Technical Bulletin **TB13-02**

Colorado State University

Agricultural Experiment Station

College of Agricultural Sciences
Department of Soil and Crop Sciences
Department of Bioag Sciences and Pest Management
USDA-ARS-NRRC

Sustainable Dryland Agroecosystems Management

2013

SUSTAINABLE DRYLAND AGROECOSYSTEMS MANAGEMENT[1]

N.C. Hansen[2], L.Sherrod[5], G.A. Peterson[3], D.G. Westfall[3], F.B. Peairs[4], D. Poss[9], T. Shaver[6]
K. Larson[7], D.L. Thompson[6], and L.R. Ahuja[8]

A Cooperative Project

of the

Colorado Agricultural Experiment Station
Department of Soil and Crop Sciences
Department of Bioagricultural Sciences and Pest Management
Colorado State University
Fort Collins, Colorado

and the

USDA - ARS
Natural Resources Research Center
Great Plains Systems Research Unit
Fort Collins, Colorado

[1] Funding is provided by the Colorado Agricultural Experiment Station and USDA-ARS.
[2] Associate Professor, Department of Soil and Crop Sciences, Colorado State University, Fort Collins, CO 80523
[3] Professor Emeritus, Department of Soil and Crop Sciences, Colorado State University, Fort Collins, CO 80523
[4] Professor, Department of Bioagricultural Sciences and Pest Management, Colorado State University, Fort Collins, CO 80523
[5] USDA-ARS Soil Scientist–Agricultural Systems Research Unit, Fort Collins
[6] Research Associate, Colorado State University
[7] Research Scientist, Plainsman Research Center at Walsh, Colorado
[8] USDA-ARS Research Leader - Great Plains Systems Research Unit
[9] Former Research Associate, Colorado State University, presently Support Scientist, USDA-ARS Central Great Plains Research Station

Contents

PROJECT HISTORY

The Dryland Agroecosystems Project was established in the fall of 1985 with the first winter wheat and corn crops harvested in 1986. The long-term research objectives are to provide producers with information that can be used to make management decisions under dryland cropping conditions and to learn more about soil quality and carbon sequestration parameters as impacted by intensive no-till dryland cropping systems in the semi-arid environment of the west central Great Plains. Grain yields, stover yields, crop residue amounts, soil water measurements, and crop N and P contents have been reported annually in previously published technical bulletins. This bulletin covers the 2008 and 2009 research results. Common introduction and materials and methods sections are presented for the two years, while the production parameters mentioned above are presented by year, in two sections identified as Section A (2008) and Section B (2009).

Results from past years have shown that cropping intensification, compared to traditional stubble mulch tillage winter wheat-fallow, is feasible and profitable in this environment if managed under no-till or minimum-till systems. The cropping systems evaluated from 1986 to 1998 included intensive rotations like winter wheat-corn(sorghum)-fallow and winter wheat-corn(sorghum)-millet-fallow with traditional winter wheat-fallow as the standard of comparison. The intense rotations of winter wheat-corn(sorghum)-fallow and winter wheat-corn(sorghum)-millet-fallow more than doubled grain water use efficiency relative to winter wheat-fallow. The increased soil water storage resulting from adoption of no-till systems made cropping intensification possible. The deletion of summer fallow, however, does increases the risk of water deficit for the following crop. The traditional winter wheat-fallow system requires less management skill and poses less risk relative to the intensive systems, but over time is less profitable. Government programs also affect management decisions greatly, particularly where producers have developed a good wheat or corn yield base.

Based on our findings with the intensive systems from 1985 to 1997 (12 cropping seasons), we altered the systems in 1998 to reduce the amount of fallow in our cropping systems. We now consider the 3-year (winter wheat-corn(sorghum)-fallow) system as the standard of comparison. These changes will be outlined later in this report. Unfortunately, shortly after we made these changes the region was hit with a drought. Some of the more intensive cropping systems have not been successful during the drought. Winter wheat planted after wheat or millet with no fallow period has had a high rate of crop failure and/or low yields due to lack of soil moisture for seed germination and/or inadequate stored soil moisture.

Adoption of Intensive Cropping Systems:

Corn is one of the principal crops grown in the more intensive cropping systems; thus we can use its acreage as an index of adoption rate by producers. Producers in northeastern Colorado adopted more intensive cropping systems at an increasing rate from 1990 until 2002. The drought of 2002 had a devastating effect on dryland crop yields. Colorado Agricultural Statistic reported that there were only 55,000 acres of dryland corn harvested in 2002 (See table below), but many thousands of additional acres were planted and not harvested. After 2002, the harvested dryland corn acreage rebounded to 205,000 in 2003, and since then has averaged about 300,000 acres per year.

Dryland Corn Acreage in Eight Northeastern Colorado Counties and state total from 1971 to 2009.

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
2001	233,000	305,000
2002	50,000	55,000
2003	150,700	205,000
2004	183,700	325,000
2005	140,900	235,000
2006	164,500	235,000
2007	204,300	360,000
2008	238,500	350,000
2009	(Data not available)	290,000

*Data from CO Agric. Statistics (Adams, Kit Carson, Logan, Morgan, Phillips, Sedgewick, Washington, Yuma)

Since dryland corn is almost exclusively grown under no-till in a three or four year rotation, we can estimate the total acreage under intensive dryland cropping systems from the corn acreage statistics. Thus the state acreage of intensified dryland cropping systems is at least 900,000 acres. Producers also grow grain sorghum and proso millet in these intensive cropping systems, and so the actual acreage likely exceeds 1,000,000 acres. Intensive cropping systems result in a 75% increase in annualized grain production compared to wheat-fallow. The average economic impact of these systems is an increased return to land, labor, capital, and management of $14.85/acre (Kann et al., 2002), under an “average” rainfall environment.

INTRODUCTION

Colorado agriculture is highly dependent on precipitation from both snow and rainfall. In the dryland environment 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 dryland winter wheat (12 kg/ha/mm), consequently profit is highly related to water conservation (Greb et al., 1974). These data point to the need for maximum precipitation use efficiency in this semi-arid cropping environment and the importance of this project to producers.

The dryland cropping systems research project was established in 1985 to identify systems that maximize efficient water use under dryland conditions in Eastern Colorado. A more comprehensive justification for its initiation can be found in Peterson, et al. (1988). A summary of our general understanding of the climate-soil-cropping systems interactions can be found in a recent publication by Peterson and Westfall (2004).

The general objective of the project is to identify no-till 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 soil test 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. Previous year’s results have been reported in CSU Agricultural Experiment Station Technical Bulletins that are available at the following web site: http://www.colostate.edu/Depts/aes/pubs_list.html. Other publications related to this project have been published by various graduate students, faculty, and postdoctoral students and are listed in Appendix C.

MATERIALS AND METHODS

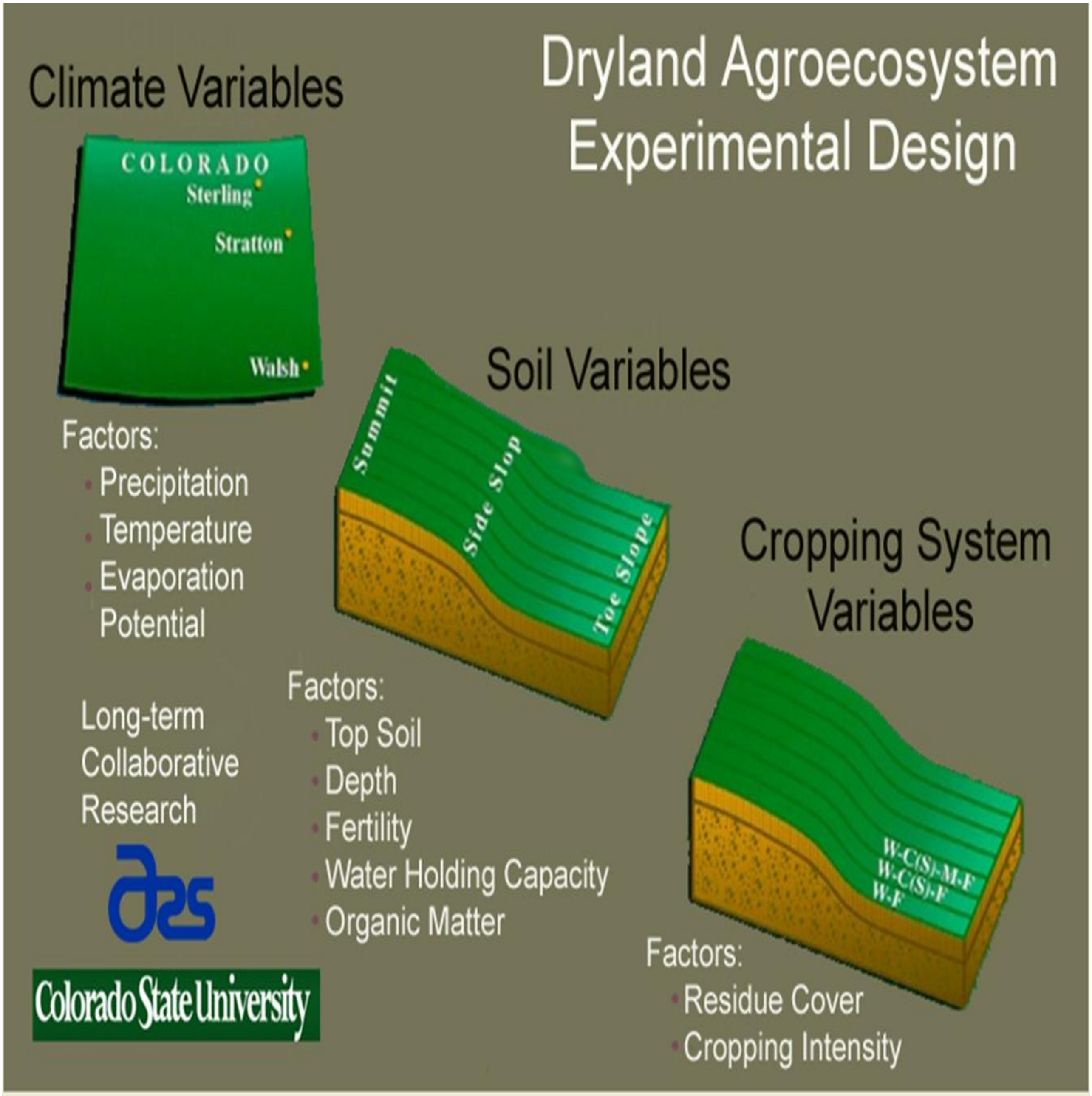
From 1986 -1997 we studied interactions of climate, soils and cropping systems at three sites, located near Sterling, Stratton, and Walsh, in Eastern Colorado, that represent a gradient in potential evapotranspiration (PET) (Fig. 1). Elevation, precipitation and evaporative demand are shown in Table 1. All sites have long-term precipitation averages of approximately 14-17 inches (400-450 mm), but increase in PET from north to south. Growing season open pan evaporation is used as an index of PET.

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

Site	Elevation	Annual Precipitation^1	Growing Season Open Pan Evaporation2	Deficit (Precip. - Evap.)
	--Ft. (m) --	---In. (mm) ---	---In. (mm) ---	---In. (mm) ---
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, and 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 2a, 2b, and 2c. There are dramatic differences in soils across slope position at a given site and from site to site. Each profile was described by NRCS personnel in the summer of 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.



