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SUSTAINABLE DRYLAND AGROECOSYSTEM MANAGEMENT[1]

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A Cooperative Project

of the

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Fort Collins, Colorado

and the

USDA - Agriculture Research Service
Natural Resources Research Center
Great Plains Systems Research Unit
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RESEARCH APPLICATION SUMMARY

We established the Dryland Agroecosystem Project in the fall of 1985, and 1986 was the first crop year. Grain yields, stover yields, crop residue amounts, soil water measurements, and crop nutrient content were reported annually in previously published technical bulletins. This summary updates our findings for the 15-year period.

Average Yields:

Annual yield fluctuations concern growers because they increase risk. Stable yields translate into stable income levels in their operations. Figure 1 provides a summary of average yield history for wheat, corn, sorghum, and soybean at our three study locations. Wheat has been grown all 15 years at all sites, corn every year at Sterling, and sorghum every year at Walsh. Other crops have been grown for shorter periods of time. Complete data for each crop are available in previously published bulletins (see reference section). Yields in Figure 1 are averaged over all years when a given crop was grown, even those where yield losses occurred due to hail, early and late freezes, insect pests, winter kill of wheat, and herbicidal carryover.

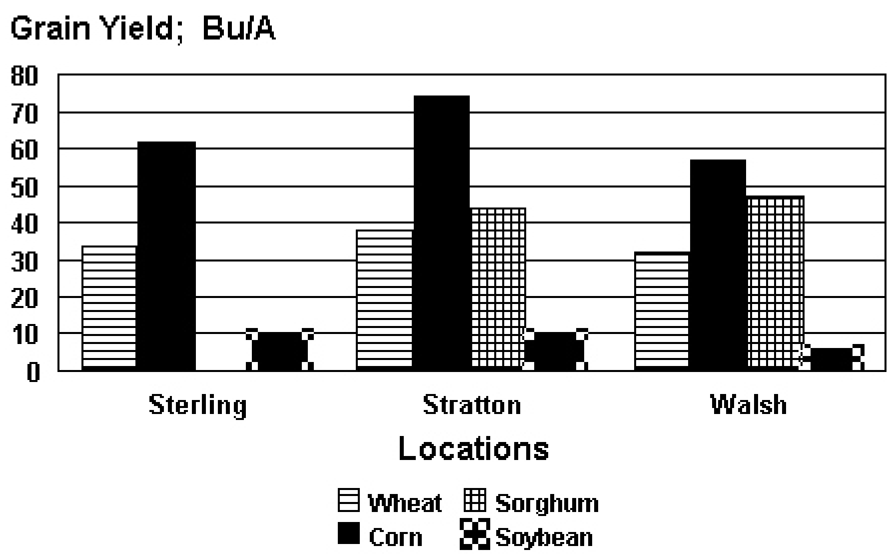


Figure 1. Grain yields averaged over soil positions for all years each crop has been grown at a given location (wheat yields after fallow).

Corn, Sorghum and Soybean Yields at Original Locations:

Fluctuations in corn and sorghum yields are of most interest because they represent the highest input crops. Yields of all crops include hail and drought years.

1) Corn yields at Sterling have averaged 62 bu/A (range = 14 to 107 bu/A).
2) Corn yields at Stratton have averaged 73 bu/A (range = 37 to 112 bu/A).
3) Corn yields at Walsh, using Bt varieties, averaged 57 bu/A from1997-2000 (range = 2 to 100 bu/A).
4) Grain sorghum yields at Stratton (4 years) averaged 44 bu/A (range = 20 to 63 bu/A).
5) Grain sorghum yields at Walsh averaged 48 bu/A (range = 27 to 75 bu/A).
6) Soybean yields have averaged 10 bu/A or less at all sites.

Cropping Systems:

The 3- and 4-year systems like wheat-corn(sorghum)-fallow and wheat-corn-millet-fallow or wheat-sorghum-sorghum-fallow increased annualized grain production by 74% compared to the 2-year wheat-fallow system during the first 12 years of our project (Figure 2). Yields are annualized to account for the nonproductive fallow year in rotation comparisons. Economic analyses show this to be a 25-40% increase in net annual income for the three-year rotation in northeastern Colorado. However, in southeastern Colorado the three year wheat-sorghum-fallow rotation, using stubble mulch tillage in the fallow prior to wheat planting, netted about the same amount of return as reduced till wheat-fallow. New herbicide programs with fewer residual materials have shown promise and are less expensive.

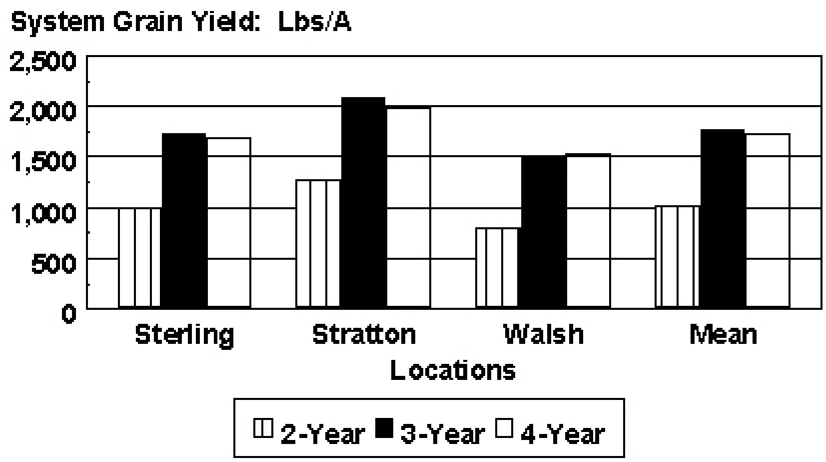


Figure 2. Annualized grain yield by system for each location averaged over the first 12 years of research.

Our data show that cropping intensification is feasible and profitable in the central Great Plains. More intensive rotations like wheat-corn(sorghum)-fallow and wheat-corn(sorghum)-millet-fallow have more than doubled grain water use efficiency. Water conserved in the no-till systems has been converted into increased grain production.

Our opportunity cropping systems have maximized production at all sites relative to all other rotations, but have not been the most profitable. The 3-year rotations have been most profitable. Based on our findings with the intensive systems from 1985 to 1997 (12 cropping seasons), we altered the systems in 1998 to reflect the new knowledge. More intensive cropping systems have been added and wheat-fallow has been omitted from the experiments. We now consider the 3-year (wheat-corn or sorghum-fallow) system as the standard of comparison.

New Research Sites:

The dryland agroecosystem project established linkage with the Department of Bioagricultural Sciences and Pest Management in 1997. We are now evaluating the interactions of cropping systems with both pest and beneficial insects at three new experimental sites. The new sites at Briggsdale, Akron, and Lamar also allow us to test our most successful intensive cropping systems at three new combinations of precipitation and evaporative demand. The new sites have much larger experimental units, enabling us to study insect dynamics as influenced by cropping system. We want to know if the presence of multiple crops in the system will alter populations of beneficial insects and provide new avenues of insect pest control.

Adoption of Intensive Cropping Systems:

Producers in northeastern Colorado have been adopting the more intensive cropping systems at an increasing rate since 1990. Corn is one of the principal crops used in more intensive systems, and we use its acreage as an index of adoption rate by producers (see Table below). Area planted to dryland corn in northeastern CO increased from about 20,000 acres per year in years previous to 1990 to 220,000 acres in 1999. Total dryland corn acreage in Colorado increased from 23,700 historically to 290,000 in 1999.

Dryland Corn Acreage in Eight Northeastern Colorado Counties and state total from 1971 to 1998.

Year	Eight NE Counties*	Total for State
	Acres	
1971-1988	21,200	23,700
1989	27,000	28,000
1990	26,000	26,000
1991	32,500	33,000
1992	48,500	50,000
1993	79,000	90,000
1994	92,500	100,000
1995	95,500	100,000
1996	104,000	110,000
1997	138,500	150,000
1998	191,000	240,000
1999	220,000	290,000
2000	198,000	340,000

*Data from Colorado Agricultural Statistics (Adams, Kit Carson, Logan, Morgan, Phillips, Sedgewick, Washington, Yuma)

Corn acreage is expanding into areas once thought to be too dry for corn production, as exemplified in Lincoln county where corn acreage increased from1500 in 1996, to 4000 in 1997, to 8000 in 1998, to 18,000 in 1999, and to 23,000 in 2000. Adoption of the new systems also is reflected in sunflower and proso millet acreage increases. For example, sunflower acreage increased from 63,000 in 1991 to 270,000 in 1999 and then decreased to 185,000 in 2000 in Colorado. Producers wishing to get started in dryland rotation farming may consult bulletins published in previous years (see reference list) and/or the publication by Croissant et al. (1992).

CONCURRENT RESEARCH PROJECTS

Triticale-Corn-Forage Soybean Rotation at Sterling: {Established in fall 1993}

Objective:

Maximize time in crop, provide both a cash crop (corn) and forage crops for a mixed livestock-grain farm. Land preparation costs would also be minimized. From 1993 - 1998 this rotation was triticale-corn-hay millet. Forage soybean replaced hay millet in 1999 in attempt to grow a sandbur free, higher protein forage.

Procedure:

i) Winter triticale is planted in September into the hay millet stubble.

ii) Harvest winter triticale for forage in June before heading, leaving a 8-10 inch stubble. Roundup and Atrazine, applied after harvest.

iii) Corn planted no-till into triticale stubble the following May.

iv) Corn is harvested in late September.

v) Forage soybean, Roundup-Ready was planted into corn stalks the following May and is harvested in August. Weeds controlled with Roundup if necessary.

Results:

i) Corn yields have averaged 52 Bu/A including 1994, when no grain was produced due to dry weather, and including 1995, when the corn froze before maturity. In the last 3 years a Roundup Ready variety was grown to aid in sandbur control.

ii) Hay millet yields were non-harvestable in all years except 1997. The failures were primarily due to heavy sandbur infestations. We had to destroy the crop because sandbur populations were equal to the millet populations in most years.

iii) Forage soybean yields in 2000 averaged 1.45 T/A over all soils.

iv) Triticale "Harvested" yields have averaged 1.75 T/A over the past 3 years, even though we left a 10-12" stubble remaining in the field for cover

Summary:

Winter triticale seems to be a well adapted cool season forage crop. Although corn yields were greatly limited by lack of rainfall in 2000, corn following triticale should be equivalent to corn after wheat, which has averaged over 50 bu/A. for a 15-year period at this site. The forage soybean yielded relatively well, 1.45 T/A, even though summer precipitation was well below the long-term average and has averaged 1.4 T/A for 2 years.

Triticale and corn grain yields by soil for 1998 -2000.

Year	Crop	Production	Soil Positions			
			Summit	Sideslope	Toeslope	Average
			---------------Tons/A or Bu/A-----------------			
1998	Triticale	Total	0.94	1.13	1.36	1.14
		Harvested[1]	0.77	1.00	1.05	0.94
	Corn	Grain	64	64	88	72
	Hay Millet	Total	0	0	0	0
1999	Triticale	Total	(Not measured in 1999)			
		Harvested[1]	1.64	1.17	1.92	1.58
	Corn	Grain	43	82	69	65
	Soybean	Forage @ 15% moisture	1.17	1.26	1.72	1.38
2000	Triticale	Total	(Not measured in 2000)			
		Harvested[1]	2.82	2.47	2.86	2.72
	Corn	Grain	18	18	24	20
	Soybean	Forage @ 15% moisture	1.60	1.39	1.35	1.45

[1] Harvested leaving 8" stubble;

Experiment Managers:
G.A. Peterson, G. Lindstrom, and D.G. Westfall

Soybean Variety Trials at Sterling and Stratton

Background:

Our interest in soybeans stems from our search for a crop we could harvest and immediately plant winter wheat, thus avoiding fallow. Soybean has the potential to be one of the crops that might fit the system. It has the following attributes:

1. Local market probable
2. Broadleaf plant for rotation
3. Roundup Ready (sandbur control)
4. Fits rotation (plant wheat after soybean harvest)
5. Use same planting and harvesting equipment as wheat
6. Economic potential good (Expected yields 20-25 bu/A and low fertilizer cost)

Objectives:

1) To determine the yield potential of dryland soybean varieties in eastern Colorado
2) To observe growth characteristics and potential harvest dates.
3) To compare drilled versus row planted soybeans

Procedure:

Planting Method:

Drilled with 12" row spacing
Row planted in 30" row spacing

Varieties:

Asgrow 2602, 2702, 2903, 3302, 3303
Dekalb 242RR, 285RR

Population:

85,000 to 90,000 seeds/A
(3000 seeds/pound)
Seed cost: Roundup Ready seed = $24 per 50 lbs; Planted @ 30#/A = $14.40/A

Planting and Harvesting Dates:

Sterling = 18 May and 9 October 2000
Sterling = 18 May and 11 October 2000

Results:

Yields ranged from 7 to 16 bu/A at Sterling and from 7 to 12 bu/ at Stratton with a tendency for higher yields with the longer maturity varieties. However, the longer season beans, like the 3303 and 3901 varieties did not mature properly and the bean quality was poor. The Asgrow 2702 variety was the "best fit" in terms of maturity and grain yield. The most consistent finding was that the soybeans planted in 30" rows yielded 3.5 bu/A more than drilled beans in 12" rows averaged over both sites. The Asgrow 2702 variety averaged 8.5 bu/A when drilled and 14 bu/A when planted in 30" rows. At the loan rate price of $5.00/bu our best yield of 14 bu/A would not be economically feasible.

Lack of varieties adapted to our arid environment remains a major problem. In addition shattering losses near harvest and low set pods that are not easily harvested with a combine header also remain as large problems.

Soybean grain yields by variety and planting method at Sterling Colorado in 2000.

Variety	Planting Method	Yield (13% moisture)
		— Bu/A—
Asgrow 2602	Drill (12")	7
	30" Row	13
Asgrow 2702	Drill (12")	9
	30" Row	16
Asgrow 2903	Drill (12")	7
	30" Row	11
Asgrow 3302	Drill (12")	8
	30" Row	12
Asgrow 3303	Drill (12")	11
	30" Row	14
Asgrow 3901	Drill (12")	12
	30" Row	16
Dekalb 242RR	Drill (12")	5
	30" Row	7
Dekalb 285RR	Drill (12")	9
	30" Row	11

Soybean grain yields by variety and planting method at Stratton Colorado in 2000.

Variety	Planting Method	Yield (13% moisture)
		— Bu/A---
Asgrow 2602	Drill (12")	8
	30" Row	10
Asgrow 2702	Drill (12")	8
	30" Row	12
Asgrow 2903	Drill (12")	7
	30" Row	9
Asgrow 3302	Drill (12")	6
	30" Row	10
Asgrow 3303	Drill (12")	7
	30" Row	10
Asgrow 3901	Drill (12")	7
	30" Row	12
Dekalb 242RR	Drill (12")	5
	30" Row	4
Dekalb 285RR	Drill (12")	7
	30" Row	8

Soybean grain yields averaged by planting method at Sterling and Stratton Colorado in 2000.

Planting Method	Yield (13% moisture)
	— Bu/A---
Drill (12")	7
30" Row	10.5

Experiment Managers: D. Poss, G.A. Peterson, D.G. Westfall.

INTRODUCTION

Colorado agriculture is highly dependent on precipitation from both snow and rainfall. Dryland acreage exceeds irrigated acreage by more than two fold, and each unit of precipitation is critical to production. At Akron each additional inch (25 mm) of water above the initial yield threshold translates into 4.5 bu/A of wheat (12 kg/ha/mm), consequently profit is highly related to water conservation (Greb et al., 1974).

Our research project was established in 1985 to address efficient water use under dryland conditions in Eastern Colorado. A more comprehensive justification for its initiation can be found in Peterson, et al.(1988). The general objective of the project is to identify dryland crop and soil management systems that will maximize water use efficiency of the total annual precipitation and economic return.

Specific objectives are to:

1. Determine if cropping sequences with fewer and/or shorter summer fallow periods are feasible.
2. Quantify the relationships among climate (precipitation and evaporative demand), soil type and cropping sequences that involve fewer and/or shorter fallow periods.
3. Quantify the effects of long-term use of no-till management systems on soil structural stability, micro-organisms and faunal populations, and the organic C, N, and P content of the soil, all in conjunction with various crop sequences.
4. Identify cropping or management systems that will minimize soil erosion by crop residue maintenance.
5. Develop a data base across climatic zones that will allow economic assessment of entire management systems.

Peterson, et al. (1988) document details of the project in regard to the "start up" period and data from the 1986-87 crop year. Results from the 1988 - 1999 crop years were reported by Peterson, et al. (1989, 1990, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 1998, 1999, and 2000). As in previous bulletins, only annual results are presented with a few summary tables. We do not draw major conclusions based on one year crop responses because cropping systems are highly time and weather dependent. Other publications, such as Wood, et al. (1990), Croissant, et al. (1992), Peterson, et al. (1993a & 1993b) and Nielsen, et al. (1996) summarize and draw conclusions based on a combination of years.

Long-term averages of summer crops, corn and sorghum, are 62, 72 and 47 bu/A for Sterling(corn), Stratton(corn) and Walsh(sorghum), respectively. These means include years of near crop failure due to drought, hail, and early frost. Our research has shown that cropping intensification is certainly possible and profitable in the central Great Plains. More intensive rotations like wheat-corn(sorghum)-fallow have more than doubled grain water use efficiency in our three study environments when compared over years. Water conserved in the no-till systems has been converted into increased grain production. Furthermore, our opportunity cropping systems have maximized production at all sites relative to all other rotations. Based on findings from1985 to 1997, we altered the systems being studied to reflect the new knowledge. Wheat-fallow was omitted from the experiments, and we consider the 3-year (wheat-corn or sorghum-fallow) system as the standard of comparison.

The dryland agroecosystem project established a linkage with the Department of Bioagricultural Sciences and Pest Management in 1998. We are evaluating the interactions of cropping systems with both pest and beneficial insects at three new experimental sites, Briggsdale, Akron, and Lamar, CO. This also allows us to test our most successful intensive cropping systems at three additional combinations of precipitation and evaporative demand. Compared with the original three experiments, they have much larger experimental units enabling us to study insect dynamics as influenced by cropping system. We want to know if the presence of multiple crops in the system will alter populations of beneficial insects and provide new avenues of biological pest management of Russian Wheat Aphid in wheat and insect pests in other crops. Details of cropping system changes at the original sites and the treatments at the new sites are explained in the methods section of this report.

MATERIALS AND METHODS

From 1986 - 1997 we studied interactions of climate, soils and cropping systems at three sites, located near Sterling, Stratton, and Walsh, in Eastern Colorado, that represent a gradient in potential evapotranspiration (PET) (Fig. 3). Elevation, precipitation and evaporative demand are shown in Table 1. All sites have long-term precipitation averages of approximately 16-18 inches (400-450 mm), but increase in PET from north to south. Open pan evaporation is used as an index of PET for the cropping season.

Table 1. Elevation, long-term average annual precipitation, and evaporation characteristics for each site.

