilizer applications included 0-20-20 and 4-12-24 at 300 and 600 lbs. per acre as previously described under the same treatments for corn in rotation. The year 1967 was not a good alfalfa hay year because of the very wet June which delayed hay harvest causing loss of leaves, coarse growth and reduction of the second crop which had started growth before the first hay crop was removed. In comparison to more normal years as far as distribution of moisture the 1967 fertilized hay yields were reduced more than 1.0 tons per. Total yields for 2 cuttings are usually 5.0 tons or more per acre.

Table 8 gives the yields for 2 cuttings of alfalfa hay. The yields in tons per acre compares the broadcast plow-down fertilizer and the yields per acre for the broadcast plow-down plus the residual carry-over of fertilizer applied previous years as a band placement for corn. These data indicate the response that maybe expected from the residual banded corn fertilizer in the improvement of the yield of alfalfa and the increase of the basic soil fertility level as corn fertilization continues in the crop rotation system. Both the broadcast and band placement contribute to the top yields of alfalfa hay.

Table 8. Fertilized Alfalfa Yields - 1967

Cuttings of Hay	Check	Yield in Tons per Acre					
		1959 1962 1965		1960 1963 1966		1961 1964 1967	
		300	600	300	600	300	600
		No Banded Residual Corn Fertilizer					
1st. cutting	2.02	2.24	2.11	2.22	2.42	2.40	2.56
2nd. cutting	1.04	1.36	1.51	1.44	1.60	1.16	1.62
Total	3.06	3.60	3.62	3.66	4.02	3.56	4.18
		Banded Residual Corn Fertilizer					
1st. cutting	1.77	2.36	2.29	2.41	2.43	2.59	2.60
2nd. cutting	1.41	1.67	1.67	1.73	1.79	2.04	2.07
Total	3.18	4.03	3.96	4.14	4.22	4.63	4.67

Fields 22 - 25 - 30.

Variety - Vernal

Alfalfa seeded without companion crop in June.

Continuous Corn - High Fertility Experiment
Rosemount Experiment Station
Established 1953

P. M. Burson, W. P. Martin, and G. W. Randall

This experiment was established in 1953. Yields have been measured annually for 15 years. During this time, soil and plant samples have been periodically taken and analyzed. Yield results from past years may be found in the 1963, 1964, 1965, 1966, and 1967 mimeographed "Bluebook".

Fertilizer treatment rates and population levels have been upgraded throughout the years to the present levels. Over the long term P and K have been applied at approximately a 1 : 1 ratio.

The corn was planted in 30 inch rows on May 16. Atrazine plus one cultivation was used to control weeds.

Yields obtained in 1967 were generally quite good, however, none were exceptionally high (Table 1). A slight response was shown to the first 100 pound increment of N at all levels of P and K. A further N addition of 100 pounds did not significantly increase the yields. Phosphorus and potassium applications gave no yield response. After 15 years yields from the check treatment were still over 100 bushels. A possible reason for this continued high yield may be due to the 4 foot depth of colluvium material on which this experiment is located. This soil would not be typical of most Minnesota soils.

Although some fertilizer response has been shown by the 15 year average yields, no striking yield differences have appeared. This again may be due to the plot location mentioned previously.

Table 1. The fertility treatment and corresponding 1967 and 15 year average corn yields.

Trt No.	Fertilizer Treatment*	1967 Yield** bu/a	15 Year Avg.** bu/a
1	0 + 0 + 0	100.1 a***	84.8
2	12 + 36 + 108	105.1 ab	92.9
3	112 + 36 + 108	114.2 cd	96.6
4	212 + 36 + 108	115.0 cd	99.9
5	28 + 84 + 252	106.4 abc	93.6
6	128 + 84 + 252	117.8 d	100.7
7	228 + 84 + 252	113.9 bcd	100.4
8	44 + 132 + 396	113.5 bcd	97.3
9	144 + 132 + 396	115.2 cd	102.3
10	244 + 132 + 396	113.9 bcd	102.6

* Pounds of $N+P_2O_5+K_2O$ applied this year.
** Combined yield average of the high and low populations at each fertility treatment.
*** Numbers followed by the same letter belong to the same .05 level population (Duncan's Multiple Range Test).

All fertility treatments were tested at two plant populations. Results given in Table 2 show higher yields at the high populations in 1967 and also over the 15 year period.

Table 2. The plant population and corresponding 1967 and 15 year average corn yie

Population plants/acre	1967 Yield * bu/a	15 Year Avg. bu/a
Low 20,000	102.8 a	91.5
High 26,000	120.2 b	102.7

* Combined yield average of all ten fertility treatments at each population.

Sixth leaf samples were taken at the silking stage from all high population plots for tissue analysis. Results are presented in Table 3.

Among the ten fertilizer treatments, highly significant differences were found in the leaf tissue concentrations of N, P, K, Mg, An, Mo and Mn. Concentration of N, P and K increased as the amount of each respective nutrient in the fertilizer treatments was increased. Manganese (Mn) content also increased with the higher fertilizer rates.

Leaf content of Mg, Zn, and Mo decreased with the higher rates of phosphate and potash. However, it appeared that the decreasing trend of Zn was reversed as higher rates of N were applied at eac h P and K treatment.

No significant differences among treatments were found in the tissue content of Ca, Fe, Cu and B.

Table 3. Spectographic analyses of sixth leaf in 1967 of continuous corn under variable fertilizer treatments.

Trt. No.	Fertilizer Treatment	%					ppm						
		N	P	K	Ca	Mg	Sr	Fe	Zn	Cu	Mo	Mn	B
1	0 + 0 + 0	2.54ab	.296a	1.51a	.639a	.448d	6.60c	210a	20.2cd	6.2a	.97c	50.1a	7.1a
2	12 + 36 +108	2.41a	.298a	1.93b	.599a	.339c	4.92abc	198a	14.0ab	5.7a	.82bc	49.3a	6.6a
3	112 + 36 +108	3.09d	.320ab	1.92b	.572a	.340c	5.49bc	207a	23.8d	6.6a	.87c	66.5b	7.0a
4	212 + 36 +108	2.96cd	.324ab	1.95b	.555a	.342c	4.13ab	227a	21.1cd	8.0a	.85c	69.7b	7.5a
5	28 + 84 +252	2.44a	.334abc	2.15bc	.590a	.273b	4.96abc	231a	13.0ab	5.1a	.70ab	65.2b	6.7a
6	128 + 84 +252	2.92cd	.378bcd	2.40cd	.519a	.257ab	4.17ab	228a	17.8bc	6.2a	.68ab	66.7b	7.4a
7	228 + 84 +252	3.03cd	.314ab	1.97bc	.475a	.204a	3.88ab	204a	15.4abc	5.5a	.63a	65.1b	6.5a
8	44 +132 +396	2.66abc	.402d	2.36cd	.528a	.232ab	3.23a	221a	11.8a	5.5a	.69ab	62.7b	6.4a
9	144 +132 +396	2.88bcd	.397cd	2.48d	.512a	.230ab	4.70abc	263a	16.9abc	5.9a	.69ab	83.4c	7.5a
10	244 +132 +396	2.98cd	.407d	2.45d	.546a	.249ab	4.70abc	244a	16.2abc	6.1a	.68ab	96.6d	7.8a
Significance		**	**	**	NS	**	**	NS	**	NS	**	**	NS
F value		5.07	4.48	10.53	1.98	12.60	2.33	1.61	4.38	1.35	4.90	3.47	1.24
CV		8.0	12.1	9.1	12.3	14.2	26.0	14.0	21.3	22.3	13.2	7.1	12.7

Weather Summary - 1967
West Central Experiment Station - Morris
Samuel D. Evans

Month	Period	Precipitation 1967	Precipitation Average 1930-59	Precipitation Deviation from Nor.	Air Temperature 1967	Air Temperature Average 1930-59	Air Temperature Deviation from Nor.	Temp. Soil(10cm) 1967
January	1-31	2.04	.56	+1.48	9.6	10.1	- 0.5	--
February	1-28	1.10	.67	+ .43	4.0	14.7	-10.7	--
March	1-31	.15	1.11	- .96	26.9	27.5	- 0.6	--
April	1-10	.60			37.5			38.8
	11-20	1.71			43.8			43.4
	21-30	.02			41.0			44.0
	Total	2.33	2.05	+ .28	40.8	43.3	- 2.5	42.1
May	1-10	.43			39.9			44.1
	11-20	.08			50.0			50.6
	21-31	.01			60.2			59.9
	Total	.52	3.07	-2.55	50.3	56.6	- 6.3	52.0
June	1-10	3.05			62.9			62.3
	11-20	1.43			65.6			65.4
	21-30	.61			64.2			67.2
	Total	5.09	3.79	+1.30	64.3	66.4	- 2.1	65.1
July	1-10	.72			64.7			67.0
	11-20	.52			68.3			70.3
	21-31	.14			72.0			74.4
	Total	1.38	3.25	-1.87	68.4	71.8	- 3.4	71.1
August	1-10	.59			67.1			69.0
	11-20	.62			68.3			70.5
	21-31	.37			72.0			64.9
	Total	1.58	2.87	-1.29	66.3	69.8	- 3.5	68.0
September	1-30	.59	1.94	-1.35	58.7	59.8	- 1.1	62.3
October	1-31	1.02	1.44	- .42	44.2	48.9	- 4.7	46.5
November	1-30	.07	1.09	-1.02	30.0	30.4	- 0.4	32.4
December	1-31	.92	.59	+ .33	18.0	17.0	+ 1.0	19.8
April 1-August 31 (Growing Season)		10.90	15.03	-4.13	58.1	61.7	- 3.6	59.7
January 1-Dec. 31 Annual		16.79	22.43	-5.64	40.3	43.0	- 2.7	--

Comparison of Phosphorus Sources
West Central Experiment Station
Samuel D. Evans

Plots were established at the West Central Experiment Station in 1967 to determine the effectiveness of 4 phosphorus materials supplied by TVA.