Dryland Agroecosystem Experimental Design

Climate Variables

Factors:

- Precipitation
- Temperature
- Evaporation Potential

Soil Variables

Factors:

- Top Soil
- Depth
- Fertility
- Water Holding Capacity
- Organic Matter

Cropping System Variables

Factors:

- Residue Cover
- Cropping Intensity

Long-term Collaborative Research

Colorado State University

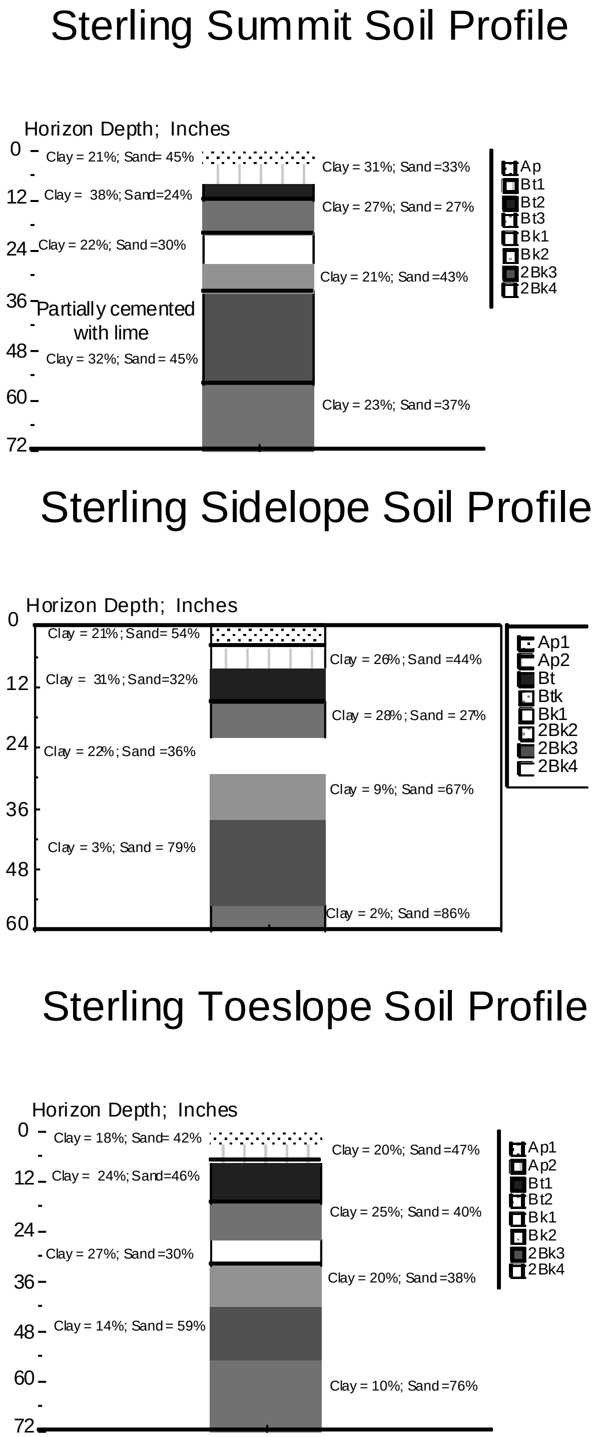


Figure 2a. Soil profile textural characteristics for soils at the Sterling site.

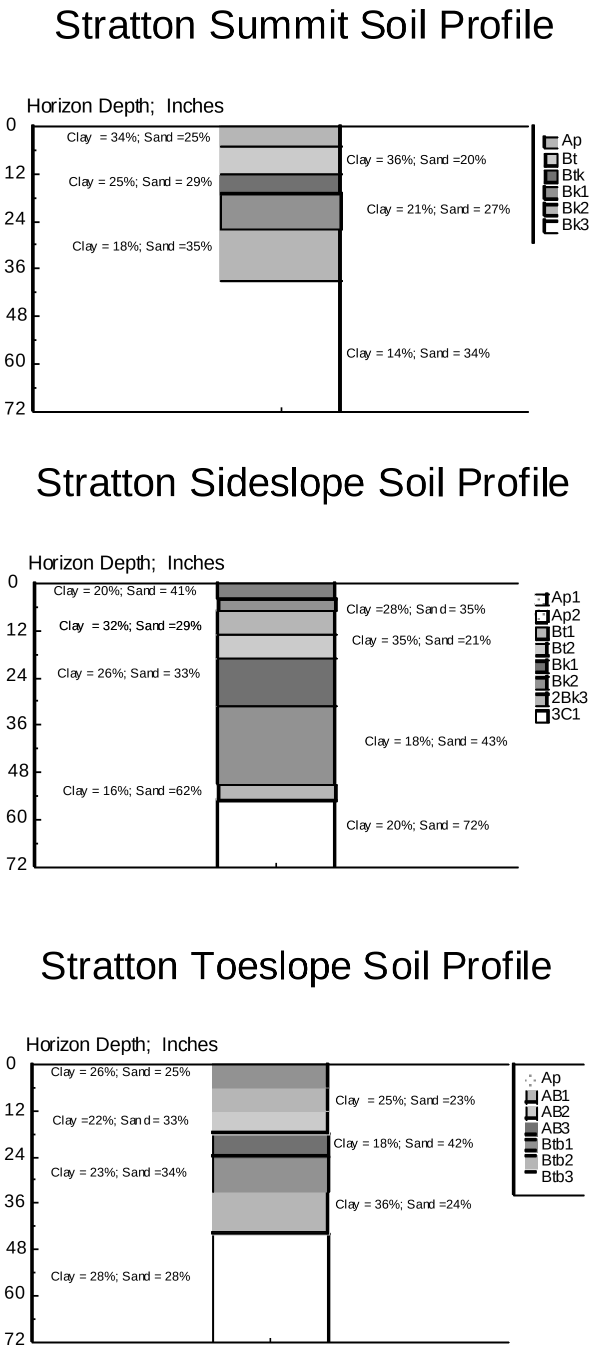
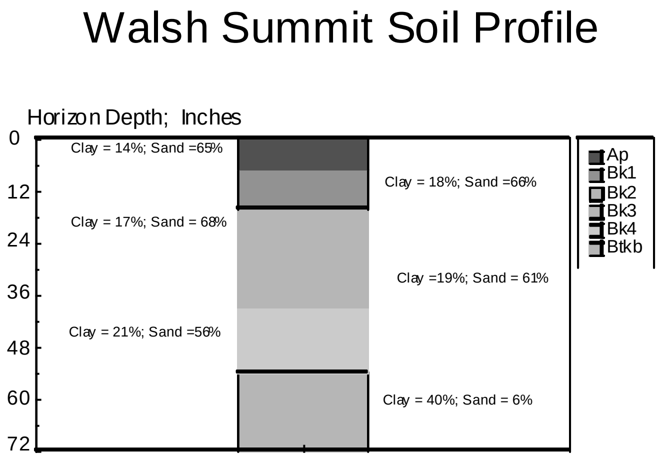
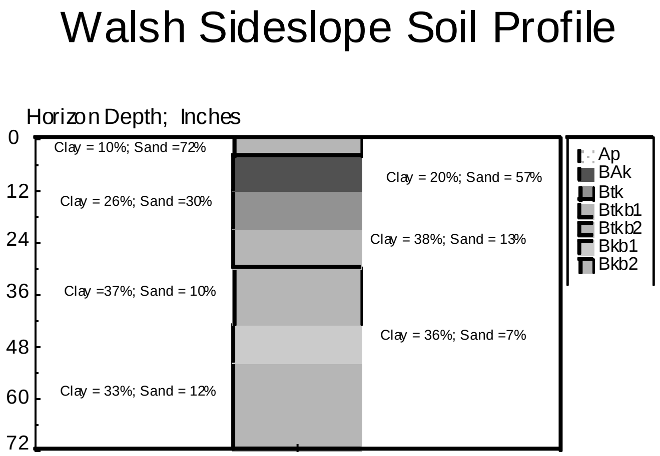


Figure 2b. Soil profile textural characteristics for soils at the Stratton site.





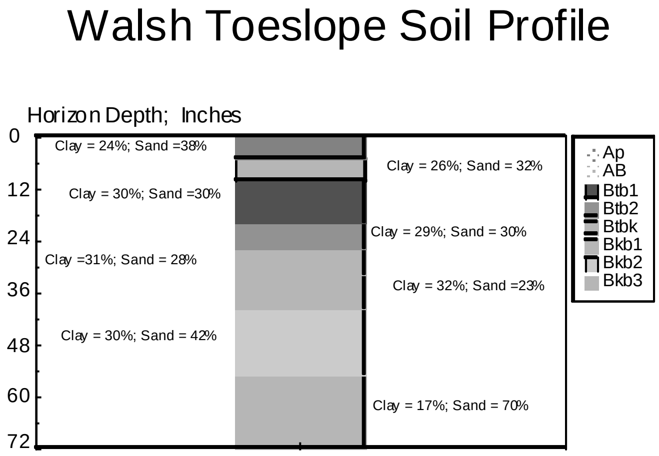


Figure 2c. Soil profile textural characteristics for soils at the Walsh site.

Cropping Systems/Management

The cropping systems that were in place in 2008 and 2009 at Sterling, Stratton and Walsh are shown in Table 2a. The “opportunity cropping system” has the goal of producing a crop every year without summer fallow, and the “opportunity” crops grown from initiation to 2008 are listed in Table 2b. The cultivars planted, planting rates, dates and harvest information for each site are reported in Table 6 for 2008 and Table 28 for 2009.

Nitrogen fertilizer is applied annually in accordance with the residual NO_3-N content of the soil profile (0-6 ft), soil organic matter content (0-6 in) before planting, and expected yield on each soil position at each site. Therefore, N rate changes by year, crop grown, and soil position, if needed. The N rates at Sterling, Stratton, and Walsh for 2008 are given in Table 3 and for 2009 in Table 27. Nitrogen fertilizer for wheat, corn, and sunflower was dribbled on the soil surface over the row at planting time at Sterling and Stratton. Zinc (0.9 lb/A) was applied to the corn with the P fertilizer. Nitrogen on wheat at Walsh was topdressed in the spring, and N was sidedressed on corn and sorghum. The N source was 32-0-0 solution of urea-ammonium nitrate.

Phosphorus management is one of the experimental variables. Phosphorus fertilizer (10-34-0) is applied at planting near the seed for all crops. Phosphorus is applied on one-half of each corn and proso millet plot over all soils, but applied to the entire wheat plot when a particular rotation is in wheat. 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 receives P in the wheat phase of the rotation. This was required because low P availability was resulting in poor wheat stand establishment and low yields. Other crops in the rotation only receive P on the half plot designated as NP. Zinc (0.9 lbs/A) is banded near the seed at corn planting at Sterling and Stratton to correct a soil Zn deficiency.

Yields, Nitrogen, and Available Soil Moisture

Grain yields were determined using a small plot research combine. The center section of each treatment was harvested on each slope position. At maturity, meter row samples of each crop were collected and processed to determine stover (straw) to grain ratio. The stover (straw) and grain were processed and analyzed for total N using a combustion N analyzer.

Soil moisture measurements were taken at planting and harvest of each crop for each treatment and slope positions using the neutron-scatter technique. This timing also represents the beginning and end of non-crop fallow periods. Galvanized metal conduit was used for neutron probe access tubes and were installed, two per soil position, in each treatment at the Sterling, Stratton and Walsh sites. The access tubes were installed at the initiation of this study in 1987 and have not been moved since original installation. Available soil water and change over the growing season was calculated based upon the available soil water holding capacity for each treatment, depth and slope position.

SECTION A
2008 Results & Discussion

Climatic Data

Precipitation is the most limiting variable in dryland agriculture in Eastern Colorado. The precipitation received during the last six months of a given year greatly influences crop yield potential for the following crop year, especially spring planted crops. For the last half of 2007 Sterling received 6.9 in of precipitation, which is near the normal, but the Stratton and Walsh sites only received about 60% of the normal (Table 4).