Site	Elevation	Annual Precipitation[1]	Growing Season Open Pan Evaporation[2]	Deficit (Precip. - Evap.)
	--Ft. (m) --	---In. (mm) ---	---In. (mm) ---	---In. (mm) ---
Nunn (Briggsdale)	4850 (1478)	13.7 (350)	61 (1550)	- 48 (- 1220)
Sterling	4400 (1341)	17.4 (440)	63 (1600)	- 45 (- 1140)
Akron	4540 (1384)	16.0 (405)	63 (1600)	- 47 (- 1185)
Stratton	4380 (1335)	16.3 (415)	68 (1725)	- 52 (- 1290)
Lamar	3640 (1110)	14.7 (375)	76 (1925)	- 62 (- 1555)
Walsh	3720 (1134)	15.5 (395)	78 (1975)	- 61 (- 1555)

[1]Annual precipitation = 1961-1990 mean [2]Growing season = March - October

Each of the original three sites (Sterling, Stratton, Walsh) was selected to represent a catenary sequence of soils common to the geographic area. Textural profiles for each soil at each location are shown in Figures 4a, 4b, and 4c. There are dramatic differences in soils across slope position at a given site and from site to site. We will contrast the summit soils at the three sites to illustrate how different the soils are. Each profile was described by NRCS personnel in summer

1991. Note first how the summit soils at the three sites differ in texture and horizonation. The surface horizons of these three soils (Ap) present a range of textures from loam at Sterling, to silt loam at Stratton, to sandy loam at Walsh. Obviously the water holding capacities and infiltration rates differ. An examination of the horizons below the surface reveals even more striking differences.

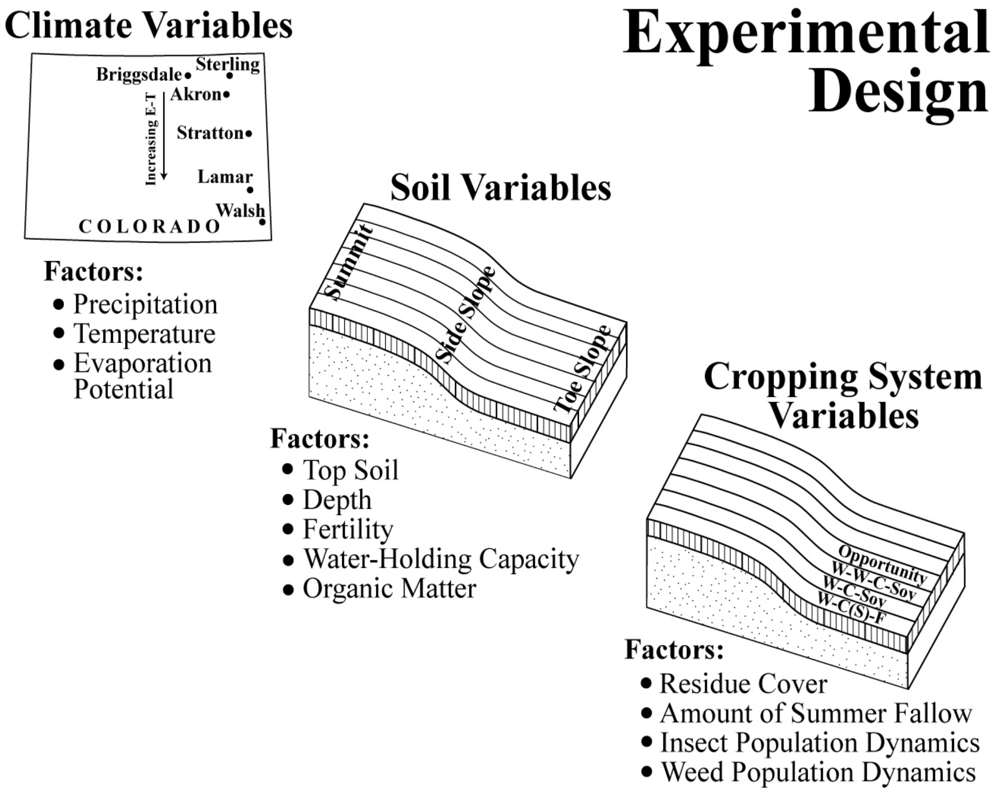
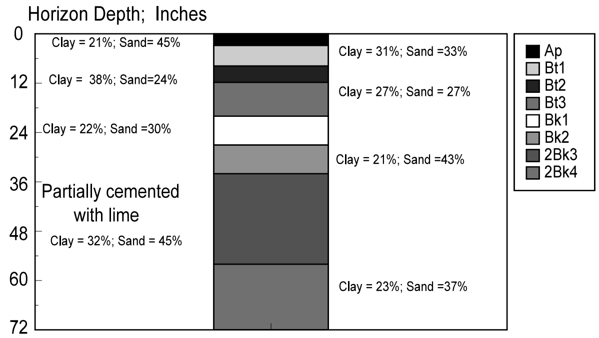


Figure 3. Experimental design with climate, soil, and cropping system variables.

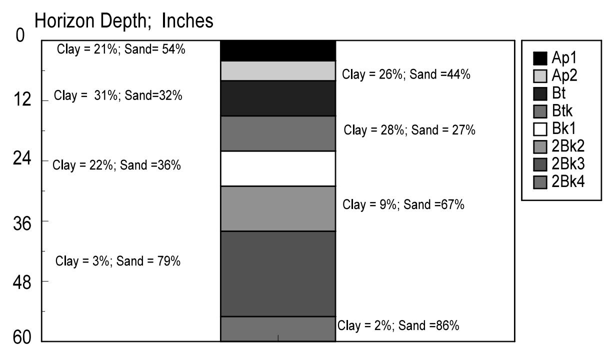
The summit soil profile at Sterling (Figure 4a) changes from a clay content of 21% at the surface(Ap) to 31% in the 3-8" depth (Bt1) to a clay content of 38% in the layer between the 8-12" depth (Bt2). At the 12" depth the clay content drops abruptly to 27%. The water infiltration in this soil is greatly reduced by this fine textured layer (Bt2). At about the 36" depth (2Bk3) there is an abrupt change from 21% clay to 32% clay in addition to a marked increase in lime content. The mixture of 32% clay and 45% sand with lime creates a partially cemented zone that is slowly permeable to water, but relatively impermeable to roots. Profile plant available water holding capacity is 9" in the upper 36 inches of the profile.

At Stratton the summit soil profile (Figure 4b) is highest in clay at the surface, 34% in the Ap horizon, and then decreases steadily to 14% clay (Bk3) below the 40" depth. There are few restrictions to water infiltration at the surface nor to roots anywhere in the profile compared to summit soil at Sterling. Profile plant available water holding capacity is 12" in the upper 72 inches of soil.

Sterling Summit Soil Profile



Sterling Sidelope Soil Profile



Sterling Toeslope Soil Profile

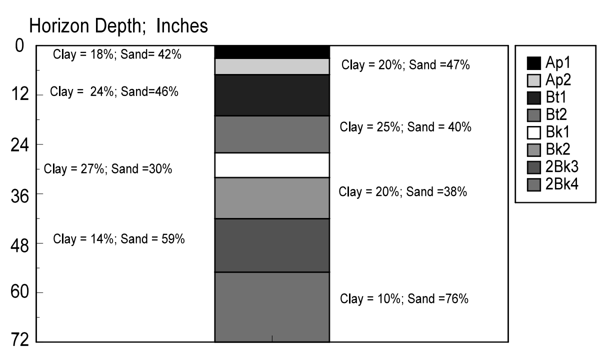
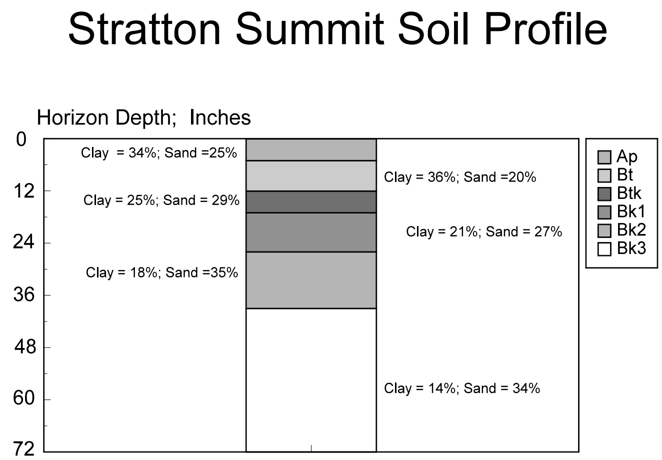
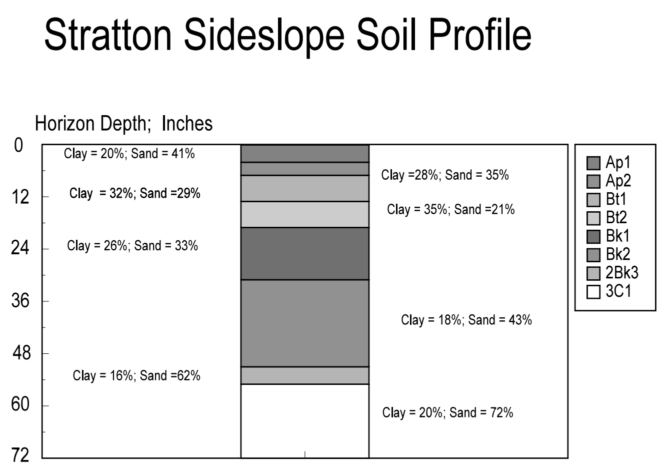


Figure 4a. Soil profile textural characteristics for soils at the Sterling site.





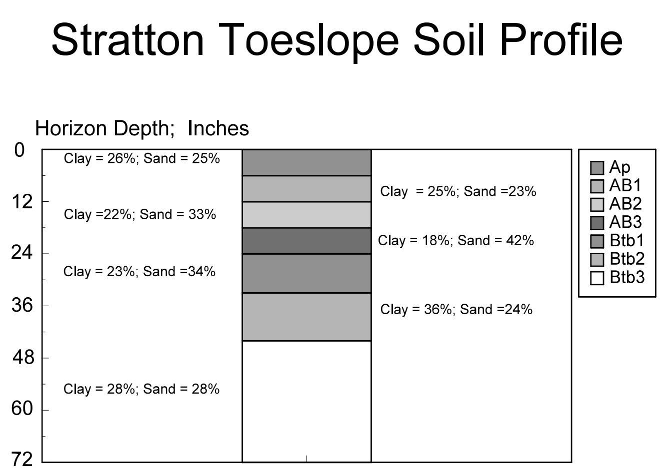
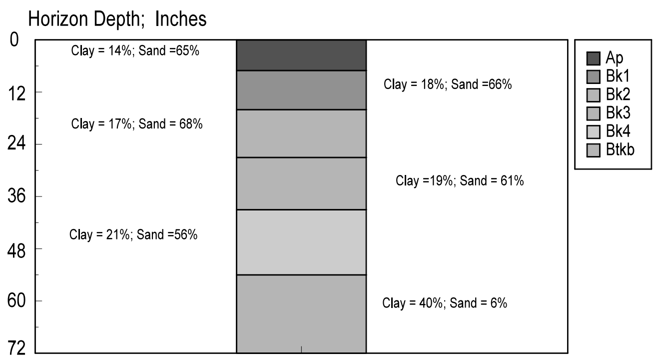
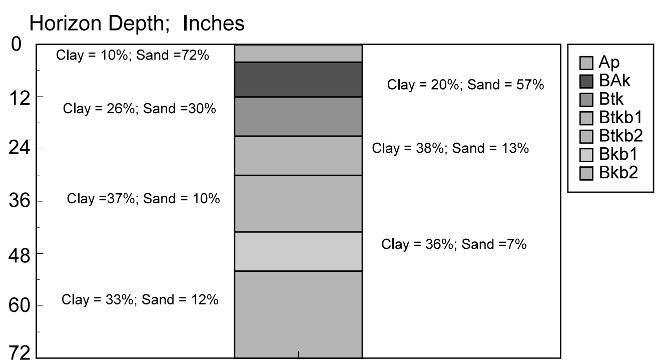


Figure 4b. Soil profile textural characteristics for soils at the Stratton site.

Walsh Summit Soil Profile



Walsh Sideslope Soil Profile



Walsh Toeslope Soil Profile

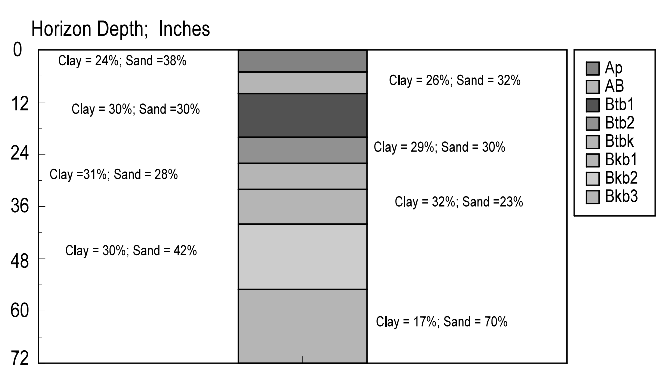


Figure 4c. Soil profile textural characteristics for soils at the Walsh site.

The summit soil at Walsh (Figure 4c) has very sandy textures above 54" compared to either summit soil at the other sites. No restrictions to water infiltration nor root penetration occur in the profile. In this soil the abrupt increase in clay content at 54", 40% in the Btkb horizon, represents a type of "plug" in the soil profile. Water can infiltrate rapidly in the coarse-textured surface horizons, but does not drain rapidly beyond the root zone due to the high clay content of the deepest horizon at 54". This makes this soil more productive than a similar soil with no clay "plug". The profile plant available water holding capacity is 11". About 2" of the total is in the 5-6' depth, leaving only a 9" storage capacity in the upper 5' of soil.

Many other soil contrasts can be observed by the reader, both within and across sites. All of these soils had been cultivated for more than 50 years, and all exhibit the effects of both wind and water erosion damage. The toeslopes are the recipients of soil materials from the summit and sideslope positions because of their landscape location relative to the others. Hence they also have the highest organic matter content in their surface horizons.

Soil profile characteristics for the three new locations are only available on a general basis. The soil type at Briggsdale and Akron is Platner loam and at Lamar it is a Wiley silt loam.

The cropping system during the previous 50 years had been primarily dryland wheat-fallow with some inclusion of grain sorghum at Walsh and corn at Sterling. At the original sites we placed cropping system treatments over the soil sequence (Fig.3) to study the interaction of systems and soils. At the three new sites we have only one soil type at each. Systems being studied at each site are listed in Tables 2a & 2b. Each system is managed with no-till techniques, and herbicide programs are reported in Appendix Tables 1 - 6. Complete details on measurements being made and reasons for treatment choices are given by Peterson, et al.(1988). Crop variety, planting rate, and planting date for each crop at each site is given in Table 3.

Nitrogen fertilizer is applied annually in accordance with the NO_3-N content of the soil profile (0-6 ft or 0-180 cm) before planting, and expected yield on each soil position at each site. Therefore, N rate changes by year, crop grown, and soil position (Table 4). Nitrogen fertilizer for wheat, corn, and sunflower was dribbled on the soil surface over the row at planting time at Sterling and Stratton. Nitrogen on wheat at Walsh was topdressed in the spring, and N was sidedressed on corn and sorghum. We made all N applications as a 32-0-0 solution of urea-ammonium nitrate.

We band applied P (10-34-0) at planting of all crops near the seed. Phosphorus was applied on one-half of each corn and soybean plot over all soils at the original sites, but applied to the entire wheat plot. The rate of P is determined by the lowest soil test on the catena, which is usually found on the sideslope position. This rate has been 20 lbs P_2O_5/A (9.5 kg/ha of P) at each site each year thus far. We changed the P fertilization treatment for wheat in fall 1992, so that the half plot that had never received P fertilizer in previous years is now treated when planted to wheat. Other crops in the rotation only receive P on the half plot designated as NP. Zinc (0.9 lbs/A or 1 kg/ha) is banded near the seed at corn planting at Sterling, Stratton, and Briggsdale to correct a soil Zn deficiency.

Table 2a. Cropping systems for each of the original sites in 1999.

Site	Rotations
Sterling	1) Wheat-Corn-Fallow (WCF)
	2) Wheat-Corn-Soybean (WCSb)
	3) Wheat-Wheat-Corn-Soybean (WWCSb)
	4) Opportunity Cropping*
	5) Perennial Grass
Stratton	1) Wheat-Corn-Fallow (WCF)
	2) Wheat-Corn-Soybean (WCSb)
	3) Wheat-Wheat-Corn-Soybean (WWCSb)
	4) Opportunity Cropping*
	5) Perennial Grass
Walsh	1) Wheat-Sorghum-Fallow (WSF)
	2) Wheat-Corn-Soybean (WCSb)
	3) Wheat-Wheat-Sorghum-Soybean (WWSSb)
	4) Continuous Row Crop (Alternate corn & sorghum)
	5) Opportunity Cropping*
	6) Perennial Grass

*Opportunity cropping is designed to be continuous cropping without fallow, but not monoculture.

Opportunity Cropping History

Year	Sterling	Stratton	Walsh
1985	Wheat	Fallow	Sorghum
1986	Wheat	Wheat	Sorghum
1987	Corn	Sorghum	Millet
1988	Corn	Sorghum	Sudex
1989	Attempted Hay Millet	Attempted Hay Millet	Sorghum
1990	Wheat	Wheat	Attempted Sunflower
1991	Corn	Corn	Wheat
1992	Hay Millet	Hay Millet	Corn
1993	Corn	Corn	Fallow
1994	Sunflower	Sunflower	Wheat
1995	Wheat	Wheat	Wheat
1996	Corn	Corn	Fallow
1997	Hay Millet	Hay Millet	Corn
1998	Wheat	Wheat	Sorghum
1999	Corn	Corn	Corn
2000	Austrian Winter Pea	Austrian Winter Pea	Soybean

We measure soil water with the neutron-scatter technique. Aluminum access tubes were installed, two per soil position, in each treatment at each original site in 1988. These tubes are not removed for any field operation and remain in the exact positions year to year. Precautions are taken to prevent soil compaction around each tube. By not moving the tubes over years we get the best possible estimates of soil water use in each rotation. Soil water measurements are made on all soils and rotations at planting and harvest of each crop, which also represents the beginning and end of non-crop or fallow periods. At the new sites soil samples are taken for gravimetric water measurements at crop planting.

Table 2b. Cropping systems for the sites initiated in 2000.

Site	Rotations
Briggsdale	1) Wheat-Fallow (WF)
	2) Wheat-Hay Millet-Fallow (WHF)
	3) Wheat-Wheat-Corn-Soybean-Sunflower-Pea (WWCSbSnPea)
	4) Opportunity
Akron	1) Wheat-Fallow (WF)
	2) Wheat-Corn-Fallow (WCF)
	3) Wheat-Corn-Proso-Fallow (WCPF)
	4) Wheat-Corn-Proso (WCP)
Lamar	1) Wheat-Fallow (WF)
	2) Wheat-Sorghum-Fallow (WSF)

Table 3. Crop variety, seeding rate, and planting date for each site in the 1999-2000 season.

Site	Crop	Variety	Seeding Rate	Planting Date
Briggsdale	Wheat (fallow & other)	Lamar & Prowers	60 lbs/A & 60 lbs/A	9/13/99 & 10/1/99
	Corn	Pioneer 3752	15,000 seeds/A	5/10/00
	Hay Millet	Golden German	10 lbs/A	6/1/00
	Sunflower	Triumph 765C	21,000 seeds/A	6/7/00
	Soybean	Asgrow 3901	90,000 seeds/A	5/16/00
Sterling	Wheat	Prairie Red	60 lbs/A & 90 lbs/A	9/20/99 & 10/6/99
	Corn	Asgrow 489	18,000 seeds/A	5/10/00
	Soybean	Asgrow RR	90,000 seeds/A	5/17/00
Akron	Wheat	Halt & Tam 107	60 lbs/A	9/6/99
	Corn	Dekalb DK 493RR	16,100 seeds/A	5/16/00
	Proso	Sunup	12 lbs/A	6/8/00
	Sunflower		------Crop Failure------	
Stratton	Wheat	Prairie Red	60 lbs/A & 90 lbs/A	9/21/99 & 10/5/99
	Corn	Pioneer 3752	18,000 seeds/A	5/11/00
	Soybean	Asgrow RR	90,000 seeds/A	5/23/00
Lamar	Wheat	Lamar & Prowers	45 lbs/A	12/15/99
	Sorghum	Cargill 770Y	42,600 seeds/A	5/31/00
Walsh	Wheat	Prairie Red	50 lbs/A	10/5/1999
	Sorghum	Cargill 627	40,000 seeds/A	5/31/00
	Corn	Asgrow RX686 RR/YG	19,000 seeds/A	5/31/00
	Soybean	Asgrow 3901 RR	110,000 seeds/A	5/31/00

RESULTS AND DISCUSSION

Climatic Data

Precipitation and its distribution in relationship to plant growth stages control grain and forage yields. Precipitation and temperature vary greatly year to year and rarely do the amounts and distributions match the long-term normals. During the last six months of 1999, the period prior to wheat planting and the fall growth period, precipitation at Sterling and Stratton was about normal, 8.0 in, (203 mm) and 8.5 in. (216 mm), respectively, while at Walsh it was 10.8 in. (274 mm), which is 2.8 in. (71 mm) above the normal (Table 5a). The first half of 2000 was well below normal at Sterling (-3.45 in. or -88 mm) , 0.45 in. (11 mm) above normal at Stratton, and -0.38 in. (-10 mm) below normal at Walsh. Precipitation was near normal during the second half of 2000 at all sites (Table 5a).