Table 1. Soil test values of the experimental area (McIntosh silt loam)

	Replicate					
	1	2	3	4	5	6
pH	7.4	7.4	7.4	7.4	7.4	7.5
O.M.%	6.2	5.1	6.3	5.7	5.7	5.7
Ext. P	10	8	7	7	18	6
Exch. K	250	250	260	240	270	240

Table 2. Zinc content (ppm) of corn plants harvested 7/10/67.

P source	Applied P_2O_5 - lbs./acre *			
	0	12	24	48
	Zinc in parts per million			
20-20-0 (Nitric Phosphate)	-	22.6	20.9	21.0
29-29-0 (Urea Ammonium Phosphate)	-	22.5	20.6	18.8
15-60-0 (Ammonium Polyphosphate)	-	24.4	22.6	19.7
15-56-0 (Ammonium Orthophosphate)	-	22.3	21.1	21.3
Check (No phosphorus applied)	25.2	-	-	-

* Additional nitrogen was applied to all plots to bring the total to 100 lbs. of actual N per acre. All of the above materials were broadcast and plowed down in the fall of 1966. The starter fertilizer used was 33 1/2-0-0 at 100 lbs./acre.

Table 3. Phosphorus content (ppm) of corn plants harvested 7/10/67.

P source	Applied P_2O_5 - lbs./acre 0	12	24	48
	Phosphorus in parts per million			
20-20-0	-	2750	3100	2975
29-29-0	-	2750	3050	3150
15-60-0	-	2800	2825	3100
15-56-0	-	2800	2850	3150
Check	2725	-	-	-

Table 4. P/Zn ratio of corn plants harvested 7/10/67.

P source	Applied P_2O_5 - lbs./acre 0	12	24	48
	P/Zn ratio			
20-20-0	-	123	151	142
29-29-0	-	123	149	169
15-60-0	-	117	128	158
15-56-0	-	126	136	148
Check	109	-	-	-

Table 5. Yield - Corn bushels/acre @ 15.5% moisture

P source	Applied P_2O_5 - lbs./acre 0	12	24	48
	Ear corn in bushels/acre			
20-20-0	-	66.88	72.90	68.64
29-29-0	-	64.12	71.48	87.02
15-60-0	-	70.96	71.40	72.44
15-56-0	-	68.95	70.82	72.26
Check	59.34	-	-	-

Summary: The urea-ammonium phosphate (29-29-0) significantly decreased the zinc content of the young plants, increased the P/Zn ratio, and increased yield. None of the other materials had a significant effect on these variables.

Variety - Trojan F98 Planted - May 20, 1967

Use of Varying Rates of Nitrogen & Starter on Corn in 1967
West Central Experiment Station - Morris
Samuel D. Evans

In the spring of 1967 an experiment was initiated on Doland silt loam to determine the effect of varying rates of nitrogen and starter on corn yields.

Table 1. Soil test results.

Sample No.	pH	O.M.%	Ext. P	Exch. K
1	6.9	5.5	12	310
2	6.7	5.5	9	260

Table 2. The yield of 1967 ear corn at Morris with varying rates of nitrogen and starter fertilizer.

Nitrogen lbs./acre	Starter (6-24-24) Applied (lbs./acre) 0	50	100	200
	Yield of ear corn @ 15.5% moisture			
0	69.1	72.0	64.8	76.2
50	74.4	76.7	67.4	73.0
150	73.2	83.4	67.7	71.1

Summary: Neither the nitrogen nor the starter fertilizers increased yields significantly over the check. All yields were low due to the dry, cool weather.

Variety - DeKalb XL 304 Planting date - May 17, 1967

Use of Seed Incorporated (Pop-up) Fertilizer
West Central Experiment Station - Morris
Samuel D. Evans

In the spring of 1967 an experiment was initiated to determine the effect of small amounts of seed incorporated fertilizer on early growth and yield of corn. The experiment was set up on a Doland silt loam on which various broadcast fertilizer rates were applied in the fall of 1966.

Table 1. Soil test data of the experimental area.

Sample No.	pH	O.M.%	Ext. P	Exch. K
1	6.9	5.5	12	310
2	6.7	5.5	9	260

Table 2. Yield (bushels/acre @ 15.5% moisture)

Broadcast treatment	Row treatment			
	Check	Pop-up(1)	Starter(2)	Pop-up + starter
100 + 0 + 0	81.2	106.4	113.7	116.4
100 + 25 + 25	52.2	76.5	78.8	83.3
100 + 50 + 50	97.6	88.3	84.7	76.6
100 + 75 + 75	89.6	93.1	95.4	92.8
100 + 100 + 100	104.6	106.6	99.9	96.3

(1) Pop-up - 37.5 lbs. of 8-32-16
(2) Starter - 150 lbs. of 8-32-16

Summary: Due to the dry weather, there was a large variation in yields and therefore no significant difference between treatments. There was no apparent difference in early growth between treatments.

Variety - DeKalb XL 304 Planting date - May 17, 1967

Phosphorus and Potassium Fertilization of Alfalfa
West Central Experiment Station
Samuel D. Evans

In the fall of 1966 an alfalfa fertility experiment was established at the station on Forman clay loam (formerly Barnes). Two cuttings were made in 1967 but dry weather seriously reduced yields.

Table 1. Soil test data of experimental area.

Sample No.	pH	O.M.%	Ext. P	Exch. K
1	7.2	5.7	24	370
2	7.2	5.6	13	480

Table 2. First cutting yields - 1967

P_2O_5 applied	K_2O applied 0	60	120	240	480	Average
	Lbs. alfalfa hay/A @ 15% moisture					
0	3193	3210	3556	3018	3364	3268
57	3148	3431	3169	3380	3344	3294
114	3388	3451	3382	3579	3580	3476
229	3102	3431	3718	3541	4004	3559
458	3564	3518	3674	3262	3829	3669
Average	3278	3408	3500	3456	3624	

Table 3. 2nd cutting yields - 1967

P_2O_5 applied	K_2O applied 0	60	120	240	480	Average
	Lbs. alfalfa hay/A @ 15% moisture					
0	3618	2552	2890	2277	3423	2952
57	2192	2615	2608	2527	3232	2635
114	2680	2690	2826	2469	2558	2645
229	2344	3057	2867	2588	3194	2810
458	3029	2926	2405	2960	3142	2892
Average	2772	2768	2719	2564	3110	

Table 4. Total 1967 yields

P_2O_5 applied	K_2O applied 0	60	120	240	480	Average
	Lbs. alfalfa hay/A @ 15% moisture					
0	6811	5762	6446	5295	6787	6220
57	5340	6046	5777	5907	6576	5929
114	6068	6141	6208	6048	6138	6121
229	5446	6488	6585	6129	7198	6369
458	6593	6444	6079	6222	6971	6561
Average	6050	6176	6219	6020	6734	

Table 5. Analysis of variance.

	1st cut	2nd cut	Total
Reps	NS	NS	NS
Phosphorus rates	*	NS	NS
Potassium rates	NS	NS	NS
P x K interaction	NS	NS	NS

Summary: There was a response to phosphorus fertilization on the first cutting, but the yield increase was not sufficient to pay for the fertilizer used.

Phosphorus Fertilization of Continuous Corn
West Central Experiment Station - Morris
Samuel D. Evans

In 1965 a phosphorus experiment was set up on Forman clay loam to determine: (1) the interaction of row and broadcast levels of phosphorus on corn yields and, (2) the effect of high phosphorus applications on the zinc content of corn leaves and corn yield.