Precipitation in the first six months of 2008 was well below the long-term normal amounts at all three sites. Sterling and Stratton received less than 60% of the normal, and Walsh only received about 40% of the normal. Based on these precipitation observations, yield potential for both fall-planted and spring-planted crops would be expected to be adversely affected at all sites.

Precipitation in the last six months of 2008 exceeded the normal amounts at all three sites: Sterling by 11%, Stratton by 65%, and Walsh by 55% (Table 4). These conditions provide excellent potential for the following winter wheat crop. In addition, late season rainfall, if stored in the soil, provides a good starting point for spring crops the following year.

An overall view of the 18 month period precipitation that affected 2008 yield potentials indicated that the Sterling, Stratton, and Walsh sites were about 80, 115, and 85% of the normal for the period, respectively (Table 4).

Precipitation received during the vegetative production stage (Sept-Mar) and the reproductive stage for corn and wheat from 1987-2008 are shown in Tables 5a-c for Sterling, Stratton, and Walsh. We will refer to these data more extensively in the crop yield discussion section of the bulletin.

Wheat Production

Winter wheat yields at the Sterling and Walsh sites (Table 7) were below average (site average yields less than 27 bu/A at Sterling and less than 3 bu/A at Walsh) below average fall precipitation (Table 4) and below normal rainfall during the reproductive period (Tables 5a and 5c). Wheat yields at Stratton after summer fallow (WCF rotation) were near the long-term expected yields, averaging 42 bu/A across soil positions. The higher yields at Stratton were related to more soil water content at planting (Table 17). Below average precipitation during the reproductive period at Stratton probably decreased the yields relative to the potential given the good water content at planting.

Wheat yields following fallow in the WCF and WSF systems were the highest at all sites, as would be expected, because of the greater opportunity to store soil water. All of the more intensely cropped systems had substantially lower wheat yields than wheat following fallow. This was to be expected given the poor soil water conditions at wheat planting and the low rainfall in late 2007.

Corn/Sorghum Production

Corn yields at Sterling were relatively good, given the below average precipitation in June and July (Table 8). Corn yields at Stratton and grain sorghum yields at Walsh were unexpectedly low given the excellent July and August precipitation relative to the normal amounts. Corn yields in Eastern CO are highly correlated to July and August precipitation amounts (Nielsen et al. 1996), and according to the data in Table 4 it would seem that Sterling corn yields should have been higher. However, June precipitation at all sites was below normal, and thus the corn and sorghum plants may have been too drought stressed to recover.

Corn yields on the sideslope soil position at Sterling and Stratton tended to be higher on the side receiving P fertilizer. This is not usually the case because usually there is enough P carryover on all slope positions from the previous wheat crop to satisfy the corn crop's needs. Soil test P levels on the toeslope positions are in the high category and no response is expected in any year. The lack of corn yield response on the summit positions probably indicates that the carryover from the wheat P fertilization was adequate for the corn.

Corn yield and sorghum yields were not affected by rotation, which is as expected because in all cases these crops follow a wheat crop and thus have the same soil moisture regime.

Proso Millet Production

The proso millet yields at Sterling were about average for this site and above average for the Stratton site, except at the summit soil position where yields were much below the expected levels. Because the proso millet stand at the summit was thin due to poor emergence, there was significant competition from sandburs that reduced yields (Table 9). The above normal August precipitation (Table 4) at both sites undoubtedly contributed to the good grain yields. No proso millet was planted at the Walsh site because there was no soil moisture to support germination.

There were no consistent effects of rotation on proso yield at either Sterling or Stratton in the WCM and WWCM system. However, proso yields in the opportunity system at Sterling were greater than either of the rotations. The proso followed a wheat crop in the opportunity system at both Sterling and Stratton, and had larger soil water reserves relative to proso following corn in the two rotations (Tables 23-25). Even though the opportunity system had more available water than the two rotations, the yields at Stratton did not react similarly.

Nitrogen Content of Grain and Stover (straw)

The N content of all grain and stover (straw) in all crops is measured annually at the Sterling, Stratton and Walsh sites (Tables 10-15). Wheat grain N content (Table 10) ranged from a low of 1.9 to a high of 2.4%, which is equivalent to grain protein contents of 10.8 to 13.7%, which would be considered normal at the wheat yield levels achieved in 2008. Straw N content varied widely depending on grain yield level (Table 11). The lowest grain N content levels were associated with the highest grain yields and vice versa.

Corn and sorghum grain N contents (Table 12) ranged from a low of 1.2 to a high of 2.4%, which is equivalent to grain protein contents of 7.4 to 14.9%. The highest N contents were found in the grain sorghum at Walsh, which had the lowest grain yields (Table 8).

Proso millet grain N content ranged from 1.5 to 1.9% at Sterling and Stratton, which is equivalent to 9.3 to 11.8% protein (Table 14). No millet was planted at Walsh in 2008. Millet stover N contents at Sterling and Stratton ranged from 0.7 to 1.6%, but there was no consistent pattern with grain yield (Table 15).

Residual Soil Nitrate

Residual soil nitrate levels before planting wheat and corn and sorghum at Sterling, Stratton, and Walsh are reported in Table 26. The residual soil N levels for the wheat crop ranged from 14 to 197 kg N/ha in the soil profile across all sites and slope positions. Residual levels prior to corn and sorghum planting ranged from 37 to 266 kg N/ha in the soil profile across all sites and slope positions. Residual levels prior to proso millet planting ranged from 28 to 223 kg N/ha in the soil profile across all sites and slope positions. Residual N levels did not appear to be related to soil position or crop grown previously.

Soil Moisture

Available soil moisture contents are measured annually at planting and harvest of each crop in one foot depth increments at the Sterling, Stratton, and Walsh sites to a depth of six feet or to bedrock in the case of the shallower soils. Soil moisture data for 2008 are presented in Tables 16-25. The total amount water used by a given crop can be estimated by adding the change in soil water content between planting and harvesting to the amount of precipitation received during the growing season. Since we have no measure of how much of the precipitation infiltrates, the crop water use with this method is an estimate.

SECTION B

2009 Results & Discussion

Climatic Data

The precipitation received during the last six months of a given year greatly influences crop yield potential for the following crop year, especially spring planted crops. For the last half of 2008 the Sterling site received 10% more rainfall than normal, the Stratton site 69%, and the Walsh site 55% more than normal (Table 29). These above normal amounts provided excellent soil moisture conditions for the winter wheat crop.

Precipitation in the first six months of 2009 also was above the long-term normal amounts at all three sites (Table 29). The amounts above normal were: 14% at Sterling, 9% at Stratton, and 12% at Walsh. The above normal precipitation in late 2008 and early 2009 provided excellent crop production potential for both winter wheat and spring crops.

Precipitation in the last six months of 2009, which is the most influential on yield potential of spring planted crops, exceeded the normal amounts at Sterling by 17%, at Stratton by 40%, and at Walsh by over 200%.

Obviously the precipitation for the entire 18 month period was highly favorable for crop production (Table 29). Soil water data provided in Tables 38-47 indicates that all crops had excellent soil water conditions at planting.

Wheat Production

Winter wheat production in 2009 was average to above average at all three sites (Table 31), which was to be expected given the above normal precipitation in late 2008 and all of 2009 (Table 29). Wheat yields were generally the highest in the WC(S)F rotation at all sites as would be expected. Note however, that wheat yields in all phases of the intensive WCM and WWCM rotations ranged from 60 to 100% of wheat yields after fallow in the WC(S)F rotation. Obviously the excellent summer precipitation accounted for these excellent yields.

Wheat yields on the side slope soil positions at Sterling and Stratton tended to be higher on the NP side (Table 31). There were no observable yield differences at the Walsh site due to P fertilizer treatment. As a reminder, the NP side of the plot has received P for the life of the experiment. We apply P fertilizer at a rate of 20 lbs P_2O_5/A (9.5 kg/ha of P) at wheat planting each year on both the N and NP sides of each plot. Originally P was only applied to the side labeled NP. 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 began receiving P fertilizer whenever wheat is planted in that plot. This change was necessary because low P availability was resulting in poor wheat stand establishment and low yields. Other crops in the rotation only receive P on the half plot designated as NP. This adjustment also permits us to measure the residual P fertilizer effect on the yield of other crops.

It should also be noted that the excellent precipitation permitted excellent wheat straw production at all sites, which is a benefit for future crop production in all rotations (Table 31)

Corn/Sorghum Production

Corn yields at Sterling exceeded the long-term mean for this site, and the sorghum yield at Walsh sites was near the long-term means for that site (Table 32). However, the corn yields at Stratton were below expectations given the excellent late summer precipitation; the reason being the combined effects of hail and lodging from corn root worm damage. The hail lowered average yields and resulted in a great deal of inconsistency in yields across rotations and soil positions. Rotation had no effect on corn yields at Sterling or on sorghum yields at Walsh. At Stratton there were no distinct effects of P fertilization across site or soil position.

Forage Millet and Proso Millet Production

Proso millet was replaced by forage millet at the Sterling and Stratton sites in 2009 (Table 33). Forage millet yields at Sterling averaged 2500 lbs/A with the highest yields on the toeslope position. Forage millet yields at Stratton averaged 3800 lbs/A with the highest yields on the toeslope position. There were no consistent effects of rotation or P fertilization on forage yields at either site.

Proso millet yields at the Walsh site ranged from 8 to 26 bu/A with the highest yields occurring at the toeslope position (Table 33). Given the excellent summer precipitation, the proso yields were less than anticipated on the summit and sideslope positions because of rodent damage. There was a tendency, on both the summit and sideslope soil positions, for the NP side to have the highest yields. These soils always test low in available P, whereas the toeslope soil tests high available P.

Nitrogen Content of Grain and Stover (straw)

The N content of all grain and stover (straw) in all crops is measured annually at the Sterling, Stratton and Walsh sites (Tables 34a-36b). Wheat grain N content (Table 34a) ranged from a low of 2.0 to a high of 3.0%, which is equivalent to grain protein contents of 11.4 and 17.1%. Given the excellent wheat yields at all sites in 2009, these grain N contents are excellent and indicate that the N fertilization program is adequate. Wheat straw N contents reported in Table 34b ranged from 0.4 to 1.25%, but in general fell below the 1.0% level.

Corn and sorghum grain N contents ranged from a low of 1.4 to a high of 2.1% (Table 35a), which is equivalent to grain protein contents of 8.7 to 13.0%. Stover N contents ranged from 0.6 to 1.2% (Table 35b).

Proso millet grain N contents are only reported for the Walsh site. They averaged 1.9%, which is equivalent to 11.8% protein (Table 36a). Millet stover N contents averaged 0.65% (Table 36b).

Forage millet at the Sterling and Stratton sites had forage N contents ranging from 1.7 to 2.5%. This is equivalent to 10.5 to 15.5% crude protein. Obviously the forage millet had excellent feed value.

Residual Soil Nitrate

Residual soil nitrate levels before planting wheat and corn and sorghum at Sterling, Stratton, and Walsh are reported in Table 37. The residual soil N levels at wheat planting ranged from 21 to 169 kg N/ha (Divide kg/ha by 1.12 to convert to lb/A) in the soil profile across all sites and slope positions. Residual levels prior to corn and sorghum planting ranged from 17 to 209 kg N/ha in the soil profile across all sites and slope positions. Residual levels prior to proso millet planting ranged from 9 to 188 kg N/ha in the soil profile across all sites and slope positions. Residual N levels did not appear to be related to soil position or crop grown previously. The high N levels prior to corn planting at Sterling probably resulted because of low wheat yields at that site in the prior year.