Precipitation at the three new sites in the last six months of 1999, the period prior to wheat planting and the fall growth period, was above the normals by 2.2 in. (56 mm) at Briggsdale, by 5.1 in. (130 mm) at Akron, and below by -2.1 in. (-53 mm) at Lamar (Table 5b). The first half of 2000 was below normal at all three sites; Briggsdale (-1.4 in. or -36 mm) , Akron (-3.2 in. or -81 mm), and Lamar (-1.7 in. or -43 mm. During the second half of 2000 precipitation was far below normal at Briggsdale (-4.7 in. or 120 mm), above normal at Akron (1.4 in. or 34 mm), and far below normal at Lamar (-3.6 in. or -90 mm) (Table 5b).

July and August rainfall are critical for production of corn, sorghum, and soybean. At Sterling, Stratton, Walsh, Briggsdale, and Lamar (July + August) rainfall was below normal, only Akron received its normal amount for those months (Table 5a & 5b). Therefore summer crops were severely stressed at five of the six sites. Specific precipitation distribution, relative to crop growing season, is given for each site in Tables 5c-5h.

Wheat

Wheat yields in the year 2000 for each site, soil and cropping system combination are shown in (Tables 6a & 6b & 10). Since the 2000 yields only reflect annual variability, the reader will find more meaningful long-term comparisons of cropping systems in Tables 7-9.

Wheat yield after fallow (WCF) at Sterling matched the three-year mean of 35 bu/A (2350 kg/ha, but at Stratton wheat after fallow (WCF) yielded only about half of the three-year mean, while at Walsh wheat yield in WSF was 10 bu/A (670 kg/ha) less than the three-year mean . The excellent precipitation during fallow before wheat seeding provided an excellent subsoil water supply at all sites except Lamar where fallow precipitation was below normal. At all sites precipitation during the vegetative stage ranged from above to just average (Tables 5c-5h), which provided a good base for production. Unfortunately, the rainfall during the reproductive stage was well below normal at all sites, an average deficit of -3.3" (84 mm) compared to the normals for that period. This resulted in relatively low wheat yields even following fallow.

Wheat yields in the more intensive systems, WCSb and first year wheat in (W)WCSb ranged from 2 to 9 bu/A (130 to 600 kg/ha) less than wheat after fallow; an average reduction of 38% (Tables 7-9). Yield of second year wheat in the W(W)CSb system was very low at Sterling and Stratton because of downy brome infestations and at Walsh the W(W)SSb was low basically because of less available water. Note at Walsh that second year wheat was about 5 bu/A (335 kg/ha) greater yield than first year wheat, which was all related to available water at planting.

Wheat yield means from 1998-2000 (Tables 7, 8 and 9) for the continuous WCSb system are about 21% less than wheat after fallow. Second year wheat in the W(W)CSb and W(W)SSb systems has yielded about 17% less than wheat after fallow.

Wheat yields at the newest sites were not affected by rotation mainly because wheat in these systems is always after fallow (Table 10). Yield differences due to cultivar, resistant to Russian wheat aphid vs. nonresistant, were not found in 2000 because Russian wheat aphid populations were low (Table 44).

Corn and Sorghum

___Corn yields following wheat averaged 19, 43, and 37 bu/A (1190, 2700, 2320 kg/ha) at Sterling, Stratton, and Walsh, respectively in 2000 (Tables 11a & 11b). The below average (July + August) rainfall at Sterling (-1.6" or 41mm) was a critical factor because most of what was received came in August. Furthermore, a very dry June, -2.1" (-53 mm) created stress conditions even before the reproductive period began. Corn yields at Stratton were well below the 72 bu/A long-term average for this site despite the fact that (July + August) was normal. A dry soil profile at planting, coupled with a very dry (May + June) rainfall, -2.7" (-69 mm) less than the long-term average for these months contributed to the low corn yield. Corn yields at Walsh were far below average, again because of low early summer precipitation (Table 5a) despite about average (July + August) rainfall. Late summer stress damaged corn yields too as evidenced by the low August and September rainfall, -2.8" (-71 mm) below normal.

___Corn yields at Briggsdale were low, 11 bu/A (690 kg/ha) and 19 bu/A (1190 kg/ha) at Akron (Table 10). Based on long-term July plus August precipitation records, we would expect that the Briggsdale site should average about 50 to 55 bu/A (3400 kg/ha) and the Akron site about 70 bu/A (4390 kg/ha). A combination of low precipitation early in the growing season and average to below (July + August) rainfall caused the yield depression.

Sorghum yields following wheat at Walsh averaged about 22 bu/A (1380 kg/ha) (Tables 11a & 11b), which is about 30 bu/A (1880 kg/ha) below the long-term average. Sorghum yields in the continuous row-crop system at Walsh (Tables 11a & 11b) have always been lower than sorghum after wheat, and 2000 was no exception. Continuous sorghum averaged 17 bu/A (1065 kg/ha), which is 25 bu/A (1570 kg/ha) below the long-term average (Tables 11a & 11b). The extraordinarily dry summer obviously decreased sorghum grain yields no matter the system.

Phosphorus fertilization had no consistent effect on corn or grain sorghum yields on any soil at any site (Tables 11a & 11b). Soil tests indicate that responses to P fertilizer are expected on the sideslopes, but are not likely on the summit or toeslope positions. Recall that the entire experimental plot now receives P fertilizer when planted to wheat. Thus it appears that the carryover P to the corn and sorghum from the fertilized wheat crop has diminished the chance for a response to P fertilizer applied to the corn crop at planting. However, a vegetative growth response usually is evident on the summit and sideslope positions. This “starter - P” response usually does not result in an increase in grain yields.

The sorghum crop at Lamar failed completely due to the dry summer as yields were below 3 bu/A (185 kg/ha)(Table 10).

Proso Millet

Proso millet yields at Akron averaged 13 bu/A (730 kg/ha) (Table 10). These yields were below expectations given the good late summer rainfall.

Sunflower

Sunflower was produced at both the Briggsdale and Akron sites. Yields at Briggsdale averaged 456 lbs/A (510 kg/ha), and at Akron the crop failed (Table 10).

Soybean

Soybean was grown at Briggsdale, Sterling, Stratton and Walsh for the first time in 1999. Soybean is planted after corn in two systems, WCSb and WWCSb. Choosing a soybean variety is difficult because there has been little testing in the dryland areas of eastern CO. Our choice this year, Asgrow 3901, was based on limited testing we did in 1999.

Soybean failed at Briggsdale in 2000 (Table 10), and yielded 8.5 bu/A (570 kg/ha) at Sterling, 6.5 bu/A (435 kg/ha) at Stratton, and 2 bu/A (135 kg/ha) at Walsh (Tables 10, 16a, 16b, 17, 18, & 19). Because the soybean plant sets pods close to the soil surface under stressed conditions, there were large field losses at all sites.

At $5.00/bu it requires about 11 bu/A to pay the out of pocket costs, and thus it is obvious that we had less than break even yields. On the positive side the Round Up Ready soybean allowed us to have excellent weed control; especially for sandbur which has been an increasing problem at Sterling and Walsh.

Opportunity Cropping

Opportunity cropping is an attempt to crop continuously without resorting to monoculture. It has no planned summer fallow periods, and is cropped as intensively as possible. In 2000 we grew Austrian winter pea as a forage crop in the opportunity system at Sterling and Stratton and grew soybean for grain at Walsh (Tables 19-21). Both the Austrian winter pea and soybean followed a 1999 corn crop at all three sites. The winter pea forage yields ranged from 0.5 T/A at Sterling to 2.1 T/A at Stratton. The toeslope at Sterling was badly infested with downy brome and there was no winter pea forage yield at that soil position (Tables 19 & 20).

From the initiation of our project in fall 1985 we have grown 13, 13, and 11 crops in 15 years at Sterling, Stratton and Walsh, respectively in the opportunity system (Tables 19-21). Productivity in opportunity cropping has been excellent at Sterling and Stratton, but more marginal at the Walsh site. In 15 years at the two northern sites the system has produced a total of 118 to 164 bushels of wheat, 368 to 427 bushels of corn or sorghum, and 5.1 to 6.8 tons of forage per acre at Sterling and Stratton, respectively. Crop productivity at Walsh over 15 years has been 93 bushels of wheat, 323 bushels of corn or sorghum, 2 bushels of soybean, and 0.5 tons of forage. Two fallow years were included at Walsh and crops failed in two years, 1987 and 1990.

Above average annual precipitation has been a major factor contributing to the excellent productivity; annual precipitation has been 2 to 3 inches above the long-term averages for all sites during the 15 year study period. Therefore, growers should use extreme caution in extrapolating these results to their own operations. On the other hand, the systems could have been even more productive had we managed them more carefully. The missed crop at Sterling and Stratton in 1989 was a management mistake and not related to weather. The stored water was used by weeds that summer and thus functioned like crop removal in terms of the water budget.

Failure to produce a millet crop at Walsh in 1987 occurred because we chose proso millet, which is not a well adapted crop for that climate. A forage like sudex, for example, would have done well that year. Sunflowers at Walsh in 1990 failed because of jack rabbit damage, and not because of climatic factors. The fallows in 1993 and 1996, however, were necessary. Soybean production was essentially a failure at Walsh in 2000, 2 bu/A (135 kg/ha), and so overall productivity of the opportunity system decreased this year.

Our goal has been to produce wheat and corn or sorghum, the highest value crops, as frequently as possible in our systems. We have used forages to transition from row crops back to fall planted wheat. We harvest the forage and plant winter wheat that fall. Another good possibility is planting proso the year after corn or sorghum, harvesting it as early as possible, and then planting wheat immediately into the proso stubble.

Opportunity cropping has had some advantages over the 3-year systems, such as excellent residue cover and ease of weed control. The combination of crop competition and no fallow has reduced weed pressures compared to other systems. One major difference in weed pressure has been in regard to the invasion of the perennials, Tumblegrass (*Schedonnardis paniculata*) and Red Threeawn (*Aristada longiseta*), in our no-till systems. All systems with fallows, especially WF and WC(S)F, have had devastating invasions of these grassy weeds and have required shallow sweep tillage to control these grasses. The opportunity system has remained free of these weeds. These particular perennial grasses are shallow rooted and cannot get established if surface soil water is low and if a crop is competing for the light. Fallow, where we are saving water and keeping the surface weed free, provides an excellent environment for their establishment. In contrast, opportunity cropping has no long fallows. Crop plants keep the soil surface dry much of the time and the two grassy invaders have not established.

<u>Crop Residue Base</u>

Maintenance of crop residue cover during non-crop periods and during seedling growth stages is vital to maximizing water storage in the soil. Crop residues provide protection from raindrop impact, slow runoff, and decrease water evaporation rates from the soil. Cover also greatly reduces erosion, both by wind and water.

Residue amount is being monitored by soil and crop within each system (Tables 22-25). Residues present at planting are needed to protect the soil during the early plant growth stages when there is little canopy present. Residue levels are subject to annual variations in climate, both in terms of production and decomposition rates. Obviously, drier years decrease production but also may decrease decomposition rates. The net effect is difficult to assess because the particular portion of the year that is extra dry or wet will change the direction of the impact. Residue quantities always are largest on toeslopes at each site, which is a function of productivity level. Walsh and Briggsdale, the most stressed sites, usually have the lowest residue amounts.

Cropping systems that involve a fallow period, like WCF or WSF, have minimum residue levels just prior to wheat planting because this time marks the end of the summer fallow period where decomposition has been occurring with no new additions of crop biomass. Therefore, cover is at its minimum, and soil erosion potential is at its maximum point. One of the advantages of our new continuous cropping systems is the avoidance of a year with no crop residue input.

Residues present at wheat planting are given in Table 22 and 25. Residue amounts were moderate to high at wheat planting in all cropping systems in 2000 except in the WF system at Briggsdale. One might expect that the system with fallow, WC(S)F, in the long-term to have less residue than the continuously cropped systems. However, the small residue input from the low-yielding soybean crops probably has not improved the continuous systems relative to WC(S)F. At corn planting, Table 23, the same thing seems to be true. The systems with fallow are no worse than the continuously cropped systems, and in fact tend to have greater amounts at the Sterling and Stratton sites. Residue amounts at soybean planting, Table 24, are about the same for both continuous cropping systems.

Over the long-term, one would expect the continuously cropped systems to have the most residue present on the surface. However, type of residue will influence accumulation because of differences in surface area for decomposition and C:N ratio of the material. For example, corn because of its large stalk diameter has a smaller surface area available for decomposition relative to wheat. Soybean residue has a C:N ratio that is much smaller than that of either corn or wheat, and therefore will decompose more quickly under similar environmental conditions. Therefore, systems with more corn and wheat are likely to have more residue accumulation, especially since our soybean yields of grain and stover are very low relative to corn and wheat.

Soil Water

Soil water supplies plant demand between rainfall events, but soils of eastern Colorado cannot store sufficient water to sustain a crop for the whole season, even if at field capacity at planting time. We monitor soil water in our systems to determine how efficiently various rotations and crops within rotations are using water. Our concern is how well precipitation is captured in non-crop periods, and subsequently how efficiently water is used for plant growth. Soil water at planting and harvest of each crop is shown by soil depth increment for each crop (Tables 26 to 38).

Wheat:

Soil profile available water was measured at all soil positions in all systems at wheat planting in the fall of 1999 (Tables 26-29 & 36). The continuous cropping systems like WCSb and WWC(S)Sb represent different opportunities for water storage prior to wheat planting and should have the least amount of stored soil water at planting compared to the most in the WCF or WSF systems. Wheat after fallow in the WCF or WSF systems has had 12 months of time to store soil water. Second year wheat in the WWC(S)Sb system has had approximately 2 months (July and August) to store water prior to planting. Wheat in the WCSb and first year wheat in the WWC(S)Sb systems are planted immediately after soybean harvest and essentially have no time between crops to store soil water. In the latter cases, only rainfall received after soybean senescence can be stored. For example, the reader can observe typical water storage differences among the systems can be observed by comparing them at the summit position at Sterling. Wheat after fallow in WCF had 170 mm of water (Table 26), while second year wheat in W(W)CSb had 94mm (Table 29). Wheat planted directly after soybean in the WCSb and (W)WCSb systems on the Sterling summit had 81 and 41 mm of water, respectively Tables 27 & 28).

As expected, available water at planting was highest following fallow (Table 26) compared to the other systems (Tables 27-29). Water use by the wheat crop in WCF or WSF was 2 to 3 times greater than use by wheat in WCSb, (W)WCSb or W(W)CSb at all sites. Basically, wheat uses all of the available stored water and since WCF and WSF had the most water at planting they had the greatest water use. The increased water use translated into greater grain production (Tables 6a & 6b).

Note that the winter wheat plant can easily extract soil water from depths as great as 6 feet (150-180 cm), and that some water was used from the deepest depth in all systems.

Corn and Sorghum:

Soil water contents at corn and sorghum planting were excellent at all sites in spring 2000 (Tables 30-32). Toeslope positions usually have a greater amount of available water than summit or sideslope positions because of possible run-on water, greater soil depth, and finer texture relative to the other positions. Since corn follows wheat in all systems, the time period for soil water recharge is identical. Therefore, one would expect similar storage among systems at a given site and soil position.

Soil depth distribution of the available soil water at corn and sorghum planting and harvest also is shown in these tables. As is observed in most years both corn and sorghum extract soil water from depths as deep as 155 cm (5-6 ft.). Soil water depletion by corn and sorghum was large at all sites and soil positions, ranging from a minimum of 105 mm to a maximum of 215 mm. The toeslope position at Stratton had some recharge during the growing season because of downpours that caused water to run on to that position, and thus water use by corn is underestimated for the toeslope.

Soybean:

Soil water contents at soybean planting tended to be lower than at corn or sorghum planting (Tables 33 & 34). This is as expected because of a shorter soil water recharge period and because corn, the preceding crop in both the WCSb and WWCSb systems greatly depletes the available soil water. The long-term average precipitation from September, when corn water use is usually complete, until soybean planting near the end of May the following spring is 9.0, 8.5, and 8.7 in.(230, 215, & 220 mm) at Sterling, Stratton, and Walsh, respectively. The average precipitation for the soil water recharge period from wheat harvest until corn planting is 11.2, 11.2, and 10.6 in. (285, 285, & 270 mm). Although the recharge period prior to corn is longer and more water is received, the storage efficiency for this period is less than prior to soybean because of high air temperatures just after wheat harvest. Thus the difference in expected available soil water at soybean planting relative to corn is smaller than the differences in total precipitation.

Opportunity:

Soil water data for the opportunity system, which was cropped to Austrian winter pea at Sterling and Stratton in 2000 and soybean at Walsh are shown in Table 35. Note that the Austrian pea obtained most of its water from the upper 75 cm of soil (30 inches) with small withdrawals from 75 to 105 cm. Thus a good reserve of available soil water remained at harvest that would be available for a wheat crop to be planted in the fall. Soybean at Walsh, on the other hand, depleted most of the soil water in the entire profile; leaving little reserve for a fall planted wheat crop.

Nitrogen Content of Grain and Stover

Nitrogen content was determined for both grain and stover for each crop at each site (Tables 39-42). The reader can calculate crude protein content for each grain type by multiplying wheat grain N content by 5.7; corn, sorghum or soybean grain N content by 6.3; and hay millet, triticale or Austrian winter pea and soybean forage N by 6.3. All nutrient concentrations are on a dry weight basis, consequently crude protein levels will appear high compared to market levels. To obtain market levels, a grain moisture correction must be applied.

On a dry matter basis, wheat proteins averaged 14.7% at Sterling, 14.0% at Stratton, 12.8 % at Walsh, 15.5% at Briggsdale, and 16.4% at Lamar (Tables 39a and 42). The relatively high protein contents at Briggsdale and Lamar are the result of dry weather and low grain yield, which concentrates protein. To correct these values for grain moisture content, multiply by 0.88, which results in a protein average of 12.9% at Sterling,12.3% at Stratton, 11.3% at Walsh, 13.6% at Briggsdale, and 14.4% at Lamar. Goos, et al. (1984) established that if grain protein levels were above 11.1%, yield was not likely to be limited by N deficiency. A comparison of 2000 wheat protein to this standard indicates that N fertilization was adequate for the wheat crop at all sites.

Wheat straw N concentrations ranged from 0.35 to 1.03% across sites and averaged 0.66% at Sterling, 0.60% at Stratton and 0.50% at Walsh; thus each ton of straw contained about 12 lbs of N (Table 39b). There was no obvious relationship of straw N concentration and crop rotation at any site.