All plots received a uniform row application of 10+0+20 and nitrogen was plowed down at the rate of 120 lbs. of actual N per acre.

1967 Yield

Broadcast P trt. (lbs./acre)	NP treatment (lbs./acre) 0 P	15 P	30 P	45 P	45 P+10 Zn	Average
	Bushels of ear corn/A @ 15.5% moisture					
0 P	64.34	59.52	65.26	62.88	70.63	64.53
45 P	71.76	69.41	65.54	65.02	72.39	68.82
Average	68.05	64.47	65.40	63.95	71.51	

Yields were extremely variable in 1967 due to the dry weather. The coefficient of variation for broadcast treatments was 34.59% and that for row treatments was 19.14%. With these large variations there were no significant differences between treatments. However, the yields again indicate, as those in 1965 and 1966 did, that the use of phosphorus on this soil tends to depress yields slightly and that this depression can be corrected by the addition of 10 lbs. of zinc per acre.

In September 1967, soil was collected from all plots and tested for phosphorus. The results are as follows:

Phosphorus Soil Test, Fall 1967* (1:10 dilution)

Broadcast P trt. (lbs./acre)	Row P treatment (lbs./acre) 0 P	15 P	30 P	45 P	45 P+10 Zn
	Pounds of soil P per acre				
0 P	24.0	23.7	28.8	47.5	47.2
45 P	53.0	67.5	78.0	117.3	92.5
Increase for 45 lbs/P/A applied	29.0	43.8	49.2	69.8	45.3

* Three applications of the annual rates had been made by this date.

Variety - DeKalb XL 304 Planting date - May 16

Zinc Fertilization of Continuous Corn
West Central Experiment Station - Morris
Samuel D. Evans

In 1965 an experiment was initiated involving the use of zinc fertilizer on continuous corn. The plots were set up on Forman clay loam and corn grown previously on this soil had not previously shown zinc deficiency symptoms, even though leaf samples indicated the zinc content to be below 20 ppm zinc.

Treatment *	When Applied	Yield Bushels/acre @ 15.5% moisture
Check	----	80.61
5 lbs. zinc as $ZnSO_4$	1965	76.88
10 lbs. zinc as $ZnSO_4$	1965	76.58
10 lbs. zinc as $ZnSO_4$	yearly	84.42
20 lbs. zinc as $ZnSO_4$	1965	87.29
0.5 lbs. zinc as ZnChel.	yearly	72.74
45 lbs. P broadcast	yearly	78.35
45 lbs. P broadcast + 10 lbs. zinc as $ZnSO_4$	yearly 1965	79.77

* Zinc 45 Chelate, ZnChel - all zinc applied in the row at planting time, all plots received a uniform row application of 125 lbs. of 8-32-16, 120 lbs. of actual N was applied in 1967.

Summary: There were large differences in yields due to the dry weather, resulting in a large coefficient of variation (14.87%). Therefore there were no significant differences in yield due to treatment. However, there is an indication of a response to the higher rates of zinc; 10 lbs. yearly and 20 lbs. per acre applied in 1965. Variety - DeKalb XL 304 Planting date - May 15, 1967

Continuous Corn Silage
West Central Experiment Station-Morris
Samuel D. Evans

In 1965 an experiment was initiated on McIntosh silt loam to determine the effect of removal of continuous corn silage and fertilizer application on corn grain and corn silage yields. Rates of fertilizer used were 74+48+48 and 148+96+96. All plots received a broadcast application of 10 lbs. of zinc as zinc sulfate in the fall of 1965.

1967 Silage Yields
Dry Matter, tons/acre

On plots harvested as grain 1965-67:

Low fertility	(74+48+48)	- 5.30 tons
High fertility	(148+96+96)	- 5.26 tons

On plots harvested as silage 1965-67:

Low fertility	(74+48+48)	- 5.58 tons
High fertility	(148+96+96)	- 6.05 tons

1967 Grain Yields
Bushels/acre @ 15.5% moisture

On plots harvested as grain 1965-67:

Low fertility	(74+48+48)	87.24
High fertility	(148+96+96)	83.34

In addition an unfertilized, unreplicated check adjacent to the experimental area yielded as follows:

Grain (0 + 0 + 0) - 32.63 bushels/acre

Silage (0 + 0 + 0) - 3.59 tons/acre

Summary: Three years of continuous corn silage caused no reduction in silage yields. Additional fertilizer above the 74+48+48 did not increase grain or silage yields.

Variety - Pioneer 3681 Planting date - May 20, 1967

Corn Irrigation Experiment
West Central Experiment Station-Morris

L. K. Lindor, S. D. Evans, and R. E. Smith

In the spring of 1967 an experiment was initiated at the station on a shallow river bottom soil to determine the effect of irrigation on corn at three populations, namely 16,000, 22,000, and 28,000 plants per acre and three nitrogen rates of 60, 120, and 180 pounds of actual nitrogen per acre. The irrigated portion was compared to an unirrigated check where the population was 16,000 plants per acre and the nitrogen rate was 60 lbs. per acre.

Table 1. Soil test results.

Sample No.	pH	O.M.%	Ext. P	Exch. K
1	7.3	over 8.5	3	240
2	7.0	over 8.5	3	200

The variety Trojan F98 was planted on May 22. Starter was applied at the rate of 200 lbs. of 6-24-24 per acre. A total of 11 inches of water was applied starting on July 21 with 2 inches being applied per irrigation at about 10 day intervals. Tensiometers were used to determine the time of irrigation and water was applied before the tension reached 1/2 atmosphere.

Table 2. Corn yields.

Nitrogen rate lbs/acre	Populations 16,000	22,000	28,000	Average
	Bushels of ear corn @ 15.5% moisture			
60	92.38	96.74	103.70	97.61
120	103.80	109.93	105.63	106.46
180	100.70	107.71	106.58	104.98
Average	98.96	104.79	105.31	

Unirrigated check (16,000 plants/acre & 60 lbs. N/acre)

18.66 bu/acre

Summary: One year's results on this soil indicate the maximum yield occurred at a population of 22,000 plants/acre and a nitrogen level of 120 lbs./acre.

TVA TEST DEMONSTRATION ACTIVITIES

H. L. Meredith & J. O. Jacobson

In 1967 corn plots were established to study varietal differences and the influence on yield as a result of fertilization.

Fourteen hybrid varieties were evaluated in 13-inch rows at 37,000 plants per acre and in 30-inch rows at 32,000 plants per acre. These data appear in Table 1.

Table 1. Yield of corn and percent moisture of 14 varieties grown on an Estherville sandy loam at Verndale, Minnesota 1967.

			Yield, Bu/A (15.5% moisture)	
Company	Variety	Moisture	13" rows 37,000 Pop.	30" rows 32,000 Pop.
Pride	R-200	31.3	145	142
Northrup-King	PX-22	33.6	136	97
Pioneer	3985	19.9	135	150
Pfister	SX-48	26.2	133	110
Funks	4170	18.0	132	93
DeKalb	XL-304	22.4	132	86
Trojan	TXS-102	35.8	131	Silage
Jacques	900J	25.9	122	131
Trojan	TX-90	19.7	111	123
Jacques	J-952	23.7	108	101
Jacques	JX-853	26.8	101	70
United Haggie	UH-108*	17.5	97	106
United Haggie	UH-127A	36.1	87	84
DeKalb	XL-307*	24.5	86	109

* Because of the location of the plot relative to the irrigation boom, the UH-108 and XL-307 plots likely did not receive sufficient water.

Shelling percentage ranged from 78 to 84.5 on the above samples. Samples were collected for spectrographic analysis at various stages of development to study uptake patterns, Table 2.

Table 2. Nutrient composition of various stages of development, Estherville sand, Verndale, Minnesota 1967.

		CORN SAMPLES (Leaves)								
Date		P	K	Ca	Mg	Zn	Cu	Mo	Mn	B
6/23/67	HF*	0.710	3.43	0.50	0.20	87.4	13.2	0.33	93.0	6.8
"	FF	0.877	3.30	0.41	0.21	44.6	5.9	0.27	81.0	5.3
7/6/67	HF	0.528	2.81	0.47	0.20	75.9	6.25	0.43	85	8.5
"	FF	0.462	2.66	0.42	0.21	50.3	6.17	0.50	53	5.5
7/17/67	HF	0.364	2.21	0.86	0.26	97.1	7.9	0.50	115.7	4.4
"	FF	0.382	2.61	0.79	0.31	70.7	6.4	0.67	89.7	6.2
8/2/67	**HF	0.366	2.48	0.90	0.31	46.8	6.5	0.67	74.1	4.8
"	FF	0.330	2.47	0.72	0.33	28.0	7.1	0.79	47.3	4.7

* High Fertility (HF) 320-120-400
(40# zinc sulfate/acre)
(20# copper sulfate/acre)
(1# Boron/acre)

Field Fertility (FF) 195-60-270 (No micronutrients)
(150# 10-40-20 starter)
(400# 0-0-60 broadcast)
(600# 30-0-0 broadcast)

**Silking stage

Spectrographic analysis was determind at silking stage for 14 varieties. This data appears in Table 3.