Soil Moisture

Available soil moisture contents are measured annually at planting and harvest of each crop in one foot depth increments at the Sterling, Stratton, and Walsh sites to a depth of six feet or to bedrock in the case of the shallower soils. Soil moisture data for 2009 are presented in Tables 38-47. The total amount water used by a given crop can be calculated by adding the change in soil water content between planting and harvesting to the amount of precipitation received during the growing season.

Crop Residue

Crop residue on the soil surface is critical to water conservation in dryland no-till systems. The amounts present at crop planting time are an indication of the minimum cover point in a particular cropping system. A snap-shot of residue present in each system is available in Tables 48-50. Note that residue present is greatly affected by location, particular phase of the cropping system, and soil position. The reader should be aware that the data in these tables represents only one year, and that the particular values vary greatly over the years depending on the climatic conditions of that year.

REFERENCES

Greb, B.W., D.E. Smika, N.P. Woodruff, and C.J. Whitfield. 1974. Summer fallow in the Central Great Plains. In: Summer Fallow in the Western United States. ARS-USDA. Conservation Research Report No. 17.

Kaan, D.A., D.M. O'Brien, P.A. Burgener, G.A. Peterson, and D.G, Westfall, D.G. 2002. An economic evaluation of alternative crop rotations compared to wheat-fallow in Northeastern Colorado. Tech. Bull. TB02-1. Agric. Exp. Stn., Colo. State Univ., Fort Collins, CO.

Nielsen, D., G.A. Peterson, R. Anderson, V. Ferreira, W. Shawcroft, and K. Remington. 1996. Estimating corn yields from precipitation records. Conservation Tillage Fact Sheet 2-96. USDA/ARS and USDA/NRCS. Akron, CO.

Peterson, G.A. and D.G. Westfall. 2004. Managing precipitation use in sustainable dryland agroecosystems. Ann. Appl. Biol. 144:127-138.

Table 2a. Cropping systems for each of the original sites in 2007-2008 and 2008-2009 cropping year.

Site	Rotations
Sterling	1) Wheat-Corn-Fallow (WCF)
	2) Wheat-Corn-Millet (WCM)
	3) Wheat1-Wheat2-Corn-Millet (WWCM)
	4) Opportunity Cropping*
	5) Perennial Grass
Stratton	1) Wheat-Corn-Fallow (WCF)
	2) Wheat-Corn-Millet (WCM)
	3) Wheat1-Wheat2-Corn-Millet (WWCM)
	4) Opportunity Cropping*
	5) Perennial Grass
Walsh	1) Wheat-Corn-Fallow (WSF)
	2) Wheat-Corn-Millet (WCB)
	3) Wheat1-Wheat2-Corn-Mung Bean (WWCB)
	4) Opportunity Cropping*
	5) Perennial Grass
	6) Continuous Row Crop (Alternate corn & sorghum)

*Opportunity cropping is designed to be continuous cropping without fallow, but not monoculture. See Table 2b for specific crops present each year.

Table 2b. Opportunity cropping history from 1985 to 2008 at the original dryland sites.

	Site		
Year	**Sterling**	**Stratton**	**Walsh**
1985	Wheat	Fallow	Sorghum
1986	Wheat	Wheat	Sorghum
1987	Corn	Sorghum	Proso 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
2001	Wheat	Wheat	Sorghum
2002	Corn	Corn	Sorghum
2003	Corn	Proso Millet	Sorghum
2004	Proso Millet	Proso Millet	Corn
2005	Corn	Corn	Corn
2006	Proso Millet	Proso Millet	Sorghum
2007	Wheat	Wheat	Corn
2008	Millet	Millet	Sorghum

Table 3. Nitrogen fertilizer application (lb/A) by soil and crop for 2008.

			ROTATION				
SITE	**SLOPE**	**CROP**	**W'WCM**	**WW'CM**	**WCM**	**WCF**	**OPP**
Sterling	Summit	Wheat	60 lb	60 lb	60 lb	60 lb	60 lb
	Sideslope	"	60 lb	60 lb.	60 lb	60 lb	60 lb
	Toeslope	"	60 lb	60 lb	60 lb	60 lb	60 lb
	Summit	Corn	52 lb	52 lb	52 lb	52 lb	-
	Sideslope	"	52 lb	52 lb	52 lb	52 lb	-
	Toeslope	"	52 lb	52 lb	52 lb	52 lb	-
	Summit	Millet	42 lb	42 lb	42 lb	-	-
	Sideslope	"	42 lb	42 lb	42 lb	-	-
	Toeslope	"	42 lb	42 lb	42 lb	-	-
Stratton	Summit	Wheat	60 lb	60 lb	60 lb	60 lb	60 lb
	Sideslope	"	60 lb	60 lb	60 lb	60 lb	60 lb
	Toeslope	"	60 lb	60 lb	60 lb	60 lb	60 lb
	Summit	Corn	52 lb	52 lb	52 lb	52 lb	-
	Sideslope	"	52 lb	52 lb	52 lb	52 lb	-
	Toeslope	"	52 lb	52 lb	52 lb	52 lb	-
	Summit	Millet	42 lb	42 lb	42 lb	-	-
	Sideslope	"	42 lb	42 lb	42 lb	-	-
	Toeslope	"	42 lb	42 lb	42 lb	-	-
			WWSM	WSM	WSF	WCM	CC
Walsh	Summit	Wheat	58 lb	58 lb	58 lb	58 lb	-
	Sideslope	"	58 lb	58 lb	58 lb	58 lb	-
	Toeslope	"	58 lb	58 lb	58 lb	58 lb	-
	Summit	Sorghum	45 lb	45 lb	45 lb	-	-
	Sideslope	"	45 lb	45 lb	45 lb	-	-
	Toeslope	"	45 lb	45 lb	45 lb	-	-
	Summit	Corn	-	-	-	60 lb	60 lb
	Sideslope	"	-	-	-	60 lb	60 lb
	Toeslope	"	-	-	-	60 lb	60 lb
	Summit	Millet	45 lb	45 lb	45 lb	-	-
	Sideslope	"	45 lb	45 lb	45 lb	-	-
	Toeslope	"	45 lb	45 lb	45 lb	-	-

Table 4. Monthly precipitation for the original sites for the 2007 - 2008 growing season.

MONTH	**LOCATION**					
	STERLING		**STRATTON**		**WALSH**	
	Inches	**Inches**	**Inches**	**Inches**	**Inches**	**Inches**
2007	2007	Normals[1]	2007	Normals[1]	2007	Normals[1]
JULY	2.21	3.23	0.82	2.80	1.59	2.62
AUGUST	2.47	1.90	1.54	2.60	0.97	1.96
SEPTEMBER	0.62	1.04	1.65	1.45	0.91	1.74
OCTOBER	0.33	0.76	0.52	0.85	0.07	0.89
NOVEMBER	0.08	0.50	0.15	0.62	0.02	0.53
DECEMBER	1.23	0.40	0.54	0.28	1.18	0.31
SUBTOTAL	6.94	7.83	5.22	8.60	4.74	8.05
	Inches	**Inches**	**Inches**	**Inches**	**Inches**	**Inches**
2008	2008	Normals[1]	2008	Normals[1]	2008	Normals[1]
JANUARY	0.06	0.33	0.11	0.28	0.21	0.27
FEBRUARY	0.23	0.33	0.32	0.30	0.23	0.28
MARCH	0.21	1.07	0.28	0.76	0.53	0.81
APRIL	0.84	1.60	0.84	1.23	0.48	1.15
MAY	1.37	3.27	1.24	2.70	0.71	2.69
JUNE	2.60	3.00	1.80	2.45	1.02	2.29
SUBTOTAL	5.31	9.60	4.59	7.72	3.18	7.49
	Inches	**Inches**	**Inches**	**Inches**	**Inches**	**Inches**
2008	2008	Normals[1]	2008	Normals[1]	2008	Normals[1]
JULY	1.78	3.23	3.81	2.80	1.65	2.62
AUGUST	3.77	1.90	6.93	2.60	7.03	1.96
SEPTEMBER	0.94	1.04	0.36	1.45	0.83	1.74
OCTOBER	1.53	0.76	3.04	0.85	2.75	0.89
NOVEMBER	0.60	0.50	0.28	0.62	0.14	0.53
DECEMBER	0.06	0.40	0.12	0.28	0.13	0.31
SUBTOTAL	8.68	7.83	14.54	8.60	12.53	8.05
YEAR TOTAL	13.99	17.43	19.13	16.32	15.71	15.54
18 MONTH TOTAL	20.93	25.26	24.35	24.92	20.45	23.59

[1] Normals = 1961 - 1990 data base

Table 5a. **Precipitation by growing season segments for STERLING SITE from 1987-2008.**

Year	Wheat Vegetative Sept.-March Inches	Wheat Reproductive April-June Inches	Corn Pre-plant July-April Inches	Corn Growing Season May - Oct. 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
2000-01	6.8	8.2	11.5	13.8
2001-02	4.2	1.9	8.2	8.1
2002-03	5.2	7.6	12.9	8.4
2003-04	1.3	5.3	6.4	10.1
2004-05	3.5	6.6	10.5	8.5
2005-06	2.7	1.3	5.0	9.3
2006-07	5.4	4.8	12.7	13.2
2007-08	2.8	4.7	11.3	14.2
Long Term Average	**4.6**	**6.1**	**10.9**	**12.5**

Table 5b. Precipitation by growing season segment for STRATTON SITE from 1987-2008.

	GROWING SEASON SEGMENTS FOR WHEAT AND CORN			
Year	Wheat Vegetative Sept.- March Inches	Wheat Reproductive April-June Inches	Corn Preplant July- April Inches	Corn Growing Season May - Oct. 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
2000-01	4.7	4.3	9.8	10.6
2001-02	3.8	2.2	9.5	6.9
2002-03	4.1	8.7	8.6	10.9
2003-04	5.1	3.8	9.8	6.3
2004-05	3.5	6.7	7.1	13.9
2005-06	4.3	4.8	9.5	9.7
2006-07	7.8	6.3	8.3	8.5
2007-08	3.7	3.9	6.8	17.2
Long Term Average	**4.6**	**6.0**	**11.2**	**12.8**

Table 5c. Precipitation by growing season segment for the WALSH site from 1987-2008.

	GROWING SEASON SEGMENTS FOR WHEAT AND CORN			
	Wheat	Wheat	Corn	Corn
Year	Vegetative Sept.-March Inches	Reproductive April-June Inches	Preplant July-April Inches	Growing Season May - Oct. 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
2000-01	9.0	7.9	13.4	9.6
2001-02	1.7	2.2	2.9	11.8
2002-03	6.7	11.4	15.8	12.5
2003-04	3.2	10.1	8.2	13.5
2004-05	3.0	4.7	8.5	8.3
2005-06	2.6	3.0	5.7	11.7
2006-07	5.2	0.9	12.0	1.8
2007-08	3.2	2.2	6.2	14.0
Long Term Average	**4.8**	**6.0**	**11.1**	**12.2**

Table 6. Crop Variety, seeding rate, and planting date for each site in 2007-2008 season.

Site	Crop	Variety	Seeding Rate	Planting Date	Harvest Date
Sterling	Wheat	Hatcher	60 lb/A	09/27/07	07/16/08
	Corn	DKC 46-60	12K seeds/A	05/05/08	11/05/08
	Proso Millet	Huntsman	15 lb/A	06/02/08	9/18/08
Stratton	Wheat	Hatcher	60 lb/A	09/20/07	07/15/08
	Corn	DKC 46-60	12K seeds/A	05/05/08	11/04/08
	Proso Millet	Huntsman	15 lb/A	06/03/08	09/17/08
Walsh	Wheat	Hatcher	45 lb/A	10/22/07	
	Corn	NC+4252VT3	17K seeds/A	05/13/08	
	Grain Sorghum	Four Star 207	40K seeds/A	05/13/08	12/02/08
	Proso Millet	Not Planted			

Table 7. Grain and stover yields for WHEAT in 2008.