Nitrogen levels in corn and sorghum grain varied from 1.21 to 2.03 %, which is equivalent to 6.4 to 10.8% protein on a market moisture basis (Table 40a). Corn stover N contents varied from 0.87 to 2.00% and averaged 1.16% (Table 40b). Each ton of corn stalks thus contained an average of 23 lbs of N. No sorghum stover samples were taken in 2000.

Nitrogen levels in soybean grain (Table 41a) ranged from 4.63 to 6.22%, which is equivalent to 25 to 34% crude protein at market moisture content of the grain. No soybean stover samples were taken in 2000.

Soil Nitrate-Nitrogen

Residual soil NO_3-N analyses are routinely conducted on soil profile samples (0-6 ft or 0-180 cm) taken prior to planting for each crop, except for soybean, on each soil at each site (Table 43). These analyses are used to make fertilizer N applications for a particular crop on each soil at each site. Accumulation of residual nitrate allows reduction in the fertilizer rate. By using residual soil nitrate analyses of the root zone we also can determine if nitrate is leaching beneath the root zone. With improved precipitation-use efficiency in the more intensive crop rotations, the amount of nitrate escaping the root zone should be minimized. In the first 12 years of experimentation we found that the wheat-fallow system generally had higher residual nitrates than the 3- or 4-year rotations at the end of fallow prior to wheat planting.

At fall wheat planting in 1999 the amount of nitrate-nitrogen present varied from site to site, but wheat planted after fallow tended to have more nitrate-nitrogen present than other systems. We would expect soil nitrate levels at wheat planting to be highest after fallow in systems like

WCF and WSF, intermediate in second year wheat in W(W)CSb, and least in the WCSb and WWCSb systems because of lack of time for N mineralization and little available water to allow mineralization. This basically held true for second year wheat, but since we did not sample soils after the soybean and before wheat planting, we can only hypothesize that wheat in WCSb and first year wheat in (W)WCSb were lowest.

Soil nitrates at corn and sorghum planting were similar to those observed in most years. It is apparent that NO_3-N is not accumulating in the soil profile of any cropping system, which indicates that no system is over-fertilized. If fertilizer N is not used by wheat, for example, it is used by the subsequent corn or sorghum crop. The carry-over N is accounted for in the soil test used and reduces the amount of fertilizer N applied to the crop. In the long-term, the systems with soybean should be the most N efficient because the soybean removes nitrate-nitrogen in addition to the amount fixed symbiotically during its growth period.

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Table 4. Nitrogen fertilizer application by soil and crop for 2000.

					ROTATION		
SITE	SOIL	CROP	WCF	WCSb	WWCSb	OPP[1]	
			------------------------------------Lbs/A------------------------------------				
Sterling	Summit	Wheat	63	63	63		
	Sideslope	"	63	63	63		
	Toeslope	"	63	63	63		
	Summit	Corn	101	101	101		
	Sideslope	"	101	101	101		
	Toeslope	"	101	101	101		
	Summit	Soybean	-	6	6		
	Sideslope	"	-	6	6		
	Toeslope	"	-	6	6		
			WCF	WCSb	WWCSb	OPP[1]	
Stratton	Summit	Wheat	63	63	63		
	Sideslope	"	63	63	63		
	Toeslope	"	63	63	63		
	Summit	Corn	101	101	101		
	Sideslope	"	101	101	101		
	Toeslope	"	101	101	101		
	Summit	Soybean	-	6	6		
	Sideslope	"	-	6	6		
	Toeslope	"	-	6	6		
			WSF	WCSb	WWSSb	OPP	CONT. CROP
Walsh	Summit	Wheat	70	70	70	-	-
	Sideslope	"	70	70	70	-	-
	Toeslope	"	70	70	70	-	-
	Summit	Sorghum	51	-	51	-	51
	Sideslope	"	51	-	51	-	51
	Toeslope	"	51	-	51	-	51
	Summit	Corn	-	106	-		101
	Sideslope	"	-	106	-		101
	Toeslope	"	-	106	-		101
	Summit	Soybean	-	6	6	6	-
	Sideslope	“	-	6	6	6	-
	Toeslope	“	-	6	6	6	-

[1]OPP = Planted to Austrian winter pea in 2000 at Sterling and Stratton and received 6 lbs/A of N as a starter fertilizer on all soils.

Table 5a. Monthly precipitation for the original sites for the 1999-2000 growing season.

MONTH	LOCATION					
	STERLING		STRATTON		WALSH	
	Inches					
1999	1999	Normals[1]	1999	Normals[1]	1999	Normals[1]
JULY	0.95	3.23	1.00	2.80	3.05	2.62
AUGUST	4.51	1.90	5.50	2.60	3.75	1.96
SEPTEMBER	1.58	1.04	1.05	1.45	2.25	1.74
OCTOBER	0.24	0.76	0.29	0.85	0.89	0.89
NOVEMBER	0.21	0.50	0.29	0.62	0.53	0.53
DECEMBER	0.55	0.40	0.37	0.28	0.31	0.31
SUBTOTAL	8.04	7.83	8.50	8.60	10.78	8.05
2000	2000	Normals	2000	Normals	2000	Normals
JANUARY	0.52	0.33	0.53	0.28	0.36	0.27
FEBRUARY	0.61	0.33	0.66	0.30	0.02	0.28
MARCH	2.01	1.07	3.04	0.76	3.55	0.81
APRIL	1.39	1.60	1.52	1.23	1.14	1.15
MAY	0.70	3.27	0.62	2.70	0.67	2.69
JUNE	0.92	3.00	1.80	2.45	1.37	2.29
SUBTOTAL	6.15	9.60	8.17	7.72	7.11	7.49
2000	2000	Normals	2000	Normals	2000	Normals
JULY	0.99	3.23	2.43	2.80	3.17	2.62
AUGUST	2.51	1.90	2.00	2.60	0.78	1.96
SEPTEMBER	1.55	1.04	0.69	1.45	0.10	1.74
OCTOBER	1.98	0.76	1.29	0.85	3.94	0.89
NOVEMBER	0.91	0.50	0.56	0.62	0.15	0.53
DECEMBER	0.30	0.40	0.13	0.28	0.81	0.31
SUBTOTAL	8.24	7.83	7.10	8.60	8.95	8.05
YEAR TOTAL	14.39	17.43	15.27	16.32	16.06	15.54
18 MONTH TOTAL	22.43	25.26	23.77	24.92	26.84	23.59

[1]Normal = 1961-1990 data base

Table 5b. Monthly precipitation for the three new sites for the 1999-2000 growing season.

	LOCATION					
MONTH	BRIGGSDALE		AKRON		LAMAR	
	---Inches---					
1999	1999	Normals[1]	1999	Normals[1]	1999	Normals[1]
JULY	1.65	2.63	2.70	2.73	1.43	2.23
AUGUST	4.33	1.77	6.45	2.04	2.62	1.85
SEPTEMBER	2.63	1.29	1.59	0.98	0.66	1.33
OCTOBER	0.39	0.70	0.72	0.60	0.13	0.71
NOVEMBER	0.18	0.36	0.53	0.56	0.12	0.56
DECEMBER	0.00	0.27	0.37	0.32	0.05	0.40
SUBTOTAL	9.18	7.02	12.36	7.23	5.01	7.08
2000	2000	Normals	2000	Normals	2000	Normals
JANUARY	0.10	0.26	0.23	0.33	0.31	0.42
FEBRUARY	0.41	0.18	0.33	0.30	0.22	0.42
MARCH	1.00	0.75	2.25	0.91	3.00	0.90
APRIL	0.75	1.27	1.17	1.32	1.38	1.15
MAY	2.63	2.08	0.80	3.25	0.44	2.50
JUNE	0.33	2.10	0.76	2.62	0.54	2.19
SUBTOTAL	5.22	6.64	5.54	8.73	5.89	7.58
2000	2000	Normals	2000	Normals	2000	Normals
JULY	0.51	2.63	2.65	2.73	1.55	2.23
AUGUST	0.32	1.77	2.12	2.04	0.39	1.85
SEPTEMBER	0.91	1.29	1.62	0.98	0.30	1.33
OCTOBER	0.19	0.70	1.94	0.60	1.19	0.71
NOVEMBER	0.10	0.36	0.15	0.56	0.06	0.56
DECEMBER	0.27	0.27	0.11	0.32	0.04	0.40
SUBTOTAL	2.30	7.02	8.59	7.23	3.53	7.08
YEAR TOTAL	7.52	13.66	14.13	15.96	9.42	14.66
18 MONTH TOTAL	16.70	20.68	26.49	23.19	14.43	21.74

[1]Normal = 1961-1990 data base

Table 5c. Precipitation by growing season segments for Sterling from 1987-2000.

	Growing Season Segments			
	Wheat		Corn	
	Vegetat.	Reprod.	Preplant	Growing Season
	Sep - Mar	Apr - Jun	Jul - Apr	May - Oct
Year	---Inches---			
1987-88	5.2	9.9	11.1	15.8
1988-89	3.1	6.5	10.5	14.3
1989-90	5.1	4.7	11.8	13.0
1990-91	3.8	7.2	12.3	11.7
1991-92	4.5	4.8	9.1	14.8
1992-93	4.5	6.2	15.5	10.6
1993-94	6.4	3.0	10.2	6.1
1994-95	7.3	14.4	9.6	17.2
1995-96	4.2	9.2	7.5	18.0
1996-97	4.7	7.0	10.6	21.4
1997-98	5.5	4.9	16.7	13.8
1998-99	5.8	7.7	13.5	12.8
1999-00	5.7	3.0	12.6	8.6
Long Term Average	4.4	7.9	11.2	13.2

Table 5d. Precipitation by growing season segment for Stratton from 1987 -2000.

	Growing Season Segments			
	Wheat		Corn	
	Vegetat.	Reprod.	Preplant	Growing Season
	Sep - Mar	Apr - Jun	Jul - Apr	May - Oct
Year	---Inches---			
1987-88	4.3	7.2	8.8	12.6
1988-89	3.0	9.4	5.3	15.5
1989-90	5.3	6.1	11.0	13.4
1990-91	4.4	4.1	10.7	14.7
1991-92	3.3	6.1	14.2	13.6
1992-93	3.3	3.8	11.8	14.7
1993-94	4.3	7.8	16.7	13.5
1994-95	7.0	10.0	14.8	13.7
1995-96	3.5	6.0	8.1	14.5
1996-97	2.9	6.2	12.2	23.2
1997-98	8.0	5.9	22.6	13.9
1998-99	4.4	8.5	15.6	12.3
1999-00	6.2	3.9	14.2	8.8
Long Term Average	4.5	6.4	11.2	12.9

Table 5e. Precipitation by growing season segment for Walsh from 1987-2000.

	Growing Season Segments			
	Wheat		Sorghum & Corn	
	Vegetat.	Reprod.	Preplant	Growing Season
	Sep - Mar	Apr - Jun	Jul - Apr	May - Oct
Year	--------Inches--------			
1987-88	4.3	7.6	7.4	11.1
1988-89	4.1	11.5	8.1	20.2
1989-90	5.7	7.4	14.1	12.5
1990-91	5.0	7.7	11.7	12.2
1991-92	2.7	5.8	7.1	13.2
1992-93	6.1	9.2	13.8	14.5
1993-94	3.2	5.3	8.7	16.3
1994-95	4.6	7.2	16.6	7.2
1995-96	1.7	3.5	1.9	17.1
1996-97	5.8	5.3	17.2	11.3
1997-98	6.9	2.3	12.3	13.3
1998-99	8.2	7.4	19.4	14.5
1999-00	7.9	3.2	15.8	10.0
Long Term Average	4.8	6.1	10.6	12.2

Table 5f. Precipitation by growing season segment for Briggsdale from 1997-2000.

	Growing Season Segments			
	Wheat		Sorghum	
	Vegetat.	Reprod.	Preplant	Growing Season
	Sep - Mar	Apr - Jun	Jul - Apr	May - Oct
Year	Inches			
1997-98	3.9	3.9	11.6	11.9
1998-99	4.6	8.4	15.3	12.4
1999-00	4.7	3.7	11.4	4.9
Long Term Average	3.8	5.5	9.5	10.6

Table 5g. Precipitation by growing season segment for Akron from 1997-2000.

	Growing Season Segments			
	Wheat		Corn	
	Vegetat.	Reprod.	Preplant	Growing Season
	Sep - Mar	Apr - Jun	Jul - Apr	May - Oct
Year	Inches			
1997-98	5.6	2.1	11.1	6.5
1998-99	2.8	7.9	11.4	17.1
1999-00	6.0	2.7	16.3	9.9
Long Term Average	4.0	7.2	10.1	12.2

Table 5h. Precipitation by growing season segment for Lamar from 1997-2000.

	Growing Season Segments			
	Wheat		Sorghum	
	Vegetat.	Reprod.	Preplant	Growing Season
	Sep - Mar	Apr - Jun	Jul - Apr	May - Oct
Year	Inches			
1997-98	10.5	2.6	19.4	15.9
1998-99	7.5	9.2	22.5	11.0
1999-00	4.5	2.4	9.9	4.4
Long Term Average	4.7	5.8	10.0	10.8

Table 6a. Grain and stover yields for WHEAT in English units in 2000.

SITE & ROTATION	SLOPE POSITION											
	SUMMIT				SIDESLOPE				TOESLOPE			
	GRAIN		STOVER		GRAIN		STOVER		GRAIN		STOVER	
	NP*	NP	NP*	NP	NP*	NP	NP*	NP	NP*	NP	NP*	NP
STERLING:	------ Bu./A. ------		------ lbs./A. ------		------ Bu./A. ------		------ lbs./A. ------		------ Bu./A. ------		------ lbs./A. ------	
WCF	33	34	4325	5025	30	29	3480	2910	42	43	6690	5205
WCSb	14	15	1550	1865	18	18	1720	2310	16	15	1940	1875
(W)WCSb	15	16	1590	1770	17	21	1765	2300	8	10	1190	2160
W(W)CSb	29	27	3130	3215	24	27	2380	3040	23	19	2820	2790
	NP*	NP	NP*	NP	NP*	NP	NP*	NP	NP*	NP	NP*	NP
STRATTON:	------ Bu./A. ------		------ lbs./A. ------		------ Bu./A. ------		------ lbs./A. ------		------ Bu./A. ------		------ lbs./A. ------	
WCF	21	22	3485	3550	10	9	2910	3620	23	26	7655	5970
WCSb	11	12	3405	1375	7	9	800	1835	30	34	10490	5375
(W)WCSb	5	8	1050	1375	6	5	1245	1170	33	34	4740	5065
W(W)CSb	10	8	3330	4100	4	2	3950	1480	13	13		
	NP*	NP	NP*	NP	NP*	NP	NP*	NP	NP*	NP	NP*	NP
WALSH:	------ Bu./A. ------		------ lbs./A. ------		------ Bu./A. ------		------ lbs./A. ------		------ Bu./A. ------		------ lbs./A. ------	
WSF	24	25	3395	2605	27	31	2815	3905	33	32	3100	3260
WCSb	12	16	1170	1350	13	16	1045	1755	14	14	1625	1775
(W)WSSb	11	17	985	1705	11	11	1035	1285	11	15	1425	1780
W(W)SSb	16	16	2075	1575	14	15	1775	2525	22	27	2540	3470

1. Wheat grain yield expressed at 12% moisture.
* Only receives phosphorus in wheat phase of each rotation.

Table 6b. Grain, stover and total biomass yields for WHEAT in 2000.

SITE & ROTATION	SLOPE POSITION																	
	SUMMIT						SIDE						TOE					
	GRAIN		STOVER		TOTAL		GRAIN		STOVER		TOTAL		GRAIN		STOVER		TOTAL	
	NP*	NP	NP*	NP	NP*	NP	NP*	NP	NP*	NP	NP*	NP	NP*	NP	NP*	NP	NP*	NP
STERLING:	kg/ha						kg/ha						kg/ha					
WCF	2200	2315	4845	5630	7045	7945	2020	1945	3895	3260	5915	5205	2850	2900	7495	5830	10345	8730
WCSb	920	1020	1735	2090	2655	3110	1215	1235	1930	2590	3145	3825	1055	1035	2170	2100	3225	3135
(W)WCSb	1040	1080	1780	1980	2820	3060	1130	1405	1975	2575	3105	3980	540	685	1335	2420	1875	3105
W(W)CSb	1970	1830	3505	3600	5475	5430	1635	1820	2665	3405	4300	5225	1540	1280	3160	3125	4700	4405
STRATTON:	kg/ha						kg/ha						kg/ha					
WCF	1380	1475	3905	3980	5285	5455	680	640	3260	4060	3940	4700	1555	1730	8575	6690	10130	8420
WCSb	740	790	3810	1540	4550	2330	475	580	895	2055	1370	2635	1985	2305	11750	6020	13735	8325
(W)WCSb	350	570	1180	1540	1530	2110	435	320	1395	1310	1830	1630	2220	2310	5305	5675	7525	7985
W(W)CSb	700	575	3330	4100	4030	4675	290	150	3950	1480	4240	1630	890	870				
WALSH:	kg/ha						kg/ha						kg/ha					
WSF	1635	1700	3800	2920	5435	4620	1845	2120	3150	4375	4995	6495	2210	2145	3470	3650	5680	5795
WCSb	840	1055	1310	1510	2150	2565	910	1100	1170	1970	2080	3070	955	975	1820	1985	2775	2960
(W)WSSb	770	1150	1105	1910	1875	3060	770	775	1160	1440	1930	2215	780	1010	1595	1990	2375	3000
W(W)SSb	1110	1090	2325	1765	3435	2855	930	980	1990	2825	2920	3805	1510	1830	2845	3890	4355	5720

* Only receives phosphorus in wheat phase of each rotation.

Table 7. Wheat yields by rotation at optimum fertility by year year and soil position at STERLING from 1999-2000.

	ROTATION	SUMMIT	SIDE	TOE	MEAN
			SLOPE POSITION		
		------------------------------Bu/A------------------------------			
1998	WCF	28	16	40	28
	WCP	32	33	30	32
	(W)WCP	---------------No yield------------			
	W(W)CP	32	36	46	38
1999	WCF	36	40	46	41
	WCSb	33	24	31	29
	(W)WCSb	29	28	29	29
	W(W)CSb	---------------No yield------------			
2000	WCF	34	30	42	35
	WCSb	14	18	16	16
	(W)WCSb	16	19	9	15
	W(W)CSb	28	26	21	25
MEAN	WCF	33	29	43	35
	WCSb	26	25	26	26
	(W)WCSb	22	24	20	22
	W(W)CSb	30	31	34	32

Table 8. Wheat yields by rotation at optimum fertility by year year and soil position at STRATTON from 1999-2000.

	ROTATION	SUMMIT	SIDE	TOE	MEAN
			SLOPE POSITION		
		------------------------------Bu/A------------------------------			
1998	WCF	37	29	51	39
	WCP	34	34	48	39
	(W)WCP	35	31	40	35
	W(W)CP	37	39	51	42
1999	WCF	55	38	50	48
	WCSb	36	27	34	32
	(W)WCSb	34	30	44	36
	W(W)CSb	---------------No yield------------			
2000	WCF	22	10	24	19
	WCSb	12	8	32	17
	(W)WCSb	6	6	34	15
	W(W)CSb	9	3	13	8
MEAN	WCF	38	26	42	35
	WCSb	27	23	38	29
	(W)WCSb	25	22	39	29
	W(W)CSb	23	21	32	25

Table 9. Wheat yields by rotation at optimum fertility by year year and soil position at WALSH from 1999-2000.