TABLE III.

PLANT ANALYSIS-Corn (6th leaf)

Variety	P
Funks 4170	0.4281
Jacques TX853	0.4119
Jacques 900J	0.3696
UH 108	0.3655
DeKalb XL307	0.3575
UH127A	0.3496
DeKalb XL304	0.3436
Jacques TX952	0.3436
Pride R-200	0.3337
Trojan TX90	0.3257
Pioneer 3985	0.3257
NKPX22	0.3218
PAGS X48	0.2981
Trojan TXS102	0.2903

AVE: .3474
Range: .4281-2903
% Range: 47.4

Variety	K
UH127A	2.7937
DeKalb XL304	2.6207
Pioneer 3985	2.5543
Trojan TX90	2.5422
Funks 4170	2.4947
UH108	2.4787
Jacques TX853	2.4267
DeKalb XL307	2.3944
NKPX22	2.3457
Jacques 900J	2.3376
Pride R-200	2.3376
PAGS X48	2.2266
Jacques TX952	2.1683
Trojan TXS102	1.8864

AVE: 2.4004
Range: 2.7937-1.8864
% Range: 48.0

Variety	Ca
UH108	0.90040
Trojan TXS102	0.8778
DeKalb XL307	0.8336
PAGSX48	0.8000
UH127A	0.7657
Funks 4170	0.7544
DeKalb XL304	0.7478
Pride R-200	0.6990
Pioneer 3985	0.6904
Jacques TX952	0.6861
Jacques 900J	0.6661
Jacques TX853	0.6606
NKPX22	0.6470
Trojan TX90	0.6213

AVE: .7538
Range: .9040-.6213
% Range: 45.5

Variety	Mg
Trojan TXS102	0.3707
DeKalb XL304	0.3118
UH108	0.3103
DeKalb XL307	0.2983
UH127A	0.2897
Pride R-200	0.2548
Funks 4170	0.2403
NKPX22	0.2308
Pioneer 3985	0.2214
Trojan TX90	0.2148
PAGS X48	0.1976
Jacques 900J	0.1805
Jacques TX952	0.1674
Jacques TX853	0.1305

AVE: .2442
Range: .3707- .1305
% Range: 185

Analyses of 6th Corn Leaf (TVA)

Variety	Zn
PAGS X48	68.3040
Jacques TX952	67.5449
Jacques TX853	65.5700
Jacques 900J	63.4412
Trojan TXS102	53.9878
UH108	46.7926
Funks 4170	46.0257
Trojan TX90	44.0302
DeKalb XL304	43.7231
Pioneer 3985	41.1102
UH127A	40.3410
NKPX22	39.4176
Pride R-200	39.2637
DeKalb XL307	36.7989

AVE: 49.7393
Range: 68.3040 - 36.7989
% Range: 85.6

Variety	Mo
DeKalb XL304	0.7537
DeKalb XL307	0.7139
UH108	0.6746
Trojan TXS102	0.6164
Pride R-200	0.5215
Trojan TX90	0.5029
UH127A	0.5029
Pioneer 3985	0.4659
NKPX22	0.4659
Funks 4170	0.4476
PAGSX48	0.4112
Jacques TX952	0.4112
Jacques TX853	0.4112
Jacques 900J	0.3396

AVE: .5170
Range: .7537 - .3396
% Range: 121.8

Variety	Cu
DeKalb XL304	7.92
Pioneer 3985	7.85
Trojan 102	7.63
NKPX22	7.56
Trojan TX90	7.49
UH127A	7.13
PAGSX48	6.99
Pride R-200	6.99
DeKalb XL307	6.70
UH108	6.49
Funks 4170	6.20
Jacques 900J	5.70
Jacques TX853	5.63
Jacques TX952	5.55

AVE: 6.845
Range: 7.92 - 5.55
% Range: 42.7

Variety	Mn
Jacques 900J	135.7120
Jacques TX853	110.2313
DeKalb XL307	96.8643
PAGS X48	92.3467
Funks 4170	89.4565
Jacques TX952	82.5327
DeKalb XL304	81.8815
UH108	74.1294
NKPX22	70.0554
Pride R-200	66.3987
Trojan TX90	65.2839
Trojan TXX102	62.7566
UH127A	61.8374
Pioneer 3985	59.4884

AVE: 82.0696
Range: 135.712 - 59.488
% Range: 128.1

Analysis of 6th Corn Leaf (TVA)

Variety	B
Jacques TX952	6.1637
DeKalb XL304	6.1061
Funks 4170	4.8941
DeKalb XL307	4.8941
UH108	4.8363
Trojan TX90	4.8363
Trojan TXS102	4.8363
Jacques 900J	4.6048
Jacques TX853	4.5469
UH127A	4.4890
NKPX22	4.2572
Pride R-200	4.1992
PAGSX48	4.1413
Pioneer 3985	4.0833

AVE: 4.7777
Range: 6.1637-4.0833
% Range: 50.9

A nitrogen study was conducted to determine the most feasible rate of nitrogen to apply. These data are presented in Table IV.

TABLE IV. Nitrogen Application Rates, Yields of No. 2 Corn and pH, Esterville Sand, Verndale, Minnesota 1967.

Nitrogen Applied #/Acre	Yield Bu/Ac (15.5% H_2O)	Soil pH
12	53	6.2
62	103	6.2
112	88	5.8
162	111	5.9
212	122	5.9
262	130	5.5
312	128	5.5
412	100	5.6

Percent Protein on Corn Grain in 13" Row Width

It was convenient to determine the variation between varieties on a protein basis in this study. Kjeldahl results appear in Table V. The values for protein were adjusted to 15.5% moisture to give a more realistic interpretation.

TABLE V. Percent Protein of Hybrid Varieties, Grain

Hybrid	%N	% Protein	#2 Corn, 15.5% H_2O % Protein	Yield Bu/Ac #2 Corn	Pounds, Total Protein/Acre in Grain (% Protein X Yie
DeKalb XL-307	2.00	12.50	10.56	86	908
Pride R-200	1.91	11.94	10.09	145	1463
Jacques 900J	1.87	11.69	9.88	122	1205
United Haggie 127A	1.86	11.62	9.82	87	854
DeKalb XL-304	1.86	11.62	9.82	132	1296
Trojan TX-90	1.86	11.62	9.82	111	1090
Trojan TSX-102	1.83	11.44	9.67	131	1267
United Haggie 108	1.81	11.31	9.56	97	927
Funks 4170	1.78	11.12	9.40	132	1241
Northrup King Px-22	1.76	11.00	9.29	136	1263
Jacques J952	1.73	10.81	9.13	108	986
Jacques 853	1.66	10.38	8.77	101	1158
Pfister SX-48	1.65	10.31	8.71	133	1158
Pioneer 3985	1.65	10.31	8.71	135	1176

Spectrographic analysis was determined on the mature grain following harvest. These values are on an oven-dry basis, Table VI.

TABLE VI. SPECTROGRAPHIC ANALYSIS OF CORN GRAIN OF 14 HYBRIDS.

Hybrid	%P	%K	% Ca	% Mg	ppm Zn	ppm Cu	ppm Mo	ppm Mn	ppm B	ppm Fe
900J	.30	.28	*	.11	20.8	3.3	*	6.6	*	16.7
UH-127A	.43	.47	*	.14	26.1	*	.93	6.6	1.8	26.6
SX-48	.30	.27	*	.11	21.3	*	*	6.5	*	17.6
952	.36	.34	*	.13	24.7	*	*	7.5	*	21.2
XL-304	.35	.32	*	.12	23.6	3.5	.51	7.3	*	23.9
XL-307	.36	.38	*	.15	37.0	*	*	8.3	1.2	27.5
R-200	.29	.32	*	.11	23.8	3.6	*	5.4	*	20.3
4170	.36	.33	*	.13	23.3	*	*	6.3	*	31.1
TXS-102	.33	.35	*	.13	25.8	4.4	*	7.1	1.0	16.7
TX-90	.42	.38	*	.14	33.0	*	*	7.5	1.6	30.2
PX-22	.35	.40	*	.13	25.2	*	*	5.5	*	27.5
3985	.38	.42	*	.13	23.8	3.9	.60	6.5	1.3	49.1
UH-108	.36	.37	*	.13	28.4	5.5	*	7.6	1.0	16.7
J-853	.36	.34	*	.14	23.3	*	*	7.1	*	14.0

* Indicates value in tissue lower than following:

Ca - less than 0.005%
Cu - less than 1.5 ppm
Mo - less than 0.25 ppm
B - less than 0.5 ppm

Effect of Irrigation, Fertility Level and Plant Population on Corn and Alfalfa at Park Rapids, Minn. 1967 - A. C. Caldwell, J. Grava, E. C. Seim, G. Rehm, E. R. Allred, J. Eix, J. B. Swan

A demonstration of the interaction of two fertility management levels with water management on a sandy loam soil (Dorset) in north central Minnesota produced outstanding evidence that neither moisture nor fertility can be neglected if profitable yields are to be achieved. Population levels were chosen in accordance with the water management level. Two 85 day hybrids and one 65 day hybrid were used in the demonstration.