	SLOPE POSITION											
	SUMMIT				SIDESLOPE				TOESLOPE			
SITE & ROTATION	*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	18.9	21.5	2011	2435	28.2	33.4	2804	4912	30.2	30.9	2200	5898
WCM	7.1	3.3	2463	2105	7.5	3.6	821	564	8.4	11.1	544	756
W1WCM	4.2	3.1	1898	1011	11.4	7.5	1325	1074	9.9	4.7	1067	403.0
WW2CM	0	0	0	0	0	0	0	0	0	0	0	0
OPP												
	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	36.6	37.4	3571	6888	38	36	5639	6756	56.1	48	7571	10158
WCM	22.2	16.6	2300	1379	15.7	13.9	1970	1757	33.7	37.8	2369	5250
W1WCM	4.5	3.9	1250	560	19.0	17.2	1889	3383	35.5	38.7	5234	3799
WW2CM	5.3	4.6	1371	1121	11.3	5.0	2181	694	33.3	48.0	4866	7344
OPP												
	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	0.6	0.1	352	220	0.8	0.7	313	473	3.8	2.2	1155	1022
WCM	0.8	0.1	288	494	1.1	0.9	520	370	2.5	4.5	570	791
W1WCM	0.8	0.6	470	368	0.5	0.9	371	504	3.1	5.2	798	939
WW2CM	1.2	1.2	488	658	3.8	4.5	646	769	3.6	3.2	744	1019

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

* Only receives phosphorus in wheat phase of each rotation.

** Yields based on 1 meter row sample at Walsh only.

Table 8. Grain and stover yields for CORN AND SORGHUM in 2008.

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	38.8	27.0	1310	820	50.8	68.9	1315	1915	34.7	52.3	945	1880
WCM	59.3	12.0	1690	540	52.5	81.1	1220	2000	46.5	65.7	1235	2760
WWCM	22.8	12.1	545	390	36.6	45.6	905	1495	37.2	42.2	890	1295
	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	26.7	23.2	680	805	36.2	54.7	970	3200	93.0	90.6	3410	2735
WCM	14.2	26.3	565	1370	40.3	26.5	3800	1010	89.9	110.1	2320	3450
WWCM	17.4	26.7	1150	2240	31.0	32.6	760	2900	71.3	106.1	1945	3070
	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	9	6	170	115	7	5	130	90	12	6	220	120
WCM	NA	NA			NA	NA			NA	NA		
WWSM	8	5	150	100	8	6	140	120	8	7	150	140
OPP-SOR	7	3	130	60	1	0	16	10	1	2	20	35
CC corn	NA	NA			NA	NA			NA	NA		
CC SOR	8	6	155	115	0	0	0	0	0	0	0	0

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

* Only receives phosphorus in wheat phase of each rotation.

Table 9. Grain and stover yields for MILLET in 2008.

	SLOPE POSITION											
	SUMMIT				SIDESLOPE				TOESLOPE			
SITE & ROTATION	*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. ------	
WCM	25	26	908	445	31	31	802	1088	33	33	975	1090
WWCM	18	18	784	759	31	31	1240	982	27	27	980	1229
OPP	43	42	1298	955	42	42	1321	1745	50	50	1886	1784
	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. ------	
WCM	8	8	213	246	53	53	1771	1305	68	69	2873	2788
WWCM	34	34	1173	1138	56	56	1867	1951	31	31	987	1193
OPP	17	25	503	1015	37	22	2752	2873	26	17	1894	1177
	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. ------	
WCB												
W1WCM	Not	Planted										
WW2CM												

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

* Only receives phosphorus in wheat phase of each rotation.

Table 10. Total Nitrogen content of WHEAT GRAIN in the 2008 crop.

	SLOPE POSITION					
	SUMMIT		SIDESLOPE		TOESLOPE	
SITE &	***N Side****	***NP Side***	***N Side****	***NP Side***	***N Side****	***NP Side***
ROTATION	**N**	**NP**	**N**	**NP**	**N**	**NP**
STERLING:	-------------- % -------------		-------------- % -------------		-------------- % -------------	
WCF	1.96	1.96	2.03	2.05	1.94	2.05
WCM	2.43	2.11	2.32	2.24	2.21	2.10
WWCM	2.33	2.23	2.08	2.00	2.03	2.22
W(W)CM						
	N	**NP**	**N**	**NP**	**N**	**NP**
STRATTON:	-------------- % -------------		-------------- % -------------		-------------- % -------------	
WCF	2.15	2.19	2.06	2.07	2.06	1.65
WWM	1.96	1.92	1.92	1.89	2.12	1.91
WWCM	2.08	2.13	2.09	1.99	1.93	1.91
W(W)CM	2.40	2.48	2.26	2.25	2.24	1.96
	N	**NP**	**N**	**NP**	**N**	**NP**
WALSH:						
	-------------- % -------------		-------------- % -----------		-------------- % -------------	
WSF						
WCM	No data					
WWCM						
W(W)CM						

* Only receives phosphorus in wheat phase of each rotation.

Table 11. Total Nitrogen content of WHEAT STRAW in the 2008 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	0.64	0.64	0.49	0.48	0.55	0.63
WCM	1.65	1.80	1.17	1.10	1.27	0.77
WWCM	1.68	1.32	0.74	0.84	1.02	0.86
	N	NP	N	NP	N	NP
STRATTON:	-------------- % -------------		-------------- % -------------		-------------- % -------------	
WCF	0.57	0.82	0.55	0.64	0.65	0.85
WCM	0.55	0.47	0.68	0.60	0.66	0.76
WWCM	0.92	0.75	0.57	0.61	0.69	0.65
W(W)CM	0.96	1.03	0.71	0.78	0.59	0.67
	N	NP	N	NP	N	NP
WALSH:	-------------- % -------------		-------------- % -----------		-------------- % -------------	
WSF	1.07	0.93	1.14	1.03	0.99	0.89
WCM	0.87		1.08	0.97	1.36	1.16
WWCM	0.93	1.26	0.99	1.25	1.32	1.14
W(W)CM	1.27	1.02	1.01	0.46	1.57	1.55

* Only receives phosphorus in wheat phase of each rotation.

Table 12. Total Nitrogen content of CORN GRAIN in the 2008 and Sorghum Grain in the 2008 crop.

	SLOPE POSITION					
	SUMMIT		SIDESLOPE		TOESLOPE	
SITE & ROTATION	*N Side**	*NP Side*	*N Side**	*NP Side*	*N Side**	*NP Side*
	N	NP	N	NP	N	NP
STERLING:	--------------- %	-------------	--------------- %	-------------	--------------- %	-------------
WCF	1.52	1.33	1.39	1.48	1.32	1.39
WCM	1.59	1.47	1.46	1.43	1.42	1.40
WWCM	1.47	1.49	1.41	1.44	1.44	1.44
	N	**NP**	**N**	**NP**	**N**	**NP**
STRATTON:	--------------- %	-------------	--------------- %	-------------	--------------- %	-------------
WCF	1.36	1.27	1.20	1.22	1.18	1.18
WCM	1.64	1.48	1.48	1.47	1.43	1.35
WWCM	1.49	1.46	1.43	1.44	1.32	1.31
	N	**NP**	**N**	**NP**	**N**	**NP**
WALSH:	--------------- %	-------------	--------------- %	-----------	--------------- %	-------------
WSF	1.95	2.19	2.18	2.31	2.29	2.30
WCM	2.45	2.47	2.30	2.36	2.44	2.33
WWSM	2.22	2.23	2.22	2.36	2.30	2.25
CC SORG	2.28	2.47	2.18		2.18	
OPP- SORG	2.39	2.49	2.30	2.36	2.44	2.33

* Only receives phosphorus in wheat phase of each rotation.

Table 13. Total Nitrogen content of CORN STOVER in the 2008 crop.

	SLOPE POSITION					
	SUMMIT		SIDESLOPE		TOESLOPE	
SITE & ROTATION	***N Side****	***NP Side***	***N Side****	***NP Side***	***N Side****	***NP Side***
	N	**NP**	**N**	**NP**	**N**	**NP**
STERLING:	-------------- % -------------		-------------- % -------------		-------------- % -------------	
WCF	1.18	1.23	0.94	0.83	1.09	1.22
WCM	1.47	1.20	1.05	1.14	1.61	1.31
WWCM	1.25	1.29	1.16	1.34	1.18	1.38
	N	**NP**	**N**	**NP**	**N**	**NP**
STRATTON:	-------------- % -------------		-------------- % -------------		-------------- % -------------	
WCF	1.03	1.32	1.13	1.06	0.89	0.86
WCM	1.63	1.56	1.49	1.26	1.05	1.09
WWCM	1.76	1.64	1.40	1.55	0.97	1.05
	N	**NP**	**N**	**NP**	**N**	**NP**
WALSH:						
	-------------- % -------------		-------------- % -----------		-------------- % -------------	
WSF	1.21	1.40	0.76	1.34	1.58	1.25
WCM						
WWSM	1.30	1.21	1.26	1.51	1.39	1.40
CC SORG	1.55	1.62	1.44	1.71	1.57	1.75
OPP-SORG	1.37	1.65	1.86	1.92	1.80	1.62

* Only receives phosphorus in wheat phase of each rotation.

Table 14. Total Nitrogen content of MILLET GRAIN in the 2008 crop.

	SLOPE POSITION					
	SUMMIT		SIDESLOPE		TOESLOPE	
SITE & ROTATION	***N Side****	***NP Side***	***N Side****	***NP Side***	***N Side****	***NP Side***
	N	**NP**	**N**	**NP**	**N**	**NP**
STERLING:	-------------- %	-------------	-------------- %	-------------	-------------- %	-------------
WCM	1.69	1.73	1.63	1.57	1.64	1.55
WWCM	1.92	2.04	1.79	1.48	1.84	1.73
OPP	1.86	1.82	1.85	1.77	1.71	1.67
	N	**NP**	**N**	**NP**	**N**	**NP**
STRATTON:	-------------- %	-------------	-------------- %	-------------	-------------- %	-------------
WWM	1.83	1.70	1.73	1.40	1.54	1.65
WWCM	1.88	1.91	1.59	1.59	1.71	1.87
OPP	1.88	1.79	1.79	1.58	1.64	1.40
	N	**NP**	**N**	**NP**	**N**	**NP**
WALSH:						
	-------------- %	-------------	-------------- %	-----------	-------------- %	-------------
WCM	Not Planted					
WWSM						

* Only receives phosphorus in wheat phase of each rotation.

Table 15. Total Nitrogen content of MILLET STRAW in the 2008 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:	-------------- % -------------		-------------- % -------------		-------------- % -------------	
WCM	1.06	0.95	0.70	0.88	0.96	0.77
WWCM	1.38	1.37	1.01	0.67	1.08	1.26
OPP	1.11	1.26	1.04	1.06	1.26	1.28
	N	**NP**	**N**	**NP**	**N**	**NP**
STRATTON:	-------------- % -------------		-------------- % -------------		-------------- % -------------	
WCM	1.54	1.05	1.07	0.72	0.99	1.28
WWCM	1.41	1.42	1.02	0.91	1.18	1.33
OPP	1.37	1.05	1.47	0.90	1.11	0.73
	N	**NP**	**N**	**NP**	**N**	**NP**
WALSH:	-------------- % -------------		-------------- % -----------		-------------- % -------------	
WCM	Not planted					
WWSM						

* Only receives phosphorus in wheat phase of each rotation.

Table 16. Available soil water by soil depth of the WHEAT phase in the WCM rotation at Sterling and Stratton, and the WCM rotation at Walsh in 2008.