		SLOPE POSITION			
	ROTATION	SUMMIT	SIDE	TOE	MEAN
		----------------------------Bu/A----------------------------			
1998	WSF	31	31	38	33
	WCSf	25	31	40	32
	(W)WSSf	8	12	20	13
	W(W)SSf	27	29	32	29
1999	WSF	52	52	54	53
	WCSb	40	46	52	46
	(W)WSSb	37	36	37	37
	W(W)SSb	54	50	52	52
2000	WSF	24	29	32	28
	WCSb	14	14	14	14
	(W)WSSb	14	11	13	13
	W(W)SSb	16	14	24	18
MEAN	WSF	36	37	41	38
	WCSb	26	30	35	30
	(W)WSSb	20	20	23	21
	W(W)SSb	32	31	36	33

Table 10. Grain[1] and stover yields for all crops at Briggsdale, Akron, and Lamar in English units in 2000.

SITE & ROTATION	Wheat				Corn/Sorghum		Millet		Sunflower		Soybean		Peas	
	GRAIN		*STOVER*		*GRAIN*	*STOVER*	*GRAIN*	*STOVER*	*GRAIN*	*STOVER*	*GRAIN*	*STOVER*	*Hay*	*Stubble*
	Susceptible Variety	Resistant Variety	Susceptible Variety	Resistant Variety										
BRIGGSDALE:	------ bu/A ------		------ lbs/A ------		bu/A	lbs/A	lb/A	lbs/A	lb/A	lbs/A	bu/A	lbs/A	lb/A	lbs/A
WF	18	21	4406	4177										
WM(Hay)**F**	15	16	3281	4260			No Yield							
(W)WCSbSfP	12	13	1912	1442	11	858			456	750	No Yield		No Yield	
W(W)CSbSfP	11	12	1658	3067										
Opportunity											No Yield			
AKRON:	------ bu/A ------		------ lbs/A ------		bu/A	lbs/A	bu/A	lbs/A	lb/A	lbs/A				
WF	27	29	4534	4153										
WCF	28	28	4154	4011	20	1230								
WCM (Proso)	18	19	2466	3319	18	2635	13	692						
WCSfF	26	27	4456	4229	10	783			No Yield					
LAMAR:	------ bu/A ------		------ lbs/A ------		bu/A	lbs/A								
WF	16	12	2483	2159										
WSF	12	14	2117	2483	2	330								

1. Grain or hay yield expressed at the following moistures: Wheat - 12%; Corn - 15.5%; Hay millet @ Briggsdale - 15%; Proso millet @ Akron - 10%; Sunflowers - 10%; Soybeans - 13%; Pea Hay - 15%.

Table 11a. Grain and stover yields for CORN AND SORGHUM in English units in 2000.

SITE & ROTATION	SLOPE POSITION											
	SUMMIT				SIDESLOPE				TOESLOPE			
	GRAIN		STOVER		GRAIN		STOVER		GRAIN		STOVER	
	N	NP	N	NP	N	NP	N	NP	N	NP	N	NP
STERLING:	---- Bu./A. ----		---- lbs./A. ----		---- Bu./A. ----		---- lbs./A. ---		---- Bu./A. ----		---- lbs./A. ----	
WCF	7	10	870	905	15	23	500	1180	25	30	570	1010
WCSb	17	18	1075	815	26	18	750	540	22	26	510	765
WWCSb	8	6	1310	1040	21	19	680	590	26	24	875	1000
	N	NP	N	NP	N	NP	N	NP	N	NP	N	NP
STRATTON:	---- Bu./A. ----		---- lbs./A.----		---- Bu./A. ----		---- lbs./A. ---		---- Bu./A. ----		---- lbs./A. ---	
WCF	41	36	1545	695	14	27	565	690	54	52	1740	2990
WCSb	53	41	1475	1255	51	39	1540	1360	56	49	2280	1980
WWCSb	46	42	1240	965	37	42	785	765	49	47	890	935
	N	NP	N	NP	N	NP	N	NP	N	NP	N	NP
WALSH:	----- Bu./A. ----		--- lbs./A. ----		---- Bu./A. ----		--- lbs./A. ----		---- Bu./A. ---		---- lbs./A. ---	
WSF	22	22	790	785	23	29	840	1035	16	19	570	695
WCSb	20	19	890	850	12	10	530	435	1	2	65	65
WWSSb	21	33	760	1195	23	36	815	1295	15	22	525	780
CS (Corn)	5	6	220	285	6	5	255	225	1	1	35	25
CS (Sorghum)	23	24	830	885	21	23	755	820	6	3	200	110

1. Corn grain yield expressed at 15.5% moisture.
2. Sorghum grain yield expressed at 14% moisture.

Table 11b. Grain, stover and total biomass yields for CORN and SORGHUM in 2000.

SITE & ROTATION	SLOPE POSITION																	
	SUMMIT						SIDE						TOE					
	GRAIN		STOVER		TOTAL		GRAIN		STOVER		TOTAL		GRAIN		STOVER		TOTAL	
	N	NP	N	NP	N	NP	N	NP	N	NP	N	NP	N	NP	N	NP	N	NP
STERLING:	kg/ha						kg/ha						kg/ha					
WCF	440	635	910	945	1350	1580	930	1440	520	1235	1450	2675	1550	1885	595	1060	2145	2945
WCSb	1085	1110	1120	850	2205	1960	1600	1100	785	570	2385	1670	1355	1600	535	800	1890	2400
WWCSb	500	390	1370	1090	1870	1480	1290	1190	715	620	2005	1810	1620	1510	915	1045	2535	2555
	N	NP	N	NP	N	NP	N	NP	N	NP	N	NP	N	NP	N	NP	N	NP
STRATTON:	kg/ha						kg/ha						kg/ha					
WCF	2580	2260	1615	725	4195	2985	855	1670	590	720	1445	2390	3400	3260	1820	3125	5220	6385
WCSb	3335	2580	1540	1310	4875	3890	3220	2475	1610	1420	4830	3895	3485	3070	2385	2070	5870	5140
WWCSb	2860	2610	1295	1010	4155	3620	2330	2660	820	800	3150	3460	3085	2975	935	980	4020	6955
	N	NP	N	NP	N	NP	N	NP	N	NP	N	NP	N	NP	N	NP	N	NP
WALSH:	kg/ha						kg/ha						kg/ha					
WSF	1370	1365	825	820	2195	2185	1455	1795	875	1080	2330	2875	985	1210	595	730	1580	1940
WCSb	1225	1165	935	885	2160	2050	725	595	550	455	1275	1050	90	105	70	70	160	175
WWSSb	1320	2070	795	1250	2115	3320	1410	2250	850	1355	2260	3605	910	1350	550	810	1460	2160
CS (Corn)	300	395	230	300	530	695	350	310	265	235	615	545	50	35	40	30	90	65
CS(Sorghum	1435	1535	865	925	2300	2460	1310	1425	790	860	2100	2285	350	190	210	115	560	305

Table 12. Corn yields by rotation at optimum fertility by year and soil position at STERLING from 1999-2000.

YEAR	ROTATION	SUMMIT	SIDE	TOE	MEAN
		SLOPE POSITION			
		------------------------------Bu/A------------------------------			
1998	WCF	50	44	54	49
	WCSb	56	71	96	74
	WWCSb	44	55	84	61
1999	WCF	56	62	81	66
	WCSb	50	56	70	59
	WWCSb	39	67	66	57
2000	WCF	10	23	28	20
	WCSb	18	21	24	21
	WWCSb	7	20	25	17
MEAN	WCF	39	43	54	45
	WCSb	41	49	63	51
	WWCSb	30	47	58	45

Table 13. Corn yields by rotation at optimum fertility by year and soil position at STRATTON from 1999-2000.

YEAR	ROTATION	SUMMIT	SIDE	TOE	MEAN
		SLOPE POSITION			
		------------------------------Bu/A------------------------------			
1998	WCF	122	94	117	111
	WCSb	110	94	124	109
	WWCSb	122	100	117	113
1999	WCF	88	80	100	89
	WCSb	73	70	96	80
	WWCSb	82	86	108	92
2000	WCF	38	20	53	37
	WCSb	47	45	52	48
	WWCSb	44	40	48	44
MEAN	WCF	83	65	90	79
	WCSb	77	70	91	79
	WWCSb	83	75	91	83

Table 14. Sorghum and corn yields by rotation at optimum fertility and soil position at WALSH from 1999-2000.

YEAR	ROTATION	SUMMIT	SIDE	TOE	MEAN
		SLOPE POSITION			
		---Bu/A---			
1998	WSF	60	76	76	71
	WCSb	38	56	100	65
	WWSSb	61	74	80	72
	Cont. Row C	54	62	80	65
	Cont. Row S	60	64	60	61
1999	WSF	64	68	60	64
	WCSb	46	65	54	55
	WWSSb	59	70	54	61
	Cont. Row C	45	58	50	51
	Cont. Row S	52	58	45	52
2000	WSF	22	26	18	22
	WCSb	20	11	2	11
	WWSSb	27	24	18	23
	Cont. Row C	6	6	1	4
	Cont. Row S	24	22	4	17
MEAN	WSF	49	57	51	52
	WCSb	35	44	22	34
	WWSSb	49	56	51	52
	Cont. Row C	35	42	44	40
	Cont. Row S	45	48	36	43

Table 15a. Grain and stover yields for Soybean at Sterling, Stratton and Walsh in English units in 2000.

SITE & ROTATION	SUMMIT GRAIN N	SUMMIT GRAIN NP	SUMMIT STOVER N	SUMMIT STOVER NP	SIDESLOPE GRAIN N	SIDESLOPE GRAIN NP	SIDESLOPE STOVER N	SIDESLOPE STOVER NP	TOESLOPE GRAIN N	TOESLOPE GRAIN NP	TOESLOPE STOVER N	TOESLOPE STOVER NP
STERLING:	------ Bu./A. ------		------ lbs./A. ------		------ Bu./A. ------		------ lbs./A. ------		------ Bu./A. ------		------ lbs./A. ------	
WCSb	8	10	320	515	4	11	160	520	9	8	665	450
WWCSb	9	10	455	475	10	11	645	695	9	8	670	690
	N	NP	N	NP	N	NP	N	NP	N	NP	N	NP
STRATTON:	------ Bu./A. ------		------ lbs./A. ------		------ Bu./A. ------		------ lbs./A. ------		------ Bu./A. ------		------ lbs./A. ------	
WCSb	7	13	410	700	5	6	335	390	11	11	570	990
WWCSb	1	3	50	175	3	4	190	230	4	10	340	750
	N	NP	N	NP	N	NP	N	NP	N	NP	N	NP
WALSH:	--------Bu/A------		--------lb./A------		--------Bu/A------		------ lbs./A. ------		--------Bu/A------		------ lbs./A. ------	
WCSb	1	1	50	80	2	3	140	215	2	3	170	230
WWSSb	2	2	190	140	3	2	150	145	2	2	120	140
OPP	1	2	40	110	2	2	90	110	2	2	150	130

1. Soybean yield expressed at 13.0% moisture.

Table 15b. Grain and stover yields for Soybean at Sterling, Stratton and Walsh in 2000.

SITE & ROTATION	SLOPE POSITION: SUMMIT GRAIN N	GRAIN NP	STOVER N	STOVER NP	TOTAL N	TOTAL NP	SIDESLOPE GRAIN N	GRAIN NP	STOVER N	STOVER NP	TOTAL N	TOTAL NP	TOESLOPE GRAIN N	GRAIN NP	STOVER N	STOVER NP	TOTAL N	TOTAL NP
STERLING:	kg/ha						kg/ha						kg/ha					
WCSb	530	600	335	535	865	1135	255	660	330	545	585	1205	540	500	695	470	1235	970
WWCSb	530	605	475	495	1005	1100	635	700	670	730	1305	1430	590	520	700	720	1290	1240
	N	NP	N	NP	N	NP	N	NP	N	NP	N	NP	N	NP	N	NP	N	NP
STRATTON:	kg/ha						kg/ha						kg/ha					
WCSb	430	800	430	730	860	1530	305	390	350	410	655	800	665	670	600	1030	1265	1700
WWCSb	60	195	105	180	165	375	215	220	395	240	610	460	265	640	350	785	615	1425
	N	NP	N	NP	N	NP	N	NP	N	NP	N	NP	N	NP	N	NP	N	NP
WALSH:	kg/ha						kg/ha						kg/ha					
WCSb	70	80	50	85	120	165	125	160	145	225	270	385	150	190	175	240	325	430
WWSSb	135	130	195	145	330	275	155	150	155	150	310	300	105	110	125	150	230	260
OPP	50	105	40	115	90	220	95	140	90	120	185	260	125	100	155	135	280	235

1. Soybean yield expressed at 13.0% moisture.

Table 16. Soybean yields by rotation at optimum fertility by year and soil postion at STERLING from 1999-2000.

YEAR	ROTATION	SUMMIT	SIDE	TOE	MEAN
		SLOPE POSITION			
		---------------------Bu/A---------------------			
1999	WCSb	10	9	11	10
	WWCSb	10	12	9	10
2000	WCSb	9	8	8	8
	WWCSb	10	10	8	9
MEAN	WCSb	10	8	10	9
	WWCSb	10	11	8	10

Table 17. Soybean yields by rotation at optimum fertility by year and soil postion at STRATTON from 1999-2000.

YEAR	ROTATION	SUMMIT	SIDE	TOE	MEAN
		SLOPE POSITION			
		---------------------Bu/A---------------------			
1999	WCSb	14	8	18	13
	WWCSb	15	10	22	16
2000	WCSb	10	6	11	9
	WWCSb	2	4	7	4
MEAN	WCSb	12	7	14	11
	WWCSb	8	7	16	10

Table 18. Soybean yields by rotation at optimum fertility by year and soil postion at WALSH from 1999-2000.

YEAR	ROTATION	SUMMIT	SIDE	TOE	MEAN
		SLOPE POSITION			
		---------------------Bu/A---------------------			
1999	WCSb	8	11	16	12
	WWSSb	8	10	14	11
2000	WCSb	1	2	2	2
	WWSSb	2	2	2	2
MEAN	WCSb	4	6	9	7
	WWSSb	5	6	8	6

Table 19. Grain and forage yields in the opportunity cropping system at STERLING.

YEAR	CROP	SLOPE POSITION SUMMIT	SIDE	TOE	MEAN
		----------Bu/A or T/A----------			
1986	Wheat	27	25	28	27
1987	Corn	46	59	70	58
1988	Corn	52	60	63	58
1989	Attempted Hay Millet	0	0	0	0
1990	Wheat	29	40	42	37
1991	Corn	57	69	105	77
1992	Hay Millet	2.35	2.45	3.17	2.66
1993	Corn	30	37	44	37
1994	Sunflower	0	0	0	0
1995	Wheat	25	31	32	29
1996	Corn	68	72	84	75
1997	Hay Millet	2.22	1.97	1.98	2
1998	Wheat	24	24	26	25
1999	Corn	55	67	66	63
2000	Austrian winter pea	0.72	0.70	0.00	0.47
Total	Wheat (4)	105	120	128	118
Yields	Corn (6)	308	364	432	368
	Forage (3)	4.57	4.42	5.15	4.71
	Sunflower (1)	0	0	0	0
	Austrian winter pea(1)	0.72	0.70	0.00	0.47

Table 20. Grain and forage yields in the opportunity cropping system at STRATTON.

YEAR	CROP	SLOPE POSITION			
		SUMMIT	SIDE	TOE	MEAN
		----------------------Bu/A or T/A----------------------			
1986	Wheat	32	29	23	28
1987	Sorghum	31	34	51	39
1988	Sorghum	30	28	52	37
1989	Attempted Hay Millet	0	0	0	0
1990	Wheat	45	32	78	52
1991	Corn	89	75	114	93
1992	Hay Millet	2.75	2.52	2.55	2.61
1993	Corn	47	54	44	48
1994	Sunflower	0	0	0	0
1995	Wheat	55	47	50	51
1996	Corn	110	118	124	117
1997	Hay Millet	2.37	2.34	1.55	2.09
1998	Wheat	30	32	40	34
1999	Corn	93	80	106	93
2000	Austrian winter pea	2.07	1.56	2.80	2.14
Total	Wheat (4)	162	140	191	164
Yields	Corn & Sorghum (6)	400	389	491	427
	Forage (3)	5.12	4.86	4.10	4.69
	Sunflower (1)	0	0	0	0
	Austrian winter pea(1)	2.07	1.56	2.80	2.14

Table 21. Grain and forage yields in the opportunity cropping system at WALSH.

YEAR	CROP	SLOPE POSITION			
		SUMMIT	SIDE	TOE	MEAN
		----------------------Bu/A or T/A----------------------			
1986	Sorghum	34	25	42	34
1987	Millet	0	0	0	0
1988	Forage	0.39	0.32	0.71	0.47
1989	Sorghum	18	38	82	46
1990	Sunflower	0	0	0	0
1991	Wheat	40	38	44	41
1992	Corn	45	46	56	49
1993	Fallow	0	0	0	0
1994	Wheat	32	37	46	38
1995	Wheat	13	12	18	14
1996	Fallow	0	0	0	0
1997	Corn	54	63	83	67
1998	Sorghum	72	80	84	79
1999	Corn	49	54	40	48
2000	Soybean	2	2	2	2
Total	Wheat (3)	85	87	108	93
Yields	Sorghum & Corn (6)	272	306	387	322
	Forage (1)	0.39	0.32	0.71	0.47
	Sunflower (1)	0	0	0	0
	Millet (1)	0	0	0	0
	Soybean (1)	2	2	2	2

Table 22. Crop residue weights on all plots in WHEAT during the 1999-2000 crop year.

SITE & ROTATION	SLOPE POSITION: SUMMIT Pre-Plant NP*	SUMMIT NP	SIDESLOPE Pre-Plant NP*	SIDESLOPE NP	TOESLOPE Pre-Plant NP*	TOESLOPE NP
STERLING:	----------kg/ha-----------		----------kg/ha-----------		----------kg/ha-----------	
WCF	2610	5290	4670	4275	5430	4455
WCSb	3620	3660	3525	3360	3790	3950
(W)WCSb	3200	4475	3195	4775	5040	4810
W(W)CSb	5520	3295	3130	4550	4765	4340
	NP*	NP	NP*	NP	NP*	NP
STRATTON:	----------kg/ha-----------		----------kg/ha--------		----------kg/ha--------	
WCF	5870	5675	5330	4310	9980	6850
WCSb	2550	3900	3295	3005	6690	6365
(W)WCSb	6030	3805	3375	4300	5560	6190
W(W)CSb	2030	3530	4090	2640	2735	3370
	NP*	NP	NP*	NP	NP*	NP
WALSH:	----------kg/ha--------		----------kg/ha--------		----------kg/ha--------	
WSF	1860	2395	3290	3885	3635	2205
WCSb	1725	2595	2560	2840	3540	2455
(W)WSSb	705	1445	1320	2540	2275	2980
W(W)SSb	3200	3315	2905	2990	3845	2970

1. For conversion to lbs/Acre multiply kg/ha by 0.893.
* Only receives phosphorus in wheat phase of each rotation.

Table 23. Crop residue weights on all plots in Corn or Sorghum during the 2000 crop year.

SITE & ROTATION	SLOPE POSITION					
	SUMMIT		SIDESLOPE		TOESLOPE	
	Pre-Plant		*Pre-Plant*		*Pre-Plant*	
	NP*	NP	NP*	NP	NP*	NP
STERLING:	------kg/ha--------		------kg/ha--------		-------kg/ha--------	
WCF	3070	3175	3615	5860	2810	3630
WCSb	1925	1780	2250	2020	2980	1830
WWCSb	1235	1060	2200	2060	820	2210
	NP*	NP	NP*	NP	NP*	NP
STRATTON:	-----kg/ha--------		-------kg/ha--------		-----kg/ha-------	
WCF	2090	2755	3515	3360	3645	2875
WCSb	1500	2475	1775	2870	1310	2090
WWCSb	2725	3660	4455	2495	4300	1695
	NP*	NP	NP*	NP	NP*	NP
WALSH:	------kg/ha--------		------kg/ha--------		-------kg/ha--------	
WSF	4310	5360	5800	3845	4590	4395
WCSb	4710	3235	6020	4590	2675	3555
WWSSb	5620	5030	6350	3620	4350	4390
CC (C)	6310	4080	4260	4320	2685	4190
CC (S)	3300	3335	3690	3485	4350	4355

1. For conversion to lbs/Acre multiply kg/ha by 0.893.
* Only receives phosphorus in wheat phase of each rotation.

Table 24. Crop residue weights on all plots in Soybean during the 2000 crop year.