The field received 9.70 inches of precipitation during the growing season. July and August rainfalls were three inches less than normal. The irrigated plots received a total of 17 inches of water applied on a schedule of 1 1/2" - 2" every 7 days adjusted for natural rainfall.

Temperature averaged below normal in May, June, July and August. In May the average monthly temperature was 48.1 F, or 5.1° below the normal average. The growth degree days (GDD50°) totaled 1768 for the 1967 growing season. This is 166 less than the GDD50° reported in 1966 but is much better than the 1529 GDD50° recorded for 1965.

Table 1 lists the hybrids and populations used for the study. Table 2 shows the average yield of all three hybrids for each fertility and water management level. Tables 3, 4, 5 show the yields, moisture at harvest, shelling percentage, actual population at harvest and % barren stalks for each hybrid.

Low fertility (100# 5-10-30 as starter) and low population levels (6-17000 plants/acre) produced 23.3 bu./acre of #2 corn without irrigation. Full fertility treatment (240# N, 25# P, 200# K, 25# S, trace applications of B, Zn and Cu, and 40# of 5-10-30 starter) without irrigation actually reduced yields by 7.7 bu. during this exceedingly dry year. Irrigation and increased populations (25 - 50000 plants/acre) without additional fertility inputs over the 100# of 5-10-30 starter produced a 7.2 bushel increase. Irrigation plus full fertility treatment at the high population levels produced 103.8 bushels of #2 corn per acre, an 80.5 bushel

increase over the low fertility, low water, and low population production.

Moisture levels are high as animal damage to the plots made it necessary to pick the corn before it had thoroughly dried. Yields however, have been calculated as #2 corn at 15.5% moisture. The highest yielding plot yielded 122.5 bushels/acre of Pioneer XE-65. This short extra early hybrid and others like it deserve much more intensive investigation as not only was it able to respond as well as the 85 day hybrids when fertility and moisture were adequate but under adverse conditions (drought or low fertility) it produced over 10 bushels more corn per acre than the 85 day hybrids.

Table 1. Hybrids and populations.

Hybrid	Maturity	Population: Non-irrig.		Population: Irrigated	
Minn. 806	85 day	6000	12,000	25,000	35,000
Pioneer 3985	85 day	6000	12,000	25,000	35,000
Pioneer 65	65 day	8000	17,000	35,000	50,000

Table 2. What fertility plus irrigation can do; corn yields on a Dorset sandy loam, Park Rapids, Minn. 1967.

Management level	Corn Yield bu/acre	Difference bu/acre
Low fert. Low pop. No irrig.	23.3	--
High fert. Low pop. No irrig.	15.6	-7.7
Low fert. High pop. Irrigated	30.5	+7.2
High fert. High pop. Irrigated	103.8	+80.5

Table 3. Yield of Pioneer XE (65) at four fertility-water management levels.

Treatment	Population plants/ acre	Yield bu/ acre	% Moisture	Shelling %	Ear Wt.	Barren Stalks (%)	% S in 6th leaf
High Fert. Irrigated	35,000	92.0	42.4	84.5	.18	7	.271
	50,000	102.6	43.8	81.9	.14	13	.281
Low Fert. Irrigated	35,000	37.1	46.3	79.8	.08	7	.207
	50,000	37.0	49.4	82.8	.06	12	.183
High Fert. Non-irrig.	8,000	26.6	37.5	81.9	.23	--	.250
	17,000	23.1	37.5	81.9	.14	--	.245
Low Fert. Non-irrig.	8,000	32.3	37.5	81.6	.23	--	.270
	17,000	34.2	37.5	82.4	.14	--	.218

Table 4. Yield of Minn. 806 at four fertility-water management levels.

Treatment	Population plants/ acre	Yield bu/ acre	% Moisture	Shelling %	Ear Wt.	Barren Stalks (%)	% S in 6th leaf
High Fert. Irrigated	25,000	108.1	36.1	79.1	.31	2	.342
	35,000	106.7	35.0	77.3	.22	1	.284
Low Fert. Irrigated	25,000	25.4	48.3	75.7	.06	17	.221
	35,000	25.7	48.8	76.1	.07	19	.271
High Fert. Non-irrig.	6,000	17.3	48.4	67.4	.06	50	.269
	12,000	6.2	60.6	63.2	.15	48	.253
Low Fert. Non-irrig.	6,000	19.2	45.5	71.9	.22	4	.249
	12,000	22.8	50.8	75.3	.13	40	.215

Table 5. Yield of Pioneer 3985 at four fertility-water management levels.

Treatment	Population plants/ acre	Yield bu/ acre	% Moisture	Shelling %	Ear Wt.	Barren Stalks (%)	% S in 6th leaf
High Fert. Irrig.	25,000	109.8	40.3	81.8	.27	4	.308
	35,000	103.5	39.6	80.2	.22	6	.309
Low Fert. Irrigated	25,000	28.2	51.4	75.5	.08	17	.199
	35,000	29.6	52.1	76.8	.07	19	.190
High Fert. Non-irrig.	6,000	9.3	60.0	76.5	.12	50	.217
	12,000	10.9	60.5	80.6	.09	48	.263
Low Fert. Non-irrig.	6,000	17.2	53.8	76.1	.19	4	.249
	12,000	14.3	61.6	75.5	.12	40	.215

The Effect of Nitrogen Source, Placement, and Time of Application to a Webster Clay Loam at Lamberton on 1960-67 Ear Corn Yields and on 1967 Corn Composition

John M. MacGregor, Wallace W. Nelson and Gyles W. Randall

A field fertilizer experiment was commenced with the 1960 growing season to determine the relative effect of annually applied N as either urea or ammonium nitrate. These were broadcast and plowed down or broadcast on the plowed surface in the fall, broadcast and worked in during corn planting in spring, or side-dressed in late June. The effect on yields and composition of field corn grown each year was the objective. The nitrogen rates were 40, 80, and 160 lbs. per acre annually in a randomized block having four replications of each treatment. Adequate amounts of phosphate and potash were supplied.

For the first three years, the entire corn plants and grain were analyzed for nitrogen content, and it was evident that much of the applied nitrogen was not being taken up and utilized. This practice was then discontinued, since the only actual N removal was that present in the grain (since all other plant residues were plowed down each fall). The nitrate nitrogen content of the soil, corn leaves, upper stalks, and lower stalks on several treatments were studied monthly during the growing seasons of 1964, 1965 and 1966 and have been previously reported (Soil Series 75, 76, 77).

The 1967 growing season at Lamberton was characterized by a dry May (1.15"), a wet June (5.69"), and a very dry July, August and September with a total three month rainfall of only 4.39". Lack of soil moisture adversely affected grain yield, but all fertilized treatments produced significant increases in yield as shown in Table 1. Pioneer 368 was the hybrid grown and the sixth leaf was sampled for analyses on August 3rd.

Table 1. The Effect of Rate, Kind, Time and Placement of Fertilizer Nitrogen on the 1967 Ear Corn Yield and Composition of the Sixth Leaf.