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	5	0	5	0	0	0	6	0	6
45	5	0	5	7	0	7	26	13	13
75	6	1	5	7	0	7	44	11	33
105	28	30	(2)	2	0	2	47	10	37
135	-	-	-	-	-	-	14	9	5
155	-	-	-	-	-	-	17	0	17
TOTAL	**44**	**31**	**13**	**16**	**0**	**16**	**154**	**43**	**111**
STRATTON:									
15	14	0	14	0	0	0	13	14	(1)
45	10	0	10	0	0	0	51	0	51
75	9	0	9	9	0	9	72	0	72
105	10	0	10	18	0	18	69	0	69
135	15	0	15	11	20	(9)	47	14	33
155	0	0	0	0	9	(9)	0	44	(44)
TOTAL	**58**	**0**	**58**	**38**	**19**	**19**	**252**	**72**	**180**
WALSH:									
15	0	0	0	0	9	(9)	0	0	0
45	0	0	0	0	9	(9)	0	0	0
75	0	4	(4)	0	13	(13)	0	32	(32)
105	0	17	(17)	4	28	(24)	0	29	(29)
135	0	26	(26)	0	0	0	0	33	(33)
155	0	28	(28)	0	17	(17)	0	26	(26)
TOTAL	**0**	**75**	**(75)**	**4**	**76**	**(72)**	**0**	**120**	(120)

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 17. Available soil water by soil depth of the WHEAT phase in the WCF rotation at Sterling and Stratton, and the WSF rotation at Walsh in 2008.

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	19	6	13	10	0	10	28	4	24
45	27	0	27	56	0	56	48	12	36
75	25	6	19	40	0	40	56	11	45
105	42	0	42	9	0	9	74	21	53
135	-	-	-	-	-	-	36	13	23
155	-	-	-	-	-	-	26	15	11
TOTAL	113	12	101	115	0	115	268	66	202
STRATTON:									
15	38	19	(19)	37	9	28	61	4	57
45	43	1	42	46	0	46	72	0	72
75	38	3	35	49	0	49	70	0	70
105	40	5	35	53	0	53	71	0	71
135	43	7	36	60	0	60	66	0	66
155	0	9	(9)	0	0	0	0	0	0
TOTAL	202	44	158	245	9	-236	340	4	336
WALSH:									
15	0	0	0	0	0	0	0	0	0
45	7	0	7	0	8	(8)	43	36	7
75	9	2	7	9	32	(23)	51	29	22
105	7	7	0	31	50	(19)	42	22	20
135	16	26	(10)	0	51	(51)	56	42	14
155	0	33	(33)	0	73	(73)	0	45	(45)
TOTAL	39	68	(29)	40	214	(174)	192	174	(18)

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 18. Available soil water by soil depth of the WHEAT 1 phase in the WWCM rotation at Sterling and Stratton, and the WWSM rotation at Walsh in 2008.

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	10	2	8	3	0	3	12	0	12
45	6	0	6	26	0	26	29	12	16
75	1	0	1	43	8	35	47	14	33
105	20	16	4	39	22	17	50	27	23
135	-	-	-	-	-	-	12	7	5
155	-	-	-	-	-	-	7	6	1
TOTAL	**37**	**18**	**19**	**111**	**30**	**81**	**157**	**66**	**91**
STRATTON:									
15	25	0	25	10	0	10	77	3	74
45	6	0	6	0	0	0	91	0	91
75	2	0	2	0	0	0	97	0	97
105	6	0	6	21	0	21	84	0	84
135	8	0	8	11	0	11	67	14	53
155	0	0	0	86	7	79	58	0	58
TOTAL	**47**	**0**	**47**	**128**	**7**	**121**	**474**	**17**	**457**
WALSH:									
15	0	0	0	0	0	0	0	0	0
45	0	4	(4)	8	26	(18)	0	28	(28)
75	0	3	(3)	7	22	(15)	0	36	(36)
105	8	5	3	0	31	(31)	0	34	(34)
135	1	6	(5)	0	24	(24)	0	40	(40)
155	0	16	(16)	6	26	(20)	0	27	(27)
TOTAL	**9**	**34**	**25**	**21**	**129**	**(108)**	**0**	**165**	**(165)**

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 19. Available soil water by soil depth of the WHEAT 2 phase in the WWCM rotation at Sterling and Stratton, and the WWSM rotation at Walsh in 2008.

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	11	36	(25)	0	10	(10)	11	41	(30)
45	10	22	(12)	27	45	(18)	17	41	(24)
75	24	20	4	39	38	1	17	20	(3)
105	37	42	(5)	0	0	0	21	24	(3)
135	-	-	-	-	-	-	9	2	7
155	-	-	-	-	-	-	12	1	11
TOTAL	**82**	**120**	**38**	**66**	**93**	**(27)**	**87**	**129**	**(42)**
STRATTON:									
15	0	19	(19)	0	4	(4)	3	0	3
45	0	0	0	0	0	0	0	0	0
75	0	2	(2)	0	0	0	0	0	0
105	0	5	(5)	0	0	0	0	0	0
135	0	7	(7)	0	4	(4)	14	0	14
155	0	13	(13)	7	19	(12)	0	0	0
TOTAL	**0**	**46**	**(46)**	**7**	**27**	**(20)**	**17**	**0**	**17**
WALSH:									
15	0	0	0	0	0	0	0	0	0
45	4	0	4	26	0	26	28	5	23
75	3	0	3	22	7	15	36	0	36
105	5	0	5	3	26	5	34	0	34
135	6	3	3	24	35	(11)	40	0	40
155	16	29	(13)	26	65	(39)	27	0	27
TOTAL	**34**	**32**	**2**	**129**	**133**	**(4)**	**165**	**5**	**160**

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 20. Available soil water by soil depth of the CORN phase in the WCM rotation at Sterling and Stratton, and the WCM rotation at Walsh in 2008.

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	20	8	0	0	0	0	0	0
45	8	0	8	0	0	0	0	0	0
75	13	0	13	0	1	(1)	0	0	0
105	13	0	13	0	0	0	0	0	0
135	-	-	-	-	-	-	0	0	0
155	-	-	-	-	-	-	0	0	0
TOTAL	**62**	**20**	**42**	**0**	**1**	**(1)**	**0**	**0**	**0**
STRATTON:									
15	16	12	4	0	8	(8)	38	38	0
45	1	13	(12)	0	10	(10)	41	57	(16)
75	0	11	(11)	0	5	(5)	20	51	(31)
105	1	13	(12)	0	3	(3)	6	41	(35)
135	6	16	(10)	0	10	(10)	15	54	(39)
155	2	15	(13)	0	13	(13)	9	53	(44)
TOTAL	**26**	**80**	**(58)**	**0**	**49**	**(49)**	**129**	**294**	**(165)**
WALSH:									
15	0			0			5		
45	0			0			14		
75	7	No		103	No		27	No	
105	14	Data		23	Data		4	Data	
135	15			0			5		
155	148			9			0		
TOTAL	**185**			**135**			**55**		

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 21. Available soil water by soil depth of the CORN phase in the WCF rotation at Sterling and Stratton, and the Sorghum phase of the WSF rotation at Walsh in 2008.

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	34	0	34	28	0	28	47	0	47
45	26	0	26	43	0	43	33	0	33
75	17	0	17	4	0	17	25	0	25
105	18	0	18	0	0	18	22	0	22
135	-	-	-	-	-	-	4	0	4
155	-	-	-	-	-	-	0	0	0
TOTAL	**95**	**0**	**95**	**75**	**75**	**95**	**131**	**0**	**131**
STRATTON:									
15	5	0	5	0	0	0	45	51	(6)
45	6	17	(11)	7	18	(11)	49	58	(9)
75	1	7	(6)	1	25	(24)	32	62	(30)
105	1	10	(9)	0	14	(14)	17	60	(43)
135	0	13	(13)	0	18	(18)	17	52	(35)
155	0	13	(13)	0	16	(16)	9	58	(49)
TOTAL	**13**	**60**	**(47)**	**8**	**91**	**(83)**	**169**	**341**	**(172)**
WALSH:									
15	0	2	(2)	0	18	(18)	0	2	(2)
45	5	0	5	23	9	9	8	0	8
75	0	6	(6)	4	16	16	2	27	(25)
105	0	13	(13)	0	0	0	0	15	(15)
135	5	16	(11)	0	0	0	0	14	(14)
155	5	0	5	0	0	0	35	11	24
TOTAL	**15**	**37**	**(22)**	**27**	**43**	**(16)**	**45**	**69**	**(24)**

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 22. Available soil water by soil depth of the CORN phase in the WWCM rotation at Sterling and Stratton, and the Sorghum phase of the WWSM rotation at Walsh in 2008.

	SLOPE POSITION								
SITE & DEPTH (cm)	SUMMIT			SIDESLOPE			TOESLOPE		
	Planting	Harvest	Change	Planting	Harvest	Change	Planting	Harvest	Change
	-------------mm/30cm-------------			-------------mm/30cm-------------			------------mm/30cm-------------		
STERLING:									
15	31	9	22	16	0	16	53	0	53
45	25	1	24	51	0	51	51	0	51
75	22	3	19	26	6	20	28	0	28
105	25	12	13	1	3	(2)	27	0	27
135	-	-	-	-	-	-	16	0	16
155	-	-	-	-	-	-	11	0	11
TOTAL	**103**	**25**	**78**	**94**	**9**	**85**	**186**	**0**	**186**
STRATTON:									
15	11	8	3	0	0	0	19	21	(2)
45	7	15	(8)	0	11	(11)	13	67	(54)
75	3	12	(9)	0	2	(2)	0	41	(41)
105	2	13	(11)	0	2	(2)	0	39	(39)
135	3	12	(9)	0	14	(14)	9	46	(37)
155	0	12	(12)	0	16	(16)	0	39	(39)
TOTAL	**26**	**72**	**(46)**	**0**	**45**	**(45)**	**41**	**253**	**(212)**
WALSH:									
15	0	0	0	0	0	0	0	0	0
45	0	1	(1)	13	16	(3)	7	8	(1)
75	0	0	0	7	10	(3)	1	10	(9)
105	0	1	(1)	13	8	5	0	0	0
135	15	0	15	19	0	19	1	0	1
155	18	0	18	52	6	46	12	43	(31)
TOTAL	**33**	**2**	**31**	**104**	**40**	**64**	**21**	**61**	**(40)**

1. To convert from millimeters of $H_2$0/30 centimeters of soil to inches of $H_2$0/foot of soil multiply by 0.04.
2. ( ) Indicates a positive change in available soil water.

Table 23. Available soil water by soil depth of the MILLET phase in the WCM rotation at Sterling, Stratton, and Walsh in 2008.

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	15	0	15	32	0	32	30	0	30
45	1	0	1	12	0	12	21	0	21
75	0	21	(21)	0	0	0	15	0	15
105	17	0	17	0	28	(28)	4	0	4
135	-	-	-	-	-	-	0	0	0
155	-	-	-	-	-	-	83	0	0
TOTAL	**34**	**21**	**13**	**44**	**28**	**16**	**153**	**0**	**153**
STRATTON:									
15	19	7	12	0	0	0	411	42	369
45	6	10	(4)	13	19	(6)	57	66	(9)
75	5	8	(3)	0	16	(16)	34	64	(30)
105	10	7	3	0	1	(1)	58	74	(16)
135	19	9	10	197	0	197	56	70	14
155	22	11	11	0	0	0	54	71	17
TOTAL	**81**	**52**	**29**	**210**	**36**	**174**	**672**	**387**	**285**
WALSH:									
15	0	0	0	3	6	(3)	0	3	(3)
45	0	4	(4)	15	21	(6)	0	35	(35)
75	0	1	(1)	7	10	(3)	0	33	(33)
105	0	0	0	26	8	18	0	12	(12)
135	17	3	14	42	9	33	0	20	(20)
155	0	15	(15)	17	27	(10)	0	26	(26)
TOTAL	**17**	**23**	**(6)**	**110**	**81**	**29**	**0**	**129**	**(129)**

1. To convert from millimeters of $H_2$0/30 centimeters of soil to inches of $H_2$0/foot of soil multiply by 0.04.
2. ( ) Indicates a positive change in available soil water.