SITE & ROTATION	SLOPE POSITION					
	SUMMIT		SIDESLOPE		TOESLOPE	
	Pre-Plant		*Pre-Plant*		*Pre-Plant*	
	NP*	NP	NP*	NP	NP*	NP
STERLING:	------kg/ha--------		------kg/ha--------		------kg/ha--------	
WCSb	2620	1310	4720	1600	2645	3900
WWCSb	2245	1910	3130	4525	1815	4390
	NP*	NP	NP*	NP	NP*	NP
STRATTON:	-----kg/ha--------		-------kg/ha--------		------kg/ha--------	
WCSb	3955	2840	2955	1680	2840	3055
WWCSb	4490	3720	3205	4205	4270	6230
	NP*	NP	NP*	NP	NP*	NP
WALSH:	------kg/ha--------		------kg/ha-------		-------kg/ha-------	
WCSb	3060	3135	2240	4755	4290	2130
WWSSb	1915	2755	1640	1055	1760	1420

1. For conversion to lbs/Acre multiply kg/ha by 0.893.
* Only receives phosphorus in wheat phase of each rotation.

Table 25. Crop residue weights at preplant for all crops at Briggsdale, Akron, and Lamar during the 1999 - 2000 crop year.

SITE & ROTATION	Crop					
	Wheat	Corn/Sorghum	Millet	Sunflower	Soybean	Peas
BRIGGSDALE:	kg/ha[1]					
WF	460					
WMF	1330		745			
(W)WCSbSfP	2855	505		985	620	4010
W(W)CSbSfP	3485					
Opportunity					2160	
AKRON:	kg/ha					
WF	275					
WCF	1230	2230				
WCM	2235	3995	1485			
WCSfF	660	2020		2650		
LAMAR:	kg/ha					
WF	2465					
WSF	2830	1930				

1. For Conversion to lbs/Acre multiply kg/ha by 0.893.

Table 26. Available soil water by soil depth in the <u>WHEAT</u> phase of the <u>WCF</u> rotation at Sterling and Stratton and <u>WSF</u> at Walsh in 2000.

SITE & DEPTH (cm)	SLOPE POSITION								
	SUMMIT			SIDESLOPE			TOESLOPE		
	Planting	Harvest	Change	Planting	Harvest	Change	Planting	Harvest	Change
	------------mm/30cm------------			------------mm/30cm------------			------------mm/30cm------------		
STERLING:									
15	59	14	45	53	12	41	53	10	43
45	41	5	36	56	5	51	47	1	46
75	39	5	34	41	13	28	53	4	49
105	31	1	30	26	0	26	41	4	37
135	-	-	-	-	-	-	30	3	27
155	-	-	-	-	-	-	25	4	21
TOTAL	170	25	145	176	30	146	249	26	223
STRATTON:									
15	39	0	39	52	13	39	70	25	45
45	43	1	42	42	2	40	73	23	50
75	40	1	39	48	6	42	82	27	55
105	42	4	38	43	0	43	81	31	50
135	42	9	33	33	3	30	71	9	62
155	41	7	34	39	35	4	80	14	66
TOTAL	247	22	225	257	59	198	457	129	328
WALSH:									
15	10	4	6	2	5	+3	2	11	+9
45	21	8	13	16	14	2	19	20	+1
75	19	6	13	24	13	11	31	14	17
105	21	20	1	38	16	22	34	38	+4
135	17	21	+4	32	18	14	38	13	25
155	0	8	+8	46	35	11	57	46	11
TOTAL	88	67	21	158	101	57	181	142	39

1. To convert from millimeters of H_20/30 centimeters of soil to inches of H_20/foot of soil multiply by 0.04.
2. ( ) Indicates a positive change in available soil water.

Table 27. Available soil water by soil depth in the WHEAT phase of the WCSb rotation at Sterling, Stratton, and at Walsh in 2000.

SITE & DEPTH (cm)	SUMMIT			SIDESLOPE			TOESLOPE		
	Planting	Harvest	Change	Planting	Harvest	Change	Planting	Harvest	Change
	------------mm/30cm------------			------------mm/30cm------------			------------mm/30cm------------		
STERLING:									
15	30	15	15	28	12	16	24	9	15
45	13	9	4	10	2	8	15	4	11
75	12	13	(+1)	33	22	11	15	10	5
105	26	28	(+2)	26	28	(+2)	12	5	7
135	-	-	-	-	-	-	8	4	4
155	-	-	-	-	-	-	15	7	8
TOTAL	81	65	16	97	64	33	89	39	50
STRATTON:									
15	17	0	17	40	18	22	58	43	15
45	17	1	16	24	5	19	48	34	14
75	17	3	14	32	16	16	65	20	45
105	20	13	7	27	13	14	77	32	45
135	30	24	6	40	51	(+11)	63	27	36
155	26	21	5	52	52	0	56	22	34
TOTAL	127	62	65	215	155	60	367	178	189
WALSH:									
15	0	0	0	0	0	0	0	0	0
45	0	0	0	0	0	0	0	0	0
75	0	0	0	0	0	0	0	0	0
105	4	0	4	0	4	(+4)	13	10	3
135	8	20	(+12)	17	4	13	21	2	19
155	6	46	(+40)	23	26	(+3)	37	34	3
TOTAL	18	66	(+48)	40	32	6	71	46	25

1. To convert from millimeters of H_20/30 centimeters of soil to inches of H_20/foot of soil multiply by 0.04.
2. ( ) Indicates a positive change in available soil water.

Table 28. Available soil water by soil depth in the WHEAT phase of the (W)WCSb rotation at Sterling and Stratton and the WHEAT phase of the (W)WSSb rotation at Walsh in 2000.

SITE & DEPTH (cm)	SLOPE POSITION								
	SUMMIT			SIDESLOPE			TOESLOPE		
	Planting	Harvest	Change	Planting	Harvest	Change	Planting	Harvest	Change
	---mm/30cm---			---mm/30cm---			---mm/30cm---		
STERLING:									
15	25	8	17	31	10	21	22	8	14
45	12	6	6	14	5	9	13	4	9
75	4	1	3	21	20	1	17	12	5
105	0	2	(+2)	28	26	2	12	8	4
135	-	-	-	-	-	-	4	5	(+1)
155	-	-	-	-	-	-	8	8	0
TOTAL	41	17	24	94	61	33	76	45	31
STRATTON:									
15	9	0	9	23	13	10	72	65	7
45	8	1	7	20	3	17	57	63	(+6)
75	7	3	4	31	12	19	68	32	36
105	16	12	4	29	8	21	74	23	51
135	25	17	8	25	8	17	58	15	43
155	23	16	7	25	10	15	60	30	30
TOTAL	88	49	39	153	54	99	389	228	154
WALSH:									
15	0	0	0	0	0	0	0	0	0
45	1	0	1	0	0	0	0	0	0
75	0	0	0	0	0	0	3	0	3
105	0	0	0	9	4	5	9	10	(+1)
135	6	1	5	15	0	15	23	0	23
155	0	0	0	18	8	10	31	21	10
TOTAL	7	1	6	42	12	30	66	31	35

1. To convert from millimeters of H_20/30 centimeters of soil to inches of H_20/foot of soil multiply by 0.04.
2. ( ) Indicates a positive change in available soil water.

Table 29. Available soil water by soil depth in the WHEAT phase of the W(W)CSb rotation at Sterling and Stratton and WHEAT phase of the W(W)SSb rotation at Walsh in 2000.

SITE & DEPTH (cm)	SLOPE POSITION								
	SUMMIT			SIDESLOPE			TOESLOPE		
	Planting	Harvest	Change	Planting	Harvest	Change	Planting	Harvest	Change
	------------mm/30cm------------			------------mm/30cm------------			------------mm/30cm------------		
STERLING:									
15	49	12	37	52	9	43	54	11	43
45	26	1	25	30	5	25	40	2	38
75	33	12	21	23	10	13	11	1	10
105	35	24	11	11	13	(+2)	8	0	8
135	-	-	-	-	-	-	5	0	5
155	-	-	-	-	-	-	8	7	1
TOTAL	94	49	94	116	37	79	126	21	105
STRATTON:									
15	32	0	32	60	20	40	62	9	53
45	35	1	34	41	6	35	62	5	57
75	23	7	16	29	21	8	68	4	64
105	25	2	23	31	19	12	65	6	59
135	29	1	28	42	35	7	48	13	35
155	37	10	27	46	36	10	57	22	35
TOTAL	181	21	160	249	137	112	362	59	303
WALSH:									
15	17	4	13	14	0	14	-	0	0
45	16	1	15	6	0	6	3	0	3
75	13	0	13	1	1	0	12	0	12
105	13	4	9	19	16	3	31	12	19
135	27	19	8	6	0	6	38	7	31
155	27	16	11	15	16	(+1)	37	24	13
TOTAL	113	134	69	61	32	28	121	43	78

1. To convert from millimeters of H_20/30 centimeters of soil to inches of H_20/foot of soil multiply by 0.04.
2. ( ) Indicates a positive change in available soil water.

Table 30. Available soil water by soil depth in the CORN phase of the WCF rotation at Sterling and Stratton and the SORGHUM phase of the WSF rotation at Walsh in 2000.

SITE & DEPTH (cm)	SLOPE POSITION								
	SUMMIT			SIDESLOPE			TOESLOPE		
	Planting	Harvest	Change	Planting	Harvest	Change	Planting	Harvest	Change
	---mm/30cm---			---mm/30cm---			---mm/30cm---		
STERLING:									
15	46	22	24	40	9	31	68	14	54
45	60	9	51	58	10	48	47	10	37
75	43	14	29	48	8	40	48	8	40
105	27	25	2	22	6	16	45	11	34
135	-	-	-	-	-	-	17	8	9
155	-	-	-	-	-	-	23	16	7
TOTAL	176	70	106	168	33	135	248	67	181
STRATTON:									
15	25	9	16	40	15	25	30	45	(+15)
45	46	12	34	51	6	45	55	46	9
75	35	5	30	55	18	37	64	29	35
105	37	10	27	46	10	36	67	31	36
135	33	18	15	48	18	30	37	19	18
155	32	28	4	29	23	6	30	20	10
TOTAL	208	82	126	269	90	179	283	190	93
WALSH:									
15	0	0	0	0	0	0	0	0	0
45	22	1	21	21	0	21	22	0	22
75	23	0	23	32	0	32	27	4	23
105	22	0	22	38	2	36	29	19	10
135	40	0	40	14	0	14	25	0	25
155	26	0	26	32	3	29	38	19	19
TOTAL	133	1	132	137	5	132	141	42	99

1. To convert from millimeters of H_20/30 centimeters of soil to inches of H_20/foot of soil multiply by 0.04.
2. ( ) Indicates a positive change in available soil water.

Table 31. Available soil water by soil depth in the CORN phase of the WCSb rotation at Sterling and Stratton and WCSb rotation at Walsh in 2000.

SITE & DEPTH (cm)	SLOPE POSITION								
	SUMMIT			SIDESLOPE			TOESLOPE		
	Planting	Harvest	Change	Planting	Harvest	Change	Planting	Harvest	Change
	---mm/30cm---			---mm/30cm---			---mm/30cm---		
STERLING:									
15	28	25	3	30	18	12	41	25	16
45	62	11	51	50	4	46	45	5	40
75	52	6	46	54	8	46	51	10	41
105	33	21	12	31	3	28	41	9	32
135	-	-	-	-	-	-	8	2	6
155	-	-	-	-	-	-	13	12	1
TOTAL	175	63	112	165	33	132	199	63	136
STRATTON:									
15	10	8	2	32	18	14	33	22	11
45	59	16	43	52	10	42	59	19	40
75	42	8	34	45	11	34	54	13	41
105	47	12	35	46	18	28	65	21	44
135	53	18	71	54	36	18	38	33	5
155	48	18	30	40	31	9	38	36	2
TOTAL	259	80	215	269	124	145	287	144	143
WALSH:									
15	No data	2		No data	0		No data	0	
45		3			0			0	
75		0			12			0	
105		0			0			12	
135		0			0			14	
155		0			0			30	
TOTAL		5			12			56	

1. To convert from millimeters of H_20/30 centimeters of soil to inches of H_20/foot of soil multiply by 0.04.
2. ( ) Indicates a positive change in available soil water.

Table 32. Available soil water by soil depth in the <u>CORN</u> phase of the <u>WWCSb</u> rotation at Sterling and Stratton and the <u>SORGHUM</u> phase of the <u>WWSSb</u> rotation at Walsh in 2000.

SITE & DEPTH (cm)	SLOPE POSITION								
	SUMMIT			SIDESLOPE			TOESLOPE		
	Planting	Harvest	Change	Planting	Harvest	Change	Planting	Harvest	Change
	---mm/30cm---			---mm/30cm---			---mm/30cm---		
STERLING:									
15	33	18	15	17	5	12	39	15	24
45	61	10	51	53	11	42	50	9	41
75	34	11	33	58	13	45	46	8	38
105	32	22	10	47	12	35	48	10	38
135	-	-	-	-	-	-	36	15	21
155	-	-	-	-	-	-	21	14	7
TOTAL	160	61	109	175	41	134	240	71	169
STRATTON:									
15	18	0	18	21	11	10	38	22	16
45	55	11	44	48	11	37	48	32	16
75	39	4	35	53	13	40	73	25	48
105	40	9	31	50	13	37	57	44	13
135	42	19	23	48	22	26	47	48	(+1)
155	43	21	22	55	30	25	28	45	(+17)
TOTAL	237	64	173	275	100	175	291	216	69
WALSH:									
15	6	0	6	2	0	2	2	0	2
45	21	0	21	21	0	21	22	0	22
75	21	0	21	26	0	26	31	0	31
105	24	0	24	30	10	20	31	11	20
135	39	0	39	4	0	4	24	2	22
155	36	0	36	34	7	27	38	30	8
TOTAL	147	0	147	116	17	99	148	43	105

1. To convert from millimeters of H_20/30 centimeters of soil to inches of H_20/foot of soil multiply by 0.04.
2. ( ) Indicates a positive change in available soil water.

Table 33. Available soil water by soil depth in the SOYBEAN phase of the WCSb rotation at Sterling and Stratton and Walsh in 2000.

SITE & DEPTH (cm)	SLOPE POSITION								
	SUMMIT			SIDESLOPE			TOESLOPE		
	Planting	Harvest	Change	Planting	Harvest	Change	Planting	Harvest	Change
	------------mm/30cm------------			------------mm/30cm------------			------------mm/30cm------------		
STERLING:									
15	35	17	18	22	15	7	32	23	9
45	48	10	38	32	1	31	31	3	28
75	24	8	16	36	9	27	20	10	10
105	26	27	(+1)	48	0	48	15	10	5
135	-	-	-	-	-	-	8	7	1
155	-	-	-	-	-	-	15	13	2
TOTAL	133	62	71	138	25	113	121	66	38
STRATTON:									
15	24	3	21	37	18	19	40	18	22
45	48	9	29	46	8	38	66	23	43
75	31	5	26	33	16	17	72	45	27
105	29	12	17	33	24	9	53	40	13
135	38	23	15	43	29	14	42	36	6
155	43	21	22	46	37	9	25	22	3
TOTAL	213	73	130	238	132	106	298	184	114
WALSH:									
15	0	0	0	0	0	0	0	0	0
45	15	0	15	15	0	15	14	0	14
75	14	7	7	27	2	25	17	0	17
105	25	8	17	32	11	21	22	8	14
135	19	6	13	9	0	9	22	5	17
155	20	0	20	24	14	10	31	15	16
TOTAL	93	21	72	107	27	80	106	28	78

1. To convert from millimeters of H_20/30 centimeters of soil to inches of H_20/foot of soil multiply by 0.04.
2. ( ) Indicates a positive change in available soil water.

Table 34. Available soil water by soil depth in the SOYBEAN phase of the WWCSb rotation at Sterling and Stratton and the WWSSb rotation at Walsh in 2000.

SITE & DEPTH (cm)	SLOPE POSITION								
	SUMMIT			SIDESLOPE			TOESLOPE		
	Planting	Harvest	Change	Planting	Harvest	Change	Planting	Harvest	Change
	--mm/30cm--			--mm/30cm--			--mm/30cm--		
STERLING:									
15	40	27	13	16	19	(+3)	39	20	19
45	48	11	37	46	8	38	40	11	29
75	41	23	18	31	0	31	29	6	23
105	41	35	6	16	0	16	18	8	10
135	-	-	-	-	-	-	21	9	13
155	-	-	-	-	-	-	10	3	7
TOTAL	170	96	74	109	27	82	157	57	101
STRATTON:									
15	23	9	14	40	18	22	44	28	16
45	39	13	26	40	10	30	75	34	41
75	24	13	11	32	18	14	67	29	38
105	18	16	2	31	21	10	63	39	24
135	18	18	0	29	21	8	47	36	11
155	20	21	(+1)	30	26	4	41	38	3
TOTAL	142	90	52	202	114	88	337	204	133
WALSH:									
15	6	0	6	8	0	8	0	0	0
45	17	0	17	28	0	28	26	0	26
75	21	0	21	21	4	17	5	3	2
105	36	0	33	5	10	(+5)	2	10	(+8)
135	30	3	30	6	0	6	20	32	(+12)
155	19	0	19	14	18	(+4)	26	51	(+25)
TOTAL	129	3	126	82	32	50	79	96	(+17)

1. To convert from millimeters of H_20/30 centimeters of soil to inches of H_20/foot of soil multiply by 0.04.
2. ( ) Indicates a positive change in available soil water.

Table 35. Available soil water by soil depth in the AUSTRIAN WINTER PEA phase of the OPP rotation at Sterling and Stratton and SOYBEAN in the OPP phase at Walsh in 2000.

SITE & DEPTH (cm)	SLOPE POSITION								
	SUMMIT			SIDESLOPE			TOESLOPE		
	Planting	Harvest	Change	Planting	Harvest	Change	Planting	Harvest	Change
	------------mm/30cm------------			------------mm/30cm------------			------------mm/30cm------------		
STERLING:									
15	23	16	7	19	10	9			
45	27	9	18	31	22	9	NO	PEAS	
75	13	14	(+1)	46	41	5			
105	28	23	5	38	34	4			
135	-	-	-	-	-	-			
155	-	-	-	-	-	-			
TOTAL	91	62	29	134	107	27			
STRATTON:									
15	6	1	5	20	18	2	12	14	(+2)
45	23	10	13	24	10	14	18	7	9
75	21	12	9	23	15	8	52	32	20
105	26	23	3	35	31	4	47	32	15
135	23	20	3	31	30	1	44	42	2
155	21	20	1	38	34	4	44	40	4
TOTAL	120	86	34	171	138	33	217	167	48
WALSH:									
15	2	0	2	0	0	0	0	0	0
45	16	5	11	27	0	27	19	0	19
75	29	2	27	26	1	25	7	6	1
105	37	0	37	6	4	2	23	15	8
135	31	8	23	0	6	(+6)	10	20	(+10)
155	30	0	30	14	6	8	34	50	(+16)
TOTAL	145	15	130	73	17	56	93	91	2

1. To convert from millimeters of H_20/30 centimeters of soil to inches of H_20/foot of soil multiply by 0.04.
2. ( ) Indicates a positive change in available soil water.