Trt. No.	Treatments	(1) bu/A Ear Corn Yield	(2) % Pl N	(3) % Pl P	(4) % Pl K	(5) % Pl Ca	(6) % Pl Mg	(7) ppm Pl Sr	(8) ppm Pl Fe	(9) ppm Pl Zn	(10) ppm Pl Cu	(11) ppm Pl Mo	(12) ppm Pl Mn	(13) ppm Pl B
			← 6th Leaf Tissue →											
1	CHECK	53.4a	1.54a	.214a	2.24a	.527a	.343a	7.8a	183.a	10.6a	5.9a	1.02a	27.7a	12.6a
2	40# NH_4NO_3 PDfall	75.6b	1.95bc	.246abc	2.43abc	.588a	.402abc	9.7abcd	221.a	13.4a	8.5ab	1.18a	38.2abc	13.5a
3	40# Urea "	86.9bc	2.01bcd	.248bc	2.33ab	.600a	.405abc	10.0abcd	192.a	12.6a	7.9ab	1.18a	32.0ab	12.9a
4	40# NH_4NO_3 Top-F	75.1b	1.81ab	.223ab	2.28a	.620a	.428abcd	10.3abcd	197.a	12.5a	7.8ab	1.34a	31.9ab	13.6a
5	40# Urea "	87.2bc	2.15bcdef	.257bcd	2.74c	.628a	.408abc	9.5abc	224.a	13.3a	11.0bcd	1.05a	39.3abc	14.5a
6	80# NH_4NO_3 PD-F	114.8def	2.60gh	.286def	2.34ab	.601a	.435bcd	11.7bcd	212.a	13.1a	9.6bc	1.25a	46.7c	13.1a
7	80# Urea "	117.2ef	2.50fg	.299ef	2.27a	.607a	.503d	12.6cd	216.a	14.3a	11.1bcd	1.34a	47.9c	13.3a
8	160# NH_4NO_3 "	127.4f	2.90h	.293ef	2.11a	.627a	.414abc	13.5d	211.a	14.7a	13.2d	1.16a	58.9d	12.4a
9	160# Urea "	121.2f	2.60gh	.313f	2.39abc	.623a	.416abc	12.5cd	212.a	14.8a	12.2cd	1.22a	60.5d	14.1a
10	40# NH_4NO_3 TDspr	99.8cd	2.20cdef	.250bc	2.44abc	.572a	.408abc	11.1abcd	200.a	13.4a	9.5bc	1.20a	37.2abc	13.9a
11	40# Urea "	95.0c	2.41efg	.262c	2.25a	.604a	.431bcd	11.0abcd	211.a	12.6a	10.3bcd	1.32a	40.2bc	13.3a
12	80# NH_4NO_3 "	128.2f	2.57gh	.289def	2.08a	.580a	.434bcd	11.2abcd	196.a	15.3a	10.6bcd	1.21a	44.4bc	12.8a
13	80# Urea "	128.6f	2.42efg	.297ef	2.25a	.632a	.439cd	11.9bcd	217.a	13.5a	10.1bcd	1.35a	44.0bc	13.3a
14	40# NH_4NO_3 S.D.	96.8c	1.97bc	.242abc	2.28a	.596a	.371abc	9.5abc	198.a	13.7a	9.0abc	1.12a	35.7abc	13.7a
15	40# Urea "	86.1bc	2.12cde	.249bc	2.56bc	.566a	.349ab	8.0ab	190.a	12.7a	8.1ab	1.04a	32.6ab	12.9a
16	80# NH_4NO_3 "	101.6cde	2.33defg	.270cde	2.43abc	.589a	.407abc	9.9abcd	231.a	14.2a	9.6bc	1.21a	40.4bc	12.7a
17	80# Urea "	117.0ef	2.42efg	.266cde	2.24a	.629a	.388abc	9.5abc	209.a	12.0a	10.3bcd	1.13a	37.9abc	14.0a
18	160# NH_4NO_3 "	120.2f	2.68gh	.307f	2.18a	.624a	.456cd	12.1cd	209.a	14.4a	12.3cd	1.20a	63.8d	13.3a
	Significance	***	**	**	*	NS	*	*	NS	NS	**	NS	**	NS
	F value	15.07	9.75	6.78	1.86	1.41	2.24	1.85	0.71	0.81	3.51	0.91	7.78	0.41
	CV	10.9	9.7	8.2	9.9	7.7	12.0	21.5	14.5	19.1	19.8	17.7	17.3	13.2

The minimum fertilized ear corn yield increase was approximately 22 bushels per acre where 40 pounds of NH_4NO_3-N was broadcast in the fall and left over winter on the plowed surface. There was no significant difference in yield from the two N sources (ammonium nitrate and urea). However, the spring applied 40 pound N rate produced an average of 97.4 bushels in comparison to a 78.2 bushel average of the fall N treatments. Where 80 pounds of N were applied in the fall the corn averaged 116.0 bushels in comparison to 128.4 with a similar rate in the spring. Doubling the 80 pound N rate failed to further increase yield. While late June sidedressing was more effective than fall broadcast N, there was less corn production than where similar N rates were broadcast at planting time.

The nitrogen content of the sixth leaf parallels both fertilizer N treatment and ear corn yield, all showing significant increases with the exception of Treatment 4. The relationship between leaf nitrogen and corn yield has been previously well established.

Mineral leaf analyses were made on the Jarrel-Ash emission spectrometer. Significant differences occurred in leaf concentrations of phosphorus (P), potassium (K), magnesium (Mg), strontium (Sr), copper (Cu), and manganese (Mn). No significant differences from N fertilization were evident in concentrations of calcium (Ca), iron (Fe), zinc (Zn), molybdenum (Mo), or of boron (B). While the relative effect of N fertilization on the concentrations of these elements is not well understood, the accumulation of additional data on this subject may become helpful in future studies.

Since the primary farmer interest in fertilizer use is grain production, the total eight year yields were summarized and are shown in Table 2. The eight year average yield shows that all treatments other than No. 2 (40 lbs. N/A as NH_4NO_3 plowed down in late fall) are significantly greater than the check yield.

Table 2. The Effect of Rate, Time, Kind, and Placement of Fertilizer Nitrogen on Ear Corn Production from a Webster Clay Loam at Lamberton for Eight Years (1960-67).

Trt. No.	1960	1961	1962	1963	1964	1965	1966	1967	Total	8 Yr. Avg.
					Bushels of ear corn per acre @ 15.5% moisture					
1	49.5	88.2	26.1	132.6	72.9	33.1	11.1	53.4	466.9	58.4 a
2	42.3	87.5	30.9	148.6	88.3	34.9	26.8	75.7	535.0	66.9 ab
3	55.1	78.2	29.1	148.8	100.3	38.8	19.8	86.9	557.0	69.6 bc
4	49.0	96.7	29.6	140.1	101.5	45.6	24.3	75.1	561.9	70.2 bc
5	62.3	101.3	37.0	140.7	84.1	57.4	30.9	87.2	600.9	75.1 bcd
6	67.4	97.9	43.6	149.6	100.8	63.4	47.3	114.8	684.8	85.6 def
7	61.7	76.9	36.7	154.5	104.9	73.0	37.8	117.2	662.7	82.8 def
8	69.8	97.9	46.7	147.7	100.9	70.8	38.5	127.4	699.7	87.5 ef
9	79.4	112.5	43.5	152.8	112.4	73.5	37.7	121.3	733.1	91.6 f
10	66.2	92.0	45.4	152.2	99.8	63.4	23.7	99.8	642.5	80.3 cdef
11	45.4	91.1	31.4	147.6	100.6	59.8	33.8	95.0	604.7	75.6 bcd
12	59.3	90.0	32.7	149.2	112.5	74.2	49.0	128.3	695.2	86.9 ef
13	57.7	99.1	40.5	149.3	115.7	84.4	41.8	128.6	717.1	89.6 f
14	63.6	92.6	39.5	148.6	90.4	54.8	38.6	96.8	624.9	78.1 cde
15	57.7	95.6	24.9	142.3	94.1	48.4	50.4	86.1	599.5	74.9 bcd
16	50.4	98.4	46.7	140.7	113.0	68.1	43.8	101.6	662.7	82.8 def
17	76.9	86.4	48.2	143.8	121.4	64.7	47.3	117.0	705.7	88.2 ef
18	40.7	97.4	77.7	151.7	109.5	77.6	51.4	120.2	726.2	90.8 f
Avg.	58.6	93.3	39.4	146.7	101.3	60.3	36.3	101.8		

ANOVA

SV	df	SS	MS	F
Total	143	202,031	--	--
Years	7	179,133	25,590	274.8 **
Trts	17	11,818	695	7.46**
Error	119	11,079	93	--

During the 1960-63 cropping seasons, the experimental area was not tile drained and frequently the corn suffered from excessive soil moisture. For this reason, the eight year corn yields shown in Table 2 were separated into two four year periods and the mathematical significance determined for the two four year periods and the data are shown in Tables 3 and 4.

Table 3. The Effect of Rate, Kind, Time and Placement of Fertilizer Nitrogen on Ear Corn Production from a Webster Clay Loam at Lamberton (1960-63).