Table 24. Available soil water by soil depth of the MILLET phase in the WWCM rotation at Sterling, Stratton, and Walsh in 2008.

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	15	13	2	20	0	20	35	0	35
45	4	13	(9)	0	0	0	17	0	17
75	22	20	2	0	0	0	18	0	18
105	31	27	4	0	0	0	19	0	19
135	-	-	-	-	-	-	17	0	17
155	-	-	-	-	-	-	26	0	26
TOTAL	**72**	**73**	**(1)**	**20**	**0**	**20**	**132**	**0**	**132**
STRATTON:									
15	26	13	13	31	10	21	32	32	0
45	3	12	(9)	9	5	4	50	70	(20)
75	0	10	(10)	0	0	0	2	50	(48)
105	5	10	(5)	0	7	(7)	1	47	(46)
135	0	7	(7)	5	14	(9)	34	49	(15)
155	0	2	(2)	0	12	(12)	31	39	(8)
TOTAL	**34**	**54**	**(20)**	**45**	**48**	**(3)**	**150**	**287**	**(137)**
WALSH:									
15	0	0	0	0	13	(13)	0	0	0
45	0	5	(5)	10	16	(6)	15	21	(6)
75	0	5	(5)	11	1	10	2	5	(3)
105	0	7	(7)	17	0	17	0	0	0
135	0	0	0	22	0	22	0	0	0
155	0	0	0	14	3	11	0	6	(6)
TOTAL	**0**	**17**	**(17)**	**74**	**33**	**41**	**17**	**32**	**(15)**

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 25. Available soil water by soil depth of the MILLET phase in the OPP rotation at Sterling, Stratton, and Walsh in 2008.

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	13	27	38	0	38	38	0	38
45	23	0	23	51	3	48	44	0	44
75	24	13	11	46	20	26	31	0	31
105	28	4	24	33	11	22	16	0	16
135	-	-	-	-	-	-	0	0	0
155	-	-	-	-	-	-	8	0	8
TOTAL	**115**	**30**	**85**	**168**	**34**	**134**	**137**	**0**	**137**
STRATTON:									
15	36	0	36	20	8	12	62	24	38
45	36	12	24	25	18	7	65	51	14
75	18	0	18	9	17	(8)	65	79	(14)
105	10	0	10	0	31	(31)	15	67	(52)
135	11	0	11	0	28	(28)	10	46	(36)
155	14	0	14	2	17	(15)	24	45	(21)
TOTAL	**125**	**12**	**113**	**56**	**119**	**(63)**	**241**	**312**	**(71)**
WALSH:									
15	0	0	0	14	0	14	0	0	0
45	0	2	(2)	11	24	(13)	18	10	8
75	0	7	(7)	12	10	2	0	13	(13)
105	9	17	(8)	16	2	14	4	19	(15)
135	18	4	14	53	0	53	0	2	(2)
155	25	0	25	54	2	52	0	9	(9)
TOTAL	**52**	**30**	**22**	**160**	**38**	**122**	**22**	**53**	**(31)**

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 26. Nitrate-N content of the soil profile at Planting for each crop during 2007-2008 crop year.

	SLOPE POSITION											
Site & Rotation	SUMMIT				SIDESLOPE				TOESLOPE			
	Crop and Time				Crop and Time				Crop and Time			
	Wheat Fall 2007	Corn S 2008	Millet S 2008		Wheat Fall 2007	Corn S 2008	Millet S 2008		Wheat S 2007	Corn S 2008	Millet S 2008	
	------------kg NO3-N ha $^{-1}$------------				----------kg NO3-N ha $^{-1}$------------				-------------kg NO3-N ha $^{-1}$-----------			
STERLING												
WCF	197	140			110	68			62	37		
WCM		143	28			130	39			152	28	
WWCM		243	114			135	46			266	50	
W(W)CM	74				60				120			
STRATTON												
WCF	82	48			66	96			100	61		
WCM		96	211			63	81			84	48	
WWCM		120	103			113	223			148	91	
W(W)CM	14				15				22			
WALSH												
WSF	40				32				66			
WCM	34				46				41			
(W)WSB	36				62				52			
W(W)SB	30				24				32			

Table 27. Nitrogen fertilizer application (lb/A) by soil and crop for 2009.

					ROTATION		
SITE	**SOIL**	**CROP**	**W'WCM**	**WW'CM**	**WCM**	**WCF**	**OPP**
Sterling	Summit	Wheat	54 lb.	54 lb.	54 lb.	54 lb.	
	Sideslope	"	54 lb.	54 lb.	54 lb.	54 lb.	
	Toeslope	"	54 lb.	54 lb.	54 lb.	54 lb.	
	Summit	Corn	75 lb.	75 lb.	75 lb.	75 lb.	75 lb.
	Sideslope	"	75 lb.	75 lb.	75 lb.	75 lb.	75 lb.
	Toeslope	"	75 lb.	75 lb.	75 lb.	75 lb.	75lb.
	Summit	Millet	42 lb.	42 lb.	42 lb.	-	-
	Sideslope	"	42 lb.	42 lb.	42 lb.	-	-
	Toeslope	"	42 lb.	42 lb.	42 lb.	-	-
			W'WCM	WW'CM	WCM	WCF	OPP
Stratton	Summit	Wheat	54 lb.	54 lb.	54 lb.	54 lb.	
	Sideslope	"	54 lb.	54 lb.	54 lb.	54 lb.	
	Toeslope	"	54 lb.	54 lb.	54 lb.	54 lb.	
	Summit	Corn	75 lb.	75 lb.	75 lb.	75 lb.	75 lb.
	Sideslope	"	75 lb.	75 lb.	75 lb.	75 lb.	75 lb.
	Toeslope	"	75 lb.	75 lb.	75 lb.	75 lb.	75lb.
	Summit	Millet					
	Sideslope	"					
	Toeslope	"					
			W’WSM	WW’SM	WSF	WCM	CONT. CROP
Walsh	Summit	Wheat	35 lb.	50 lb.	35 lb.	50 lb.	-
	Sideslope	"	35 lb.	50 lb.	35 lb.	50 lb.	-
	Toeslope	"	35 lb.	50 lb.	35 lb.	50 lb.	-
	Summit	Sorghum	45 lb.	45 lb.	45 lb.	45 lb.	-
	Sideslope	"	45 lb.	45 lb.	45 lb.	45 lb.	-
	Toeslope	"	45 lb.	45 lb.	45 lb.	45 lb.	-
	Summit	Corn	-	-		60 lb.	60 lb.
	Sideslope	"	-	-	-	60 lb.	60 lb.
	Toeslope	"	-	-	-	60 lb.	60 lb.
	Summit	Millet	45 lb.	45 lb.	-	45 lb.	-
	Sideslope	"	45 lb.	45 lb.	-	45 lb.	-
	Toeslope	"	45 lb.	45 lb.	-	45 lb.	-

Table 28. Crop Variety, seeding rate, and planting date for each site in 2008-2009 season.

Site	Crop	Variety	Seeding Rate	Planting Date	Harvest Date
Sterling	Wheat	Hatcher	60 lb/A	9/23/08	7/20/09
	Corn	DKC52-59	12K seeds/A	5/27/09	11/12/09
	Forage Sorghum	Graze X II	12 lb/A	6/25/09	8/19/09
Stratton	Wheat	Hatcher	60 lb/A	9/24/08	7/21/09
	Corn				11/13/09
	Forage Sorghum	Graze X II	12 lb/A	6/25/09	8/19/09
Walsh	Wheat	Hatcher	50 lb/A	10/06/08	7/07/09
	Corn	Mycogen 2R577	1600 seeds/A	5/12/09	11/02/09
	Grain Sorghum	Pioneer 86G32	40K seeds/A	6/18/09	11/06/09
	Proso Millet	Huntsman	17 lb/A	6/26/09	10/1/09

Table 29. Monthly precipitation for the original sites for the 2008 - 2009 growing season.

	LOCATION					
	STERLING		STRATTON		WALSH	
MONTH	Inches	Inches	Inches	Inches	Inches	Inches
2008	2008	Normals[1]	2008	Normals[1]	2008	Normals[1]
JULY	1.78	3.23	3.81	2.80	1.65	2.62
AUGUST	3.77	1.90	6.93	2.60	7.03	1.96
SEPTEMBER	0.94	1.04	0.36	1.45	0.83	1.74
OCTOBER	1.53	0.76	3.04	0.85	2.75	0.89
NOVEMBER	0.60	0.50	0.28	0.62	0.14	0.53
DECEMBER	0.06	0.40	0.12	0.28	0.13	0.31
SUBTOTAL	8.68	7.83	14.54	8.60	12.53	8.05
2009	2009	Normals[1]	2009	Normals[1]	2009	Normals[1]
JANUARY	0.04	0.33	0.02	0.28	0.02	0.27
FEBRUARY	0.51	0.33	0.48	0.30	0.36	0.28
MARCH	0.46	1.07	0.36	0.76	1.93	0.81
APRIL	2.61	1.60	2.49	1.23	2.57	1.15
MAY	1.91	3.27	1.81	2.70	0.80	2.69
JUNE	5.49	3.00	3.24	2.45	3.71	2.29
SUBTOTAL	11.02	9.60	8.40	7.72	9.39	7.49
2009	2009	Normals[1]	2009	Normals[1]	2009	Normals[1]
JULY	2.06	3.23	4.80	2.80	7.92	2.62
AUGUST	2.11	1.90	3.53	2.60	1.75	1.96
SEPTEMBER	2.67	1.04	1.91	1.45	2.5	1.74
OCTOBER	2.14	0.76	1.64	0.85	6.04	0.89
NOVEMBER	0.17	0.50	0.14	0.62	0.28	0.53
DECEMBER	0.06	0.40	0.02	0.28	0.18	0.31
SUBTOTAL	9.21	7.83	12.04	8.60	18.67	8.05
YEAR TOTAL	20.23	17.43	20.44	16.32	28.06	15.4
18 MONTH TOTAL	28.91	25.26	34.98	24.92	40.59	23.59

[1] Normals = 1961 - 1990 data base

Table 30a. Precipitation by growing season segments for Sterling from 1987-2009.

	GROWING SEASON SEGMENTS			
	WHEAT	WHEAT	CORN	CORN Growing Season
	Vegetative	Reproductive	Preplant	
	Sep - Mar	APRIL-JUNE	JULY-APRIL	MAY-OCT.
Year	Inches	Inches	Inches	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
2000-01	6.8	8.2	11.5	13.8
2001-02	4.2	1.9	8.2	8.1
2002-03	5.2	7.6	12.9	8.4
2003-04	1.3	5.3	6.4	10.1
2004-05	3.5	6.6	10.5	8.5
2005-06	2.7	1.3	5.0	9.3
2006-07	5.4	4.8	12.6	13.2
2007-08	2.7	4.8	8.3	12.0
2008-09	4.1	10.0	12.3	16.4
Long Term Average	**4.6**	**5.6**	**10.9**	**12.6**

Table 30b. Precipitation by growing season segment for Stratton from 1987-2009.