Table 36. Total soil water by soil depth in WHEAT at Briggsdale, Akron, and Lamar in 2000.

SITE & DEPTH	WF			WMF			(W)WCSbSfP			W(W)CSbSfP		
	Planting	Harvest	Change	Planting	Harvest	Change	Planting	Harvest	Change	Planting	Harvest	Change
BRIGGSDALE:		%			%			%			%	
15	14.5	7.3	7.2	16.9	6.2	10.7	14.1	4.5	9.6	8.6	10.4	(1.8)
45	15.6	5.6	10.0	16.1	5.4	10.7	13.8	6.1	7.7	9.6	5.7	3.9
75	13.2	4.4	8.8	12.3	4.7	7.6	11.4	5.6	5.8	9.0	4.7	4.3
105	11.9	4.5	7.4	9.7	4.9	4.8	8.7	11.5	(2.8)	11.0	5.5	5.5
135	11.6	2.4	9.2	9.2	5.3	3.9	10.5	7.2	3.3	10.0	4.3	5.7
155	12.4	–	12.4	10.7	–	10.7	11.3	7.2	4.1	10.2	3.2	7.0
MEAN	13.2	4.0	9.2	12.5	4.4	8.1	11.6	7.0	4.6	9.7	5.6	4.1

	WF			WCF			WCM			WCSfF		
	Planting	Harvest	Change	Planting	Harvest	Change	Planting	Harvest	Change	Planting	Harvest	Change
AKRON:		%			%			%			%	
15												
45												
75												
105												
135												
155												
MEAN												

	WF			WSF		
	Planting	Harvest	Change	Planting	Harvest	Change
LAMAR:		%			%	
15	12.0	6.4	5.6	11.4	6.7	4.7
45	13.8	6.1	7.7	12.2	6.8	5.4
75	14.6	7.2	7.4	13.3	6.1	7.2
105	15.1	8.3	6.8	14.4	7.4	7.0
135	15.9	7.8	8.1	16.2	8.3	7.9
155	16.6	6.8	9.8	17.1	6.1	10.0
MEAN	14.7	7.1	7.6	14.1	7.1	7.0

1. ( ) Indicates a positive change in available soil water.

Table 37. Total soil water by soil depth in SPRING planted crops and PEAS at Briggsdale in 2000.

SITE & DEPTH	Crop (Rotation)								
	Corn (WWCSbSfP)			Soybean (WWCSbSfP)			Sunflower (WWCSbSfP)		
	Planting	Harvest	Change	Planting	Harvest	Change	Planting	Harvest	Change
BRIGGSDALE:	------------ % ------------			------------ % ------------			------------ % ------------		
15	13.2			13.0			13.4		
45	15.7			10.8			13.1		
75	11.4			6.8			9.3		
105	9.3			6.7			8.5		
135	9.3			7.4			12.0		
155	10.2			7.1			11.4		
MEAN	11.5			8.6			11.3		
	Millet (WMF)			Soybean (Opportunity)			Peas (WWCSbSfP)		
	Planting	Harvest	Change	Planting	Harvest	Change	Planting	Harvest	Change
BRIGGSDALE:	------------ % ------------			------------ % ------------			------------ % ------------		
15	12.7			13.1			12.8	5.0	7.8
45	14.2			14.2			8.8	5.3	3.5
75	15.8			9.3			6.9	4.8	2.1
105	7.3			8.9			5.9	3.9	2.0
135	6.8			7.7			6.4	4.7	1.7
155	10.3			7.0			8.0	5.8	2.2
MEAN	11.2			10.0			8.1	4.9	3.2

1. ( ) Indicates a positive change in available soil water.

Table 38. Total soil water by soil depth in SPRING planted crop at Akron and Lamar in 2000.

SITE & DEPTH	Crop (Rotation)								
	Corn (WCF)			Corn (WCM)			Corn (WCSfF)		
	Planting	Harvest	Change	Planting	Harvest	Change	Planting	Harvest	Change
AKRON:	------------ % ------------			------------ % ------------			------------ % ------------		
15									
45									
75									
105									
135									
155									
MEAN									

SITE & DEPTH	Millet (WCM)			Sunflower (WCSfF)		
	Planting	Harvest	Change	Planting	Harvest	Change
AKRON:	------------ % ------------			------------ % ------------		
15						
45						
75						
105						
135						
155						
MEAN						

SITE & DEPTH	Sorghum (WSF)		
	Planting	Harvest	Change
LAMAR:	------------ % ------------		
15	19.1	6.7	12.4
45	20.3	8.1	12.2
75	15.9	5.3	10.6
105	14.9	6.2	8.7
135	15.9	6.1	9.8
155	14.4	5.0	9.4
MEAN	16.8	6.2	10.6

1. ( ) Indicates a positive change in available soil water.

Table 39a. Total Nitrogen content of WHEAT GRAIN in the 1999-2000 crop.

SITE & ROTATION	SLOPE POSITION					
	SUMMIT		SIDESLOPE		TOESLOPE	
	*N Side**	*NP Side*	*N Side**	*NP Side*	*N Side**	*NP Side*
	N	NP	N	NP	N	NP
STERLING:	%		%		%	
WCF	2.54	2.52	2.30	2.06	2.31	2.33
WCSb	2.83	2.81	2.65	2.57	2.68	2.71
(W)WCSb	2.88	2.73	2.68	2.39	3.23	3.09
W(W)CSb	2.51	2.47	2.30	2.12	2.47	2.50
	N	NP	N	NP	N	NP
STRATTON:	%		%		%	
WCF	2.40	2.41	2.61	2.63	2.29	2.82
WCSb	2.45	2.40	2.11	2.52	2.40	2.34
(W)WCSb	2.55	2.42	2.33	2.10	2.17	2.34
W(W)CSb	2.51	2.43	2.67	2.59	2.63	2.68
WALSH:						
	%		%		%	
WSF	2.16	2.16	2.11	2.12	2.00	2.04
WCSb	2.25	2.26	2.23	2.29	2.31	2.30
(W)SSb	2.25	2.21	2.27	2.29	2.37	2.52
W(W)SSb	2.29	2.28	2.36	2.32	2.24	2.28

* Only receives phosphorus in wheat phase of each rotation.

Table 39b. Total Nitrogen content of WHEAT STRAW in the 1999-2000 crop.

SITE & ROTATION	SUMMIT N Side* (N)	SUMMIT NP Side (NP)	SIDESLOPE N Side* (N)	SIDESLOPE NP Side (NP)	TOESLOPE N Side* (N)	TOESLOPE NP Side (NP)
	SLOPE POSITION					
STERLING:	-------------- % -------------		-------------- % -------------		-------------- % -------------	
WCF	0.79	0.77	0.47	0.82	0.62	0.51
WCSb	0.75	0.77	0.56	0.71	0.64	0.67
(W)WCSb	0.58	0.79	0.73	0.51	0.68	0.92
W(W)CSb	0.99	0.63	0.49	0.49	0.43	0.53
	N	**NP**	**N**	**NP**	**N**	**NP**
STRATTON:	-------------- % -------------		-------------- % -------------		-------------- % -------------	
WCF	0.45	0.51	0.44	0.59	0.72	0.74
WCSb			0.72	0.50	1.03	0.66
(W)WCSb		0.50	0.47	0.45	0.39	0.48
W(W)CSb	0.50	0.67	0.68	0.47	0.94	0.70
	N	**NP**	**N**	**NP**	**N**	**NP**
WALSH:	-------------- % -------------		-------------- % -----------		-------------- % -------------	
WSF	0.53	0.36	0.35	0.53	0.37	0.37
WSSb	0.47	0.45	0.42	0.44	0.54	0.56
(W)WSSb	0.50	0.38	0.43	0.47	0.64	0.58
W(W)SSb	0.50	0.52	0.53	0.92	0.52	0.61

* Only receives phosphorus in wheat phase of each rotation.

Table 40a. Total Nitrogen content of CORN GRAIN or SORGHUM GRAIN in the 2000 crop.

SITE & ROTATION	SUMMIT N Side* (N)	SUMMIT NP Side (NP)	SIDESLOPE N Side* (N)	SIDESLOPE NP Side (NP)	TOESLOPE N Side* (N)	TOESLOPE NP Side (NP)
STERLING:	%		%		%	
WCF	1.86	1.79	1.21	1.69	1.80	1.79
WCSb	1.83	1.74	1.70	1.79	1.77	1.75
WWCSb	1.89	1.90	1.81	1.74	1.79	1.77
	N	NP	N	NP	N	NP
STRATTON:	%		%		%	
WCF	1.59	1.69	1.54	1.56	1.46	1.46
WCSb	1.62	1.44	1.46	1.60	1.44	1.55
WWCSb	1.56	1.47	1.53	1.48	1.44	1.59
	N	NP	N	NP	N	NP
WALSH:	%		%		%	
WSF	2.03	1.91	1.89	1.85	1.98	2.07
WCSb	1.68	1.67	1.72	1.73	No sample	
WWSSb	1.89	1.85	1.91	1.70	2.02	1.92
Cont. Crop (C)	1.74	1.71	1.71	1.74	No sample	
Cont. Crop (S)	1.90	1.92	1.89	1.99	1.93	2.09

* Only receives phosphorus in wheat phase of each rotation.

Table 40b. Total Nitrogen content of CORN STOVER or SORGHUM STOVER in the 2000 crop.

	SLOPE POSITION					
	SUMMIT		SIDESLOPE		TOESLOPE	
SITE & ROTATION	*N Side** N	*NP Side* NP	*N Side** N	*NP Side* NP	*N Side** N	*NP Side* NP
STERLING:	-------------- % -------------		-------------- % -------------		-------------- % -------------	
WCF	1.37	1.60	1.21	0.97	0.87	0.92
WCSb	1.14	1.40	0.96	1.28	1.04	1.26
WWCSb	1.75	2.00	1.30	1.18	1.31	1.70
	N	**NP**	**N**	**NP**	**N**	**NP**
STRATTON:	-------------- % -------------		-------------- % -------------		-------------- % -------------	
WCF	0.82	0.78	0.99	0.93	1.20	1.18
WCSb	1.03	0.90	1.05	0.86	1.07	1.70
WWCSb	1.0	1.2	0.90	0.82	0.86	1.03
	N	**NP**	**N**	**NP**	**N**	**NP**
WALSH:	-------------- % -------------		-------------- % -----------		-------------- % -------------	
WSF						
W(S)Sb	No sample		No sample		No sample	
WW(S)Sb						
Cont. Crop (C)						
Cont. Crop (S)						

* Only receives phosphorus in wheat phase of each rotation.

Table 41. Total Nitrogen content of SOYBEAN GRAIN in the 2000 crop.

SITE & ROTATION	SLOPE POSITION					
	SUMMIT		SIDESLOPE		TOESLOPE	
	*N Side**	*NP Side*	*N Side**	*NP Side*	*N Side**	*NP Side*
	N	NP	N	NP	N	NP
STERLING:	%		%		%	
WCSb	5.52	5.89	5.09	5.30	4.63	5.28
WWCSb	6.22	6.06	5.34	5.29	5.29	5.06
	N	NP	N	NP	N	NP
STRATTON:	%		%		%	
WCSb	5.41	5.42	5.28	5.60	5.81	No sample
WWCSb	5.84	5.50	5.20	5.57	No sample	5.80
	N	NP	N	NP	N	NP
WALSH:	%		%		%	
WCSb	No sample		No sample		6.00	6.00
WWSSb	5.60	5.40			5.00	

* Only receives phosphorus in wheat phase of each rotation.

Table 42. Total Nitrogen content of Grain for all crops at Briggsdale, Akron, and Lamar in 2000.

SITE & ROTATION	Crop						
	Wheat		Corn/Sorghum	Millet	Sunflower	Soybean	Peas
	Susceptible Variety	Resistant Variety					
BRIGGSDALE:	------ % ------		– % --	– % --	– % --	– % --	– % --
WF	2.8	2.7					
WMF	2.9	2.9		No Yield			
(W)WCSbSfP	2.4	2.5	1.7		1.9	No Yield	No Yield
W(W)CSbSfP	2.8	2.8					
Opportunity						No Yield	
AKRON:	------ % ------		– % --	– % --	– % --		
WF							
WCF							
WCM							
WCSfF							
LAMAR:	------ % ------		– % --				
WF	2.8	2.8					
WSF	3.1	2.8					

Table 43. Nitrate-N content of the soil profile at Planting for each crop during 1999-2000 crop year.

Site & Rotation	SLOPE POSITION								
	SUMMIT			SIDESLOPE			TOESLOPE		
	Crop and Time			Crop and Time			Crop and Time		
	Wheat Fall 99	Corn S 00	Sorghum S 00	Wheat Fall 99	Corn S 00	Sorghum S 00	Wheat S 99	Corn S 00	Sorghum S 00
	------------kg NO3-N ha $^{-1}$------------			----------kg NO3-N ha $^{-1}$------------			-------------kg NO3-N ha $^{-1}$-----------		
STERLING									
WCF	142	80		55	54		72	46	
WCSb		79			73			107	
(W)WCSb		137			103			106	
W(W)CSb	113			40			37		
STRATTON									
WCF	100	54		97	47		80	74	
WCSb		65			60			91	
(W)WCSb		90			104			99	
W(W)CSb	71			76			90		
WALSH									
WSF	50		19	38		26	49		48
WCSb	25	39		53	55		44	62	
(W)WSSb	26		23	28		28	44		55
W(W)SSb	37			44			46		
CC (C)		17			15			31	
CC (S)			22			40			46.5

Table 44. Nitrate-N content of the soil profile at planting of each crop during the 1999-2000 crop year.

SITE & ROTATION	Crop			
	Wheat	Corn/Sorghum	Millet	Sunflower
BRIGGSDALE:	kg NO_3-N/ha	kg NO_3-N/ha	kg NO_3-N/ha	kg NO_3-N/ha
WF	76			
WMF	90		37	
(W)WCSbSfP	15	64		29
W(W)CSbSfP	50			
Opportunity				
AKRON:	kg NO_3-N/ha	kg NO_3-N/ha	kg NO_3-N/ha	kg NO_3-N/ha
WF	75			
WCF	69	47		
WCM	22	47	62	
WCSfF	187	45		52
LAMAR:	kg NO_3-N/ha	kg NO_3-N/ha		
WF (grazed)	31			
WF (ungrazed)	44			
WSF (grazed)	35	39		
WSF (ungrazed)	55	33		

Table 45. Pest insects in wheat by crop stage at Briggsdale, Akron, and Lamar in 2000.

Site & Insect	Date (growth stage)		
	28 March (tillering)	26April (jointing)	22 May (boot)
BRIGGSDALE:			
Army Cutworm (#/5 ft.^{2})	0.44	0.66	–
Russian Wheat Aphid (#/50 tillers)	0.06	2.22	22.20
Other Cerial Aphids (#/50 Tillers)	0.63	2.31	0.16
Brown Wheat Mite (#/ 1.75 ft.^{2})	287	54	3
Banks Grass Mite (#/50 tillers)	0.00	0.31	0.06
AKRON:			
Army Cutworm (#/5 ft.^{2})	0.0	0.0	0.0
Russian Wheat Aphid (#/50 tillers)	0.02	0.01	0.0
Other Cerial Aphids (#/50 Tillers)	0.01	0.01	0.01
Brown Wheat Mite (#/ 1.75 ft.^{2})	0.01	0.01	0.0
Banks Grass Mite (#/50 tillers)	0.0	0.0	0.0
		May 31 (jointing)	
LAMAR:			
Army Cutworm (#/5 ft.^{2})		0	
Russian Wheat Aphid (#/50 tillers)		58.8	
Other Cerial Aphids (#/50 Tillers)		0	
Brown Wheat Mite (#/ 1.75 ft.^{2})		0	
Banks Grass Mite (#/50 tillers)		0	

Table 46. Russian wheat aphid (RWA) in wheat by day, variety, and rotation at Briggsdale, Akron, and Lamar in 2000.

Site & Rotation	Date (Growth stage)								
	28 March (tillering)			26 April (jointing)			22 May (boot)		
	Lamar	Prowers	Mean	Lamar	Prowers	Mean	Lamar	Powers	Mean
BRIGGSDALE:	---- RWA/50 tillers ----			---- RWA/50 tillers ----			---- RWA/50 tillers ----		
WF	0	0	0	1.5	2	1.75	33.5	16.5	25
WMF	0.5	0	0.25	3.25	1.25	2.25	34.75	31.75	33.25
(W)WCSbSfP	0	0	0	0.25	2.25	1.25	10.25	5.75	8
W(W)CSbSfP	0	0	0	2.5	4.75	3.63	33.25	11.75	22.5
	TAM 107	Prairie Red	Mean	TAM 107	Prairie Red	Mean	TAM 107	Prairie Red	Mean
AKRON:	---- RWA/50 tillers ----			---- RWA/50 tillers ----			---- RWA/50 tillers ----		
WF	2	2	2	2	1	1.5	0	1	0.5
WCF	7	8	7.5	2	1	1.5	0	0	0
WCM	3	2	2.5	1	2	1.5	0	0	0
WCSfF	4	7	5.5	4	3	3.5	1	0	0.5
	Lamar	Prowers	Mean	Lamar	Prowers	Mean	Lamar	Prowers	Mean
LAMAR:	---- RWA/50 tillers ----			---- RWA/50 tillers ----			---- RWA/50 tillers ----		
WF				71.6	30.2	50.9			
WSF				102.8	30.4	66.6			

Table 47. Brown wheat mite (BWM) in wheat by crop growth stage, variety, and rotation at Briggsdale, Akron, and Lamar in 2000.

Site & Rotation	Date (Growth stage)								
	28 March (Tillering)			26 April (jointing)			22 May (boot)		
	Lamar	Prowers	Mean	Lamar	Prowers	Mean	Lamar	Powers	Mean
BRIGGSDALE:	-------- #/1.75 ft.^{2} --------			-------- #/1.75 ft.^{2} --------			-------- #/1.75 ft.^{2} --------		
WF	171	406	289	34	63	49	3	4	4
WMF	215	427	321	85	45	65	6	5	6
(W)WCSbSfP	93	95	94	4	11	8	1	1	1
W(W)CSbSfP	368	523	446	108	91	100	2	3	3
	TAM 107	Prairie Red	Mean	TAM 107	Prairie Red	Mean	TAM 107	Prairie Red	Mean
AKRON:	-------- #/1.75 ft.^{2} --------			-------- #/1.75 ft.^{2} --------			-------- #/1.75 ft.^{2} --------		
WF	0	8	4	9	1	5	0	0	0
WCF	0	4	2	1	0	0.5	0	0	0
WCM	3	9	6	0	5	2.5	0	0	0
WCSfF	9	7	8	2	12	7	0	0	0
	Lamar	Prowers	Mean	Lamar	Prowers	Mean	Lamar	Prowers	Mean
LAMAR:	-------- #/1.75 ft.^{2} --------			-------- #/1.75 ft.^{2} --------			-------- #/1.75 ft.^{2} --------		
WF (Grazed)									
WF (Ungrazed)									
WSF (Grazed)									
WSF (Ungrazed									

Table 48. Predator insects in wheat by growth stage at Briggsdale, Akron, and Lamar in 2000.