Trt. No.	Treatment Lbs. N/A Kind, Rate & Time	Year 1960	1961	1962	1963	Total	4 Yr. Avg.
		Bushels of ear corn per acre @ 15.5% moisture					
1	CHECK	49.5	88.2	26.1	132.6	296.4	74.1 a
2	40 NH_4NO_3 P.D.Fall	42.3	87.5	30.9	148.6	309.3	77.3 ab
3	40 Urea "	55.1	78.2	29.1	148.8	311.2	77.8 ab
4	40 NH_4NO_3 Top Fall	49.0	96.7	29.6	140.1	315.4	78.8 ab
5	40 Urea "	62.3	101.3	37.0	140.7	341.3	85.3 abc
6	80 NH_4NO_3 P.D.Fall	67.4	97.9	43.6	149.6	358.5	89.6 bc
7	80 Urea "	61.7	76.9	36.7	154.5	329.8	82.4 abc
8	160 NH_4NO_3 "	69.8	97.9	46.7	147.7	362.1	90.5 bc
9	160 Urea "	79.4	112.5	43.5	152.8	388.2	97.0 c
10	40 NH_4NO_3 Spring	66.2	92.0	45.4	152.2	355.8	89.0 abc
11	40 Urea "	45.4	91.1	31.4	147.6	315.5	78.9 ab
12	80 NH_4NO_3 "	59.3	90.0	32.7	149.2	331.2	82.8 abc
13	80 Urea "	57.7	99.1	40.5	149.3	346.6	86.6 abc
14	40 NH_4NO_3 S.D.	63.6	92.6	39.5	148.6	344.3	86.1 abc
15	40 Urea "	57.7	95.6	24.9	142.3	320.5	80.1 ab
16	80 NH_4NO_3 "	50.4	98.4	46.7	140.7	336.2	84.0 abc
17	80 Urea "	76.9	86.4	48.2	143.8	355.3	88.8 abc
18	160 NH_4NO_3 "	40.7	97.4	77.7	151.7	367.5	91.9 bc
	Average	58.6	93.3	39.4	146.7		

ANOVA

SV	df	SS	MS	F
Total	71	126,000	--	--
Years	3	119,680	39,893	527.2 **
Trts	17	2,461	144.8	1.91*
Error	51	3,858	75.7	--

Table 4. The Effect of Rate, Kind, Time and Placement of Fertilizer Nitrogen on Ear Corn Production from a Webster Clay Loam at Lamberton (1964-67).

Trt. No.	Treatment Lbs. N/A Kind, Rate & Time		Year 1964	1965	1966	1967	Total	4 Yr. Avg.
			Bushels of ear corn per acre @ 15.5% moisture					
1	CHECK		72.9	33.1	11.1	53.4	170.5	42.6 a
2	40 NH_4NO_3	P.D.Fall	88.3	34.9	26.8	75.7	225.7	56.4 b
3	40 Urea	"	100.3	38.8	19.8	86.9	245.8	61.4 bc
4	40 NH_4NO_3	TopFall	101.5	45.6	24.3	75.1	246.5	61.6 bc
5	40 Urea	"	84.1	57.4	30.9	87.2	259.6	64.9 bc
6	80 NH_4NO_3	P.D.Fall	100.8	63.4	47.3	114.8	326.3	81.6 def
7	80 Urea	"	104.9	73.0	37.8	117.2	332.9	83.2 def
8	160 NH_4NO_3	"	100.9	70.8	38.5	127.4	337.6	84.4 ef
9	160 Urea	"	112.4	73.5	37.7	121.3	344.9	86.2 f
10	40 NH_4NO_3	Spring	99.8	63.4	23.7	99.8	286.7	71.7 cde
11	40 Urea	"	100.6	59.8	33.8	95.0	289.2	72.3 cde
12	80 NH_4NO_3	"	112.5	74.2	49.0	128.3	364.0	91.0 f
13	80 Urea	"	115.7	84.4	41.8	128.6	370.5	92.6 f
14	40 NH_4NO_3	S.D.	90.4	54.8	38.6	96.8	280.6	70.2 cd
15	40 Urea	"	94.1	48.4	50.4	86.1	279.0	69.8 bcd
16	80 NH_4NO_3	"	113.0	68.1	43.8	101.6	326.5	81.6 de
17	80 Urea	"	121.4	64.7	47.3	117.0	350.4	87.6 f
18	160 NH_4NO_3	"	109.5	77.6	51.4	120.2	358.7	89.7 f
	Average		101.3	60.3	36.3	101.8		

ANOVA

SV	df	SS	MS	F
Total	71	72,727	--	--
Years	3	56,149	18,716	263.0 **
Trts	17	12,948	761.6	10.70**
Error	51	3,630	71.2	--

The data of Tables 3 and 4 show that corn yields were relatively high during the first four years but significant differences due to the nitrogen fertilizer treatments occurred only where 160 pounds of N per acre was applied. In the second four year period (Table 4) the effect of tile drainage and soil nitrogen depletion was becoming more evident with significant effects of the nitrogen treatments becoming consistently evident with spring and side dressed nitrogen being more effective.

The nitrogen content of 1967 corn grain from one of the four replicates was determined. Crude protein content was calculated, which in combination with

grain yield, indicated apparent crude protein production per acre, and these data are shown in Table 5.

Table 5. The Effect of Rate, Kind, Time and Placement of Fertilizer Nitrogen on Crude Protein Concentration and Production of Field Corn at Lamberton in 1967 (Data from only 1 replication).

	Treatment (lbs N/A)	% Crude Protein in Corn Grain	Lbs./A of Crude Protein
(1)	Check	7.6	243
(2)	40 NH_4NO_3 -plowed down-fall	6.9	365
(3)	40 Urea " " "	7.5	328
(4)	40 NH_4NO_3 -top of plowing-fall	--	--
(5)	40 Urea " " " "	7.9	364
(6)	80 NH_4NO_3 -plowed down-fall	9.4	596
(7)	80 Urea " " "	8.8	566
(8)	160 NH_4NO_3 " " "	11.3	766
(9)	160 Urea " " "	10.3	870
(10)	40 NH_4NO_3 -at spring planting	8.1	395
(11)	40 Urea " " "	7.6	352
(12)	80 NH_4NO_3 " " "	9.0	588
(13)	80 Urea " " "	10.8	736
(14)	40 NH_4NO_3 -as late sidedressing	7.5	328
(15)	40 Urea " " "	8.6	356
(16)	80 NH_4NO_3 " " "	9.3	656
(17)	80 Urea " " "	8.1	580
(18)	160 NH_4NO_3 " " "	11.3	766

The data of this table shows the comparative effect of fall, spring and side dress application. Although corn grain from only one replication was available for analysis and crude protein concentrations and per acre production computed, it is evident that rate of annual N fertilization has a marked effect on corn grain protein.

The Effect of Nitrogen Time of Application on Field Corn Yield 1960-67 from N Plots at Lamberton

	Corn Yields		
	Fall Trts 2,3,6,7	Spring 10,11,12,13	Side Dress 14,15,16,17
1960-67 (8 years)	75.1	83.1	81.1
1960-63 (4 years)	81.8	84.3	84.8
1964-67 "	70.7	81.9	77.3
1967	98.6	112.9	100.4

Nitrate Nitrogen Content of a Barnes Loam Soil at Morris in November, 1967, after Eleven Years of Continuous Corn with Varying Rates of Nitrogen Fertilization (1957-67).

J. M. MacGregor, G. R. Blake, S. Evans & R. Thompson

A continuous corn fertilizer experiment was commenced in 1957 on a Barnes loam at the West Central Experiment Station at Morris. Adequate amounts of phosphate and potash were applied annually with four rates of N application. Although a plant population of 16-18,000 corn plants per acre was desired, this was not always obtained, since different methods of seedbed preparation were employed. All vegetative residues remained on the field, either being plowed down or worked into the surface. Ear corn yields for the eleven years are shown in Table 1.

Table 1. The Effect of Annual Fall or Spring Nitrogen Topdressings on a Barnes Loam at Morris on Ear Corn Yield (1957-67).

N Appl. (Lbs/A)	(a)	Year 1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	11 Yr. Av.
		Bushels of ear corn per acre at 15.5% moisture											
0	(S)	65.2	73.2	36.1	53.3	32.3	38.1	62.7	33.2	50.4	49.0	66.8	50.9
40	(F)	71.0	81.5	40.9	48.2	48.3	59.0	60.9	34.1	68.3	63.7	69.2	60.5
40	(S)	69.4	81.0	41.5	55.0	47.6	62.0	83.5	29.6	75.3	66.3	71.2	62.0
80	(S)	72.1	82.4	39.7	53.7	45.0	65.3	77.4	29.1	80.8	75.9	69.7	62.8
240	(S)	71.3	80.3	36.8	52.5	46.1	67.1	79.5	24.7	82.8	33.1	71.3	58.7

(a) 40 pounds of both phosphate and potash were applied to all plots at time of N application.

(S)= Spring

(F)= Fall

During the eleven years of continuous corn, it is evident that while the annual 40 pound per acre N fertilization rate increased ear corn yields approximately 10 bushels per acre, further increases in the rate of annual N fertilization rate did not result in a further increase in corn yields.

Late in October of 1965 soils of four treatments were sampled to a depth of 96 inches and analyzed for NO_3-N in an attempt to locate any accumulated N with continuing N applications. As was reported in the "Blue Book" of February, 1966 (page 85, Soil Series 80) where 40 lbs/A of N was applied in each of the nine years 3.3% of this remained as NO_3-N in the first 4' soil depth and 2.3% was present in the 4 to 8 soil depth. Where 80 pounds of N/A was annually applied (a total of 760 lbs of N/A), 7.1% remained in the upper 4', and 14.7% was in the 4' to 8' soil depth. Where 240 lbs N/A had been applied in each of the nine years (a total of 2160 lbs N/A), 28.2% was in the upper 4' and 34.3% was in the 4' to 8' depth. These values indicated that there was a downward movement of applied N in nitrate form, expecially with the continued heavier annual applications of fertilizer nitrogen. In the entire 8' soil depth, 5.6% of the 40 lb N rate, 21.8% of the 80 lb rate and 62.5% of the 240 lb. rate persisted as nitrate N.

The question of NO_3-N movement to soil depths greater than 8' remained, so in early November 1967, three replications of the annual 0-40-40, the 40-40-40 and of the 240-40-40 treatment soils were sampled at 4' intervals to a 32' depth and analyzed for NO_3-N. The results are shown on Table 2.

Table 2. Pounds of Nitrate Nitrogen per acre in Barnes Loam after Eleven Years of Increasing Rates of N Fertilization.

Soil depth (ft)	Annual	Nutrient application in pounds per acre 0-40-40	40-40-40	240-40-40
	11 year total N	0	440	2640
		Pounds of nitrate nitrogen per acre		
0-0.5		20.4	33.0	83.4
0.5-1.0		11.1	13.0	122.0
1-2		8.8	10.4	123.8
2-3		9.4	9.6	110.8
3-4		6.6	12.2	72.3
7-8		8.9	18.3	145.8
11-12		17.3	22.8	47.9
15-16		19.7	24.3	42.8
19-20		18.6	16.4	22.9
23-24		10.7	14.0	13.6
27-24		12.8	11.9	16.7
31-32		13.2	11.6	13.4

From the data of Tables 1 and 2 it appears that where 40 pounds of N was applied per acre annually during the eleven years of this study, ear corn yields increased approximately 10 bushels but some of the excess N at this low rate penetrated the subsoil as nitrate to a minimum depth of 16 feet. The 240 pound rate of N fertilization resulted in no additional corn yield and apparently more of the applied fertilizer N moved downward as the nitrate to a minimum 28 foot depth in those plots.

It is apparent that the continued application of excessive amounts of fertilizer N should be avoided both on the basis of additional fertilizer expense, and the possible contamination of both subsoils and of subterranean water supplies even under the relatively limited annyal precipitation of western Minnesota.

STRUCTURE - NITROGEN STUDY

MORRIS 1967

pH 1/

Fertilizer	pH	Statistical Notes
	0 - 6 inches	
0-40-40	7.26	a
40-40-40 (fall)	7.28	a
40-40-40	7.14	a
80-40-40	7.11	a
240-40-40	6.50	b 99% level
	8 - 12 inches	
0-40-40	7.29	A > C 99% level
40-40-40	7.17	B > C 95% level
240-40-40	6.87	
	20 - 24 inches	
0-40-40	7.65	Reps only, significant
40-40-40	7.51	
240-40-40	7.55	
	32 - 36 inches	
0-40-40	7.82	Reps only, significant
40-40-40	7.83	
240-40-40	7.70	

1/ Tillage Method had no effect on pH.

1967 Phosphorus Placement Study
Southwest Experiment Station
W. W. Nelson and G. W. Randall

An experiment was initiated at Lamberton in the spring of 1966 to determine the effect of various methods of row applied fertilizer on the 1) early growth of corn, 2) chemical composition of the plant at both an early stage and again at silking stage, and 3) the yield of corn. In 1967 the experiment was expanded to include 1) the measurement of nutrient uptake by the small plant and 2) the effect of planting date on the growth, uptake, composition and yield of corn. The design used for each planting date was a split plot with four row treatments and two broadcast treatments, all replicated four times.

All plots received 100# N broadcast before planting. Ramrod and diazonon were applied at planting time along with atrazine + oil applied post emergence for control of weeds and root worm. The soil type, Nicollet silty clay loam, had soil test values of pH = 6.0, O.M. = 4.7%, P = 7 (Low) and K - 270 (Very High). Corn yields were again somewhat low in 1967, probably due to a lack of rainfall (0.11 inch) between July 10 and August 20.

Table 1. Row and broadcast treatments applied to the phosphorus placement experiment.

Row Treatment		Fertilizer Treatment*			
		No Broadcast 100+0+0		Broadcast 100+60+30	
Placement	Nutrients Applied (lbs/A	Trt. No.	Total Nutrients (lbs/A)	Trt. No.	Total Nutrients (lbs/A)
No Row	0+0+0	1	100+0+0	5	100+60+30
Pop-Up	5+16+8	2	105+16+8	6	105+76+38
2 x 2 Band	16+48+24	3	116+48+24	7	116+108+54
Pop-Up + 2 x 2	21+64+32	4	121+64+32	8	121+124+62

* all plots received broadcast N at the rate of 100 lbs. N/A

Table 2. Average weight, height, yield and moisture content of corn planted May 3.

Trt. No.	Weight*	Height*	Yield**	Moisture percent at harvest
1	671 gm.	16.2 in.	59.5 bu/A	23.8
2	1484	21.8	80.4	17.6
3	1382	20.8	80.6	18.0
4	2004	23.5	90.1	16.6
5	1410	20.8	72.7	17.9
6	1778	23.2	80.3	16.7
7	1934	22.2	83.2	16.1
8	1904	21.5	81.8	15.8

* weight and height of 10 small plants harvested June 28.

** bushels of ear corn per acre at 15.5% moisture

Table 3. Average weight, height, yield, and moisture content of the corn planted May 3 from the row treatments with broadcast treatments combined.

Trt. No.	Description	Weight gms	Height inches	Yield bu/A	Moisture %
1. (1+5)	No Row	1041 a*	18.5 a	66.1 a	20.8 b
2. (2+6)	Pop-Up	1631 b	22.5 b	80.4 b	17.2 a
3. (3+7)	2 x 2 Band	1658 b	21.5 b	81.9 b	17.1 a
4. (4+8)	Pop-Up + 2 x 2	1954 c	22.5 b	86.0 b	16.2 a

* numbers followed by the same letter belong to the same .05 level population (DMRT).

Table 4. Average weight, height, yield and moisture content of corn planted May 3 from the broadcast treatments with row treatments combined.

Treatment	Weight gms	Height inches	Yield bu/A	Moisture %
No Broadcast	1385 a	20.6 a	77.6 a	19.0 a
Broadcast	1756 b	21.9 a	79.5 a	16.6 a

Table 5. Average weight, height, yield, and moisture content of corn planted June 1.

Trt. No.	Weight*	Height*	Yield**	Moisture percent at harvest
1	2199 gms	26.5 in.	53.0 bu/A	35.7
2	4033	34.5	74.6	27.5
3	3871	36.0	75.4	28.0
4	4340	36.0	75.7	29.2
5	3970	32.5	72.3	28.4
6	4413	35.5	75.4	29.2
7	4659	36.5	85.7	28.2
8	4632	37.2	86.6	27.8

* weight and height of 10 small plants harvested July 19

** bushels per acre at 15.5% moisture

Table 6. Average weight, height, yield, and moisture of ear corn planted June 1 from the row treatments with broadcast treatments combined.

Trt. No.	Description	Weight gms	Height inches	Yield bu/A	Moisture %
1. (1+5)	No Row	3085 a	29.5 a	62.6 a	32.0 b
2. (2+6)	Pop-Up	4223 b	35.0 b	75.0 b	28.4 a
3. (3+7)	2 x 2 Band	4265 b	36.2 b	80.5 b	28.1 a
4. (4+8)	Pop-Up + 2 x 2	4486 b	36.6 b	81.4 b	28.5 a

Table 7. Average weight, height, yield, and moisture of ear corn planted June 1 from the broadcast treatments with row treatments combined.

Treatment	Weight gms	Height inches	Yield bu/A	Moisture %
No Broadcast	3610 a	33.2 a	69.7 a	30.1 a
Broadcast	4419 b	35.4 b	80.1 a	28.4 a

Interpretation

May 3 planting

The small plant weight and height, yield and moisture content of the corn were all significantly affected by the row treatments. The corn fertilized with pop-up, 2 x 2 band, or combination (pop-up + 2 x 2 band) treatment showed a significant increase in weight, height, and yield as well as a significant decrease in moisture over the no row (check) treatment. In all cases except plant weight, there were no significant differences among the pop-up, 2 x 2 band,