Site & Insect	Date (growth stage)		
	28 March (Tillering)	26 April (Jointing)	22 May (Boot)
BRIGGSDALE:	------------------ #/4-30 second counts ------------------		
Coccinellids	0.34	0.72	6.38
Lacewing	0	0.03	0
Mite Destroyers	0	0	0
Mummies	0	0	0
Nabids	0	0	0.03
Pirate Bugs	0	0	0
Predatory Mites	0	0	0
Spiders	0	0.19	0.19
Syrphids	0	0	0.34
AKRON:	------------------ #/4-30 second counts ------------------		
Coccinellids	0	0	3
Lacewing	0	0	0
Mite Destroyers	0	0	0
Mummies	0	0	0
Nabids	0	0	0
Pirate Bugs	0	0	0
Predatory Mites	0	0	0
Spiders	0	1	1
Syrphids	0	0	0
		31 May (Jointing)	
LAMAR:	------------------ #/4-30 second counts ------------------		
Coccinellids		0.25	
Lacewing		0	
Mite Destroyers		0	
Mummies		0	
Nabids		0	
Pirate Bugs		0	
Predatory Mites		0	
Spiders		0	
Syrphids		0	

APPENDIX I

ANNUAL HERBICIDE PROGRAMS FOR EACH SITE

Table 1. Weed control methods including herbicide rate, cost and date applied at STERLING in 2000.

Crop	Herbicide/Tillage	Rate (English)	Rate (Metric)	Cost	Date Applied
Rotation: Wheat-Corn-Fallow					
Wheat:	Landmaster BW*	54 oz/A	3.94 l/ha	$7.48/A	7/27/2000
	Fallowmaster*	44 oz/A	3.21 l/ha	$6.49/A	9/01/2000
	Atrazine 4L	32 oz/A	2.33 l/ha	$2.80/A	9/01/2000
Corn (RR):	Fallowmaster*	44 oz/A	3.21 l/ha	$6.49/A	5/05/2000
	Round-up Ultra*	20 oz/A	1.46 l/ha	$6.02/A	6/09/2000
Fallow:	Fallowmaster*	44 oz/A	3.21 l/ha	$6.49/A	5/05/2000
	Fallowmaster*	44 oz/A	3.21 l/ha	$6.49/A	7/10/2000
	Gromozone Extra	32oz/A	2.33 l/ha	$8.02/A	8/24/2000
	Landmaster BW*	40 oz/A	2.92 l/ha	$5.54/A	9/18/2000
Rotation: Wheat-Corn-Soybean					
Wheat:	Landmaster BW*	54 oz/A	3.94 l/ha	$7.48/A	7/27/2000
	Fallowmaster*	44 oz/A	3.21 l/ha	$6.49/A	9/01/2000
	Atrazine 4L	32 oz/A	2.33 l/ha	$2.80/A	9/01/2000
Corn (RR):	Fallowmaster*	44 oz/A	3.21 l/ha	$6.49/A	5/05/2000
	Round-up Ultra*	20 oz/A	1.46 l/ha	$6.02/A	6/09/2000
Soybean:	Round-up Ultra*	32 oz/A	2.33 l/ha	$9.64/A	5/05/2000
	Round-up Ultra*	20 oz/A	1.46 l/ha	$6.02/A	6/09/2000
	Landmaster BW*	40 oz/A	2.92 l/ha	$5.54/A	9/18/2000
Rotation:Wheat-Wheat-Corn-Soybean					
Wheat:	Landmaster BW *	54 oz/A	3.94 l/ha	$7.48/A	7/27/2000
	Fallowmaster*	44 oz/A	3.21 l/ha	$6.49/A	9/01/2000
	Landmaster BW*	40 oz/A	2.92 l/ha	$5.54/A	9/18/2000
Wheat:	Landmaster BW*	54 oz/A	3.94 l/ha	$7.48/A	7/27/2000
	Fallowmaster*	44 oz/A	3.21 l/ha	$6.49/A	9/01/2000
	Atrazine 4L	32 oz/A	2.33 l/ha	$2.80/A	9/01/2000
Corn (RR):	Fallowmaster*	44 oz/A	3.21 l/ha	$6.49/A	5/05/2000
	Round-up Ultra*	20 oz/A	1.46 l/ha	$6.02/A	6/09/2000
Soybean:	Round-up Ultra*	32 oz/A	2.33 l/ha	$9.64/A	5/05/2000
	Round-up Ultra*	20 oz/A	1.46 l/ha	$6.02/A	6/09/2000
	Landmaster BW*	40 oz/A	2.92 l/ha	$5.54/A	9/18/2000
Rotation: Opportunity					
Forage Pea:	Fallowmaster*	44 oz/A	3.21 l/ha	$6.49/A	7/10/2000
	Gromozone Extra*	32 oz/A	2.33 l/ha	$8.02/A	8/24/2000
	Landmaster BW*	40 oz/A	2.92 l/ha	$5.54/A	9/18/2000

*Applied 1qt. Quest/100 gallons water with Round-up products.

Note: Atrazine is applied at 75 % of the rate on summit and sideslope soils.

Table 2. Weed control methods including herbicide rate, cost and date applied at STRATTON in 2000.

Crop	Herbicide/Tillage	Rate (English)	Rate (Metric)	Cost	Date Applied
Rotation: Wheat-Corn-Fallow					
Wheat:	2,4-D ester 4# Banvel Fallowmaster* Fallowmaster* Atrazine 4L	12 oz/A 4 oz/A 32 oz/A 32 oz/A 32 oz/A	0.87 l/ha 0.29 l/ha 2.33 l/ha 2.33 l/ha 2.33 l/ha	$1.22/A $2.80/A $4.72/A $4.72/A $2.80/A	4/07/2000 4/07/2000 8/04/2000 9/12/2000 9/12/2000
Corn:	Fallowmaster* Atrazine 4L Prowl	44 oz/A 32 oz/A 32 oz/A	3.21 l/ha 2.33 l/ha 2.33 l/ha	$6.49/A $2.80/A $5.11/A	5/04/2000 5/04/2000 5/04/2000
Fallow:	Fallowmaster* Fallowmaster* Fallowmaster* Fallowmaster* Round-up Ultra*	44 oz/A 32 oz/A 32 oz/A 32 oz/A 16 oz/A	3.21 l/ha 2.33 l/ha 2.33 l/ha 2.33 l/ha 1.17 l/ha	$6.49/A $4.72/A $4.72/A $4.72/A $4.82/A	5/04/2000 6/20/2000 7/12/2000 8/04/2000 10/02/2000
Rotation: Wheat-Corn-Soybean					
Wheat:	2,4-D ester 4# Banvel Fallowmaster* Fallowmaster* Atrazine 4L	12 oz/A 4 oz/A 32 oz/A 32 oz/A 32 oz/A	0.87 l/ha 0.29 l/ha 2.33 l/ha 2.33 l/ha 2.33 l/ha	$1.22/A $2.80/A $4.72/A $4.72/A $2.80/A	4/07/2000 4/07/2000 8/04/2000 9/12/2000 9/12/2000
Corn:	Fallowmaster* Atrazine 4L Prowl	44 oz/A 32 oz/A 32 oz/A	3.21 l/ha 2.33 l/ha 2.33 l/ha	$6.49/A $2.80/A $5.11/A	5/04/2000 5/04/2000 5/04/2000
Soybean:	Round-up Ultra* Round-up Ultra* Round-up Ultra* Round-up Ultra*	32 oz/A 24 oz/A 24 oz/A 16 oz/A	2.33 l/ha 1.75 l/ha 1.75 l/ha 1.17 l/ha	$9.64/A $7.23/A $7.23/A $4.82/A	5/04/2000 6/20/2000 7/12/2000 10/02/2000
Rotation: Wheat-Wheat-Corn-Soybean					
Wheat:	2,4-D ester 4# Banvel Fallowmaster* Landmaster BW* Round-up Ultra*	12 oz/A 4 oz/A 32 oz/A 40 oz/A 48 oz/A	0.87 l/ha 0.29 l/ha 2.33 l/ha 2.92 l/ha 3.50 l/ha	$1.22/A $2.80/A $4.72/A $5.54/A $14.46/A	4/07/2000 4/07/2000 8/04/2000 9/12/2000 10/02/2000
Wheat:	2,4-D ester 4# Banvel Fallowmaster* Fallowmaster* Atrazine 4L	12 oz/A 4 oz/A 32 oz/A 32 oz/A 32 oz/A	0.87 l/ha 0.29 l/ha 2.33 l/ha 2.33 l/ha 2.33 l/ha	$1.22/A $2.80/A $4.72/A $4.72/A $2.80/A	4/07/2000 4/07/2000 8/04/2000 9/12/2000 9/12/2000
Corn:	Fallowmaster* Atrazine 4L Prowl	44 oz/A 32 oz/A 32 oz/A	3.21 l/ha 2.33 l/ha 2.33 l/ha	$6.49/A $2.80/A $5.11/A	5/04/2000 5/04/2000 5/04/2000
Soybean:	Round-up Ultra* Round-up Ultra* Round-up Ultra* Round-up Ultra*	32 oz/A 24 oz/A 24 oz/A 16 oz/A	2.33 l/ha 1.75 l/ha 1.75 l/ha 1.17 l/ha	$9.64/A $7.23/A $7.23/A $4.82/A	5/04/2000 6/20/2000 7/12/2000 10/02/2000
Rotation: Opportunity					
Forage Pea:	Fallowmaster* Fallowmaster* Round-up Ultra*	44 oz/A 32 oz/A 16 oz/A	3.21 l/ha 2.33 l/ha 1.17 l/ha	$6.49/A $4.72/A $4.82/A	7/12/2000 8/04/2000 10/02/2000
*Applied 1qt. Quest/100 gallons water					
Note: Atrazine is applied at 75 % of the rate on the sideslope soils.					

Table 3. Weed control methods including herbicide rate, cost and date applied at WALSH in 2000.

Crop	Herbicide/Tillage	Rate (English)	Rate (Metric)	Cost	Date Applied
Rotation: Wheat-Sorghum-Fallow					
Wheat:	Ally	0.1 oz/A	7.0 g/ha	$2.30/A	3/13/2000
	2,4-D	8 oz/A	0.58 l/ha	$0.82/A	3/13/2000
Sorghum:	Tillage - Sweeps				4/14/2000
	Round-up Ultra	16 oz/A	1.17 l/ha	$4.82/A	6/16/2000
	Round-up Ultra	16 oz/A	1.17 l/ha	$4.82/A	7/10/2000
	Round-up Ultra	16 oz/A	1.17 l/ha	$4.82/A	8/09/2000
Fallow:	Round-up Ultra	16 oz/A	1.17 l/ha	$4.82/A	3/13/2000
	Tillage - Sweeps				4/14/2000
	Round-up Ultra	16 oz/A	1.17 l/ha	$4.82/A	8/09/2000
Rotation: Wheat-Corn-Soybean					
Wheat:	Ally	0.1 oz/A	7.0 g/ha	$2.30/A	3/13/2000
	2,4-D	8 oz/A	0.58 l/ha	$0.82/A	3/13/2000
Corn:	Tillage - Sweeps				4/14/2000
	Round-up Ultra	16 oz/A	1.17 l/ha	$4.82/A	6/16/2000
	Round-up Ultra	16 oz/A	1.17 l/ha	$4.82/A	7/10/2000
Soybean:	Tillage - Sweeps				4/14/2000
	Round-up Ultra	16 oz/A	1.17 l/ha	$4.82/A	6/16/2000
	Round-up Ultra	16 oz/A	1.17 l/ha	$4.82/A	7/10/2000
	Round-up Ultra	16 oz/A	1.17 l/ha	$4.82/A	8/09/2000
Rotation: Wheat-Wheat-Sorghum-Soybean					
Wheat:	Ally	0.1 oz/A	7.0 g/ha	$2.30/A	3/13/2000
	2,4-D	8 oz/A	0.58 l/ha	$0.82/A	3/13/2000
Wheat:	Ally	0.1 oz/A	7.0 g/ha	$2.30/A	3/13/2000
	2,4-D	8 oz/A	0.58 l/ha	$0.82/A	3/13/2000
Sorghum:	Tillage - Sweeps				4/14/2000
	Round-up Ultra	16 oz/A	1.17 l/ha	$4.82/A	6/16/2000
	Atrazine	0.75 lb a.i./A	53 g a.i./A	$3.26/A	7/10/2000
	Clarity	4 oz/A	0.29 l/A	$2.81/A	7/10/2000
	2,4-D	8 oz/A	0.58 l/ha	$0.82/A	7/10/2000
Soybean:	Tillage - Sweeps				4/14/2000
	Round-up Ultra	16 oz/A	1.17 l/ha	$4.82/A	6/16/2000
	Round-up Ultra	16 oz/A	1.17 l/ha	$4.82/A	7/10/2000
	Round-up Ultra	16 oz/A	1.17 l/ha	$4.82/A	8/09/2000
Opportunity					
Soybean:	Tillage - Sweeps				4/14/2000
	Round-up Ultra	16 oz/A	1.17 l/ha	$4.82/A	6/16/2000
	Round-up Ultra	16 oz/A	1.17 l/ha	$4.82/A	7/10/2000
	Round-up Ultra	16 oz/A	1.17 l/ha	$4.82/A	8/09/2000
Continuous Cropping:					
Corn:	Tillage - Sweeps				4/14/2000
	Round-up Ultra	16 oz/A	1.17 l/ha	$4.82/A	6/16/2000
	Round-up Ultra	16 oz/A	1.17 l/ha	$4.82/A	7/10/2000
Sorghum:	Tillage - Sweeps				4/14/2000
	Round-up Ultra	16 oz/A	1.17 l/ha	$4.82/A	6/16/2000
	Round-up Ultra	16 oz/A	1.17 l/ha	$4.82/A	7/10/2000
	Round-up Ultra	16 oz/A	1.17 l/ha	$4.82/A	8/09/2000

Table 4 . Weed control methods including herbicide rate, cost and date applied at Briggsdale in 2000 season.					
Crop	**Herbicide/Tillage**	**Rate (English)**	**Rate (Metric)**	**Cost**	**Date Applied**
Rotation: Wheat-Fallow					
Wheat:	Ally 2,4-D ester 4#	0.1 oz/A 8 oz/A	7.0 g/ha 0.58 l/ha	$2.30/A $0.82/A	4 May 2000 4 May 2000
Fallow:	Fallowmaster* Fallowmaster*	44 oz/A 44 oz/A	3.2 l/ha 3.2 l/ha	$6.49/A $6.49/A	13 May 2000 21 June 2000
Rotation: Wheat-Millet-Fallow					
Wheat:	Ally 2,4-D ester 4#	0.1 oz/A 8 oz/A	7.0 g/ha 0.58 l/ha	$2.30/A $0.82/A	4 May 2000 4 May 2000
Millet:	Fallowmaster* Round-up Ultra*	44 oz/A 24 oz/A	3.21 l/ha 1.75 l/ha	$6.49/A $7.23/A	13 May 2000 21 June 2000
Fallow:	Fallowmaster* Fallowmaster*	44 oz/A 44 oz/A	3.21 l/ha 3.21 l/ha	$6.49/A $6.49/A	13 May 2000 21 June 2000
Rotation:Wheat-Wheat-Corn-Soybean-Sunflower-Pea:					
Wheat:	Ally 2,4-D ester 4# Fallomaster* 2,4D ester	0.1 oz/A 8 oz/A 32 oz/A 8 oz/A	7.0 g/ha 0.58 l/ha 2.33 l/ha 0.58 l/ha	$2.30/A $0.82/A $4.72/A $0.82/A	4 May 2000 4 May 2000 2 Aug. 2000 2 Aug. 2000
Wheat:	Ally 2,4-D ester 4#	0.1 oz/A 8 oz/A	7.0 g/ha 0.58 l/ha	$2.30/A $0.82/A	4 May 2000 4 May 2000
Corn:	Prowl Atrazine 4L Fallowmaster*	32 oz/A 32 oz/A(1#) 44 oz/A	2.33 l/ha 2.33 l/ha(454g) 3.21 l/ha	$5.11/A $2.80/A $6.49/A	13 May 2000 13 May 2000 13 May 2000
Soybeans:	Round-up Ultra* Round-up Ultra*	32 oz/A 24oz/A	2.33 l/ha 1.75 l/ha	$9.64/A $7.23/A	13 May 2000 22 June 2000
Sunflowers :	Landmaster* Prowl	40 oz/A 48 oz/A	2.92 l/ha 3.50 l/ha	$5.54/A $7.66/A	13 May 2000 13 May 2000
Peas	Fallowmaster* 2,4-D ester 4#	44 oz/A 8 oz/A	3.21 l/ha 0.58 l/ha	$6.49/A $0.82/A	21 June 2000 21 June 2000
Rotation: Opportunity					
Soybeans:	Round-up Ultra* Round-up Ultra*	32 oz/A 24oz/A	2.33 l/ha 1.75 l/ha	$9.64/A $7.23/A	13 May 2000 22 June 2000
*Applied 17 lbs. Ammonium Sulfate/100 gallons water with Round-up products.					

Table 5. Weed control methods including herbicide rate, cost and date applied at Akron in 2000 season.					
Crop	**Herbicide/Tillage**	**Rate (English)**	**Rate (Metric)**	**Cost**	**Date Applied**
Rotation: Wheat-Fallow					
Wheat:					
Fallow:					
Rotation: Wheat-Corn-Fallow					
Wheat:	Round-up Ultra				
Corn:	Round-up Ultra	32 oz/A	2.33 l/ha	$9.64/A	12 May 2000
Fallow:	Round-up Ultra				
Rotation:Wheat-Corn-Millet:					
Wheat:	Round-up Ultra	32 oz/A	2.33 l/ha	$9.64/A	
Corn:	Round-up Ultra	32 oz/A	2.33 l/ha	$9.64/A	12 May 2000
Millet:	Round-up Ultra				
Rotation: Wheat-Corn-Sunflower-Fallow:					
Wheat:	Round-up Ultra				
Corn:	Round-up Ultra	32 oz/A	2.33 l/ha	$9.64/A	12 May 2000
Sunflower:	Round-up Ultra				
Fallow:	Round-up Ultra				

Table 6. Weed control methods including herbicide rate, cost and date applied at Lamar in 1999-2000 growing season.

Crop	Herbicide/Tillage	Rate (English)	Rate (Metric)	Cost	Date Applied
Rotation: Wheat-Fallow					
Wheat:	Paramount	5.33 oz/A	374 g/ha		9/09/1999
	Landmaster BW*	54 oz/A	3.94 l/ha	$9.21/A	9/09/1999
	Ally	0.1 oz/A	7.0 g/ha	$2.41/A	5/07/2000
	2,4-D 6#	8 oz/A	0.58 l/ha	$1.20/A	5/07/2000
Fallow:	Tillage - Sweep				6/13/2000
	Fallowmaster*	32 oz/A	2.33 l/ha	$4.92/A	7/21/2000
	Landmaster BW*	32 oz/A	2.33 l/ha	$5.53/A	7/21/2000
	Fallowmaster*	32 oz/A	2.33 l/ha	$4.92/A	8/05/2000
	Landmaster BW*	32 oz/A	2.33 l/ha	$5.53/A	8/05/2000
Rotation: Wheat-Sorghum-Fallow					
Wheat:	Paramount	5.33 oz/A	374 g/ha		9/09/1999
	Landmaster BW*	54 oz/A	3.94 l/ha	$9.21/A	9/09/1999
	Ally	0.1 oz/A	7.0 g/ha	$2.41/A	5/07/2000
	2,4-D 6#	8 oz/A	0.58 l/ha	$1.20/A	5/07/2000
Sorghum:	Round-up Ultra*	20 oz/A	1.46 l/ha		6/03/2000
	Atrazine 4L	16 oz/A	1.17 l/ha		6/03/2000
Fallow:	Tillage - Sweep				6/13/2000
	Fallowmaster*	32 oz/A	2.33 l/ha	$4.92/A	7/21/2000
	Landmaster BW*	32 oz/A	2.33 l/ha	$5.53/A	7/21/2000
	Fallowmaster*	32 oz/A	2.33 l/ha	$4.92/A	8/05/2000
	Landmaster BW*	32 oz/A	2.33 l/ha	$5.53/A	8/05/2000

APPENDIX II
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