	GROWING SEASON SEGMENTS			
Year	WHEAT Vegetative Sep - Mar Inches	WHEAT Reproductive APRIL-JUNE Inches	CORN Preplant JULY-APRIL Inches	CORN Growing Season MAY-OCT. 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
2000-01	4.7	4.3	9.8	10.6
2001-02	3.8	2.2	9.5	6.9
2002-03	4.1	8.7	8.6	10.9
2003-04	5.1	3.8	9.8	6.3
2004-05	3.5	6.7	7.1	13.9
2005-06	4.3	4.8	9.5	9.7
2006-07	2.4	6.3	8.3	8.4
2007-08	3.7	3.9	6.9	17.2
2008-09	4.6	7.5	17.9	16.9
Long Term Average	**4.4**	**6.0**	**11.5**	**12.9**

Table 30c. Precipitation by growing season segment for Walsh from 1987-2009.

	GROWING SEASON SEGMENTS			
Year	WHEAT Vegetative Sep - Mar Inches	WHEAT Reproductive APRIL-JUNE Inches	CORN Preplant JULY-APRIL Inches	CORN Growing Season MAY-OCT. 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
2000-01	9.0	7.9	13.4	9.6
2001-02	1.7	2.2	2.9	11.8
2002-03	6.7	11.4	15.8	12.5
2003-04	3.2	10.1	8.2	13.5
2004-05	3.0	4.7	8.5	8.3
2005-06	2.6	3.0	5.7	11.7
2006-07	5.1	0.9	12.0	1.8
2007-08	3.2	2.2	6.2	14.0
2008-09				

Table 31. Grain and straw yields for WHEAT in 2009.

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	28	36	2525	3045	25	33	2205	3160	45	50	4600	8525
WCM	25	22	2370	2050	21	21	1900	1905	25	30	2440	2910
W1WCM	26	22	2060	2015	24	30	2235	2725	30	30	3570	5945
WW2CM	26	18	3240	1160	26	34	2425	3170	25	30	2065	2505
	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	46	42	4600	4645	46	47	5390	5360	46	51	4890	5535
WCM	28	39	3085	3340	39	48	3570	3905	55	52	7330	6795
W1WCM	33	51	5275	5660	42	50	10910	5990	56	64	6775	7550
WW2CM	34	40	5130	3740	52	49	11000	5180	51	53	8850	6500
	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	34	33	2360	2510	33	30	2225	2205	31	29	2875	4220
WCM	39	32	2675	3270	42	25	1840	2960	36	34	5360	3693
W1WCM	35	33	2430	2465	31	29	2295	2790	33	34	4115	3920
WW2CM	34	38	2730	3070	31	37	2240	3220	34	37	5340	3775

1. Wheat grain yield expressed at 12% moisture.

* Only receives phosphorus in wheat phase of each rotation.

Table 32. Grain and stover yields for CORN AND SORGHUM in 2009.

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	50	64	1355	1290	65	95	2420	2760	109	106	3175	2445
WCM	44	40	1825	3360	71	60	2230	1370	92	94	1730	2320
WWCM	48	52	1700	1850	84	92	1885	2070	108	104	3485	3140
OPP	36	48	1390	1590	61	63	2285	2475	81	88	4010	2905
	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	30	14	1055	525	61	49	1975	1595	46	35	1955	1220
WCM	50	59	2270	1905	37	55	1145	1445	74	96	2470	3305
WWCM	5	5	210	295	72	43	2200	1365	34	38	1555	2715
OPP	11	20	400	645	42	60	1700	2220	23	12	665	840
	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	32	25	1300	1490	36	31	1470	1485	61	56	3240	2645
WCM	38	49	985	2140	40	55	965	1540	40	41	1535	1770
WWSM	48	44	2035	2260	51	55	2580	2185	76	78	3120	3015
OPP	18	32	1175	1250	22	18	2240	595	44	45	2515	935
CC Corn	30	36	660	805	31	29	1235	720	57	44	2440	1425
CC SOR	47	42	1815	1745	50	56	2360	2385	69	69	3245	3345

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

* Only receives phosphorus in wheat phase of each rotation.

Table 33. Grain and stover yields for MILLET in 2009 (Forage Sorghum in place of Millet in Sterling and Stratton (Fs)).

	SLOPE POSITION											
	SUMMIT				SIDESLOPE				TOESLOPE			
SITE & ROTATION	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. ------	
WCM(Fs)			2165	1515			2620	2760			2195	2970
WWCM (Fs)			2400	2360			2490	2490			2960	3020
	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. ------	
WCM (Fs)			3950	3160			2620	3680			4815	5720
WWCM (Fs)			3550	2570			3540	1955			5375	4895
	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. ------	
WCB	14	15	240	210	18	22	345	340	22	26	400	430
WWCM	8	11	120	160	14	15	235	190	20	24	340	390

1. Millet grain yield expressed at 10% moisture.

* Only receives phosphorus in wheat phase of each rotation.

Table 34a. Total Nitrogen content of WHEAT GRAIN in the 2009 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	2.68	2.55	2.38	2.34	2.32	2.29
WCM	2.75	2.78	2.51	2.48	2.61	2.49
WWCM	2.99	2.91	2.36	2.57	2.75	2.62
W(W)CM	2.87	2.75	2.50	2.48	2.76	2.77
	N	NP	N	NP	N	NP
STRATTON:	-------------- % -------------		-------------- % -------------		-------------- % -------------	
WCF	2.49	2.59	2.38	2.60	2.54	2.34
WCM	2.80	2.68	2.46	2.54	2.56	2.53
WWCM	2.63	2.86	2.58	2.93	2.54	2.60
W(W)CM	2.69	2.53	2.47	2.37	2.40	2.37
	N	NP	N	NP	N	NP
WALSH:						
	-------------- % -------------		-------------- % -----------		-------------- % -------------	
WSF	2.18	2.44	2.15	2.28	2.29	2.34
WCM	2.54	2.39	2.47	2.43	2.39	2.53
WWCM	2.23	2.21	2.13	2.24	2.33	2.23
W(W)CM	2.21	2.06	1.99	2.18	2.10	2.17

* Only receives phosphorus in wheat phase of each rotation.

Table 34b. Total Nitrogen content of WHEAT STRAW in the 2009 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	0.99	0.82	0.70	0.63	0.78	0.64
WCM	0.92	0.87	0.88	0.92	0.94	0.98
WWCM	0.80	0.74	0.82	0.83	1.36	1.53
W(W)CM	1.01	0.85	0.94	1.11	0.91	1.01
	N	NP	N	NP	N	NP
STRATTON:	-------------- %	-------------	-------------- %	-------------	-------------- %	-------------
WCF	0.87	0.91	0.80	0.64	0.62	0.58
WCM	1.03	0.94	0.84	0.75	0.66	0.66
WWCM	1.23	1.21	1.26	0.85	0.71	0.73
W(W)CM	1.09	1.05	0.85	0.81	0.93	0.70
	N	NP	N	NP	N	NP
WALSH:	-------------- %	-------------	-------------- %	-----------	-------------- %	-------------
WSF	0.52	0.50	0.42	0.60	0.72	0.90
WCM	0.60	0.52	0.66	0.68	0.71	0.78
WWSM	0.49	0.52	0.59	0.80	0.80	0.80
W(W)SM	0.66	0.57	0.50	0.55	0.99	0.58

** Only receives phosphorus in wheat phase of each rotation.*

Table 35a. Total Nitrogen content of CORN GRAIN in the 2009 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	1.65	1.76	1.46	1.53	1.68	1.67
WCM	1.78	1.61	1.71	1.58	1.63	1.83
WWCM	1.69	1.66	1.66	1.53	1.75	1.64
W(W)CM OPP	1.75	1.76	1.53	1.73	1.78	1.73
	N	NP	N	NP	N	NP
STRATTON:	-------------- % -------------		-------------- % -------------		-------------- % -------------	
WCF	1.61	1.55	1.47	1.48	1.53	1.58
WCM	1.49	1.46	1.45	1.42	1.50	1.48
WWCM	1.54	1.56	1.45	1.45	1.50	1.55
W(W)CM OPP	1.55	1.65	1.47	1.42	1.55	1.53
	N	NP	N	NP	N	NP
WALSH:						
	-------------- % -------------		-------------- % -----------		-------------- % -------------	
WSF	1.84	1.96	1.75	1.89	1.76	1.80
WCM	1.68	1.83	1.70	1.64	1.98	1.72
WWSM	2.00	1.98	1.78	1.94	1.84	1.85
CC	2.07	2.05	2.13	2.06	1.92	1.92
CORN OPP	1.67	1.64	1.71	1.77	1.77	1.76
CC CORN	1.70	1.60	1.71	1.73	1.77	1.75

* Only receives phosphorus in wheat phase of each rotation.

Table 35b. Total Nitrogen content of CORN STOVER in the 2009 crop.

	SLOPE POSITION					
	SUMMIT		SIDESLOPE		TOESLOPE	
SITE & ROTATION	N Side*	NP Side	N Side*	NP Side	N Side*	NP Side
	N	NP	N	NP	N	NP
STERLING:	-------------- % -------------		-------------- % -------------		-------------- % -------------	
WCF	0.81	0.84	0.71	0.68	0.69	0.76
WCM	1.25	1.33	0.74	0.77	0.76	0.77
WWCM	0.80	0.79	0.73	0.79	0.94	0.89
OPP	0.96	0.98	0.88	0.80	1.03	0.86
	N	NP	N	NP	N	NP
STRATTON:	-------------- % -------------		-------------- % -------------		-------------- % -------------	
WCF	0.77	0.77	0.72	0.75	0.80	0.87
WCM	0.82	0.79	0.81	0.69	0.74	0.78
WWCM	0.78	0.84	0.64	0.62	0.87	0.99
OPP	0.79	0.88	0.66	0.65	0.82	0.83
	N	NP	N	NP	N	NP
WALSH:						
	-------------- % -------------		-------------- % -----------		-------------- % -------------	
WSF	0.96	0.85	0.65	0.81	0.64	0.63
WCM	0.94	0.92	0.85	0.86	1.15	1.04
WWSM	0.91	0.88	0.95	0.98	0.73	0.82
CC SORG	1.06	0.84	1.03	0.93	1.13	0.97
CC CORN	0.92	0.94	1.09	0.91	1.10	0.69
OPP	0.94	1.06	1.34	1.06	1.02	0.81

** Only receives phosphorus in wheat phase of each rotation.*

Table 36a. Total Nitrogen content of MILLET GRAIN in the 2009 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:	-------------- % -------------		-------------- % -------------		-------------- % -------------	
	No data					
WCM						
WWCM						
	N	NP	N	NP	N	NP
STRATTON:	-------------- % -------------		-------------- % -------------		-------------- % -------------	
WCM	No data					
WWCM						
	N	NP	N	NP	N	NP
WALSH:						
	-------------- % -------------		-------------- % -----------		-------------- % -------------	
WCM	1.88	1.79	1.95	1.82	2.13	2.07
WWSM	1.71	1.80	1.80	1.85	2.08	1.99

** Only receives phosphorus in wheat phase of each rotation.*

Table 36b. Total Nitrogen content of MILLET STRAW in the 2009 crop (Forage Sorghum in place of millet at Sterling and Stratton).

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:	%		%		%	
WCM	2.05	2.35	2.31	2.17	2.47	2.26
WWCM	2.37	2.24	2.11	2.18	2.23	2.07
	N	NP	N	NP	N	NP
STRATTON:	%		%		%	
WCM	1.91	2.04	2.05	1.69	1.69	2.03
WWCM	2.29	2.15	1.85	1.93	1.78	2.05
	N	NP	N	NP	N	NP
WALSH:	%		%		%	
WCM	0.55	0.66	0.51	0.48	1.06	0.90
WWSM	0.47	0.49	0.58	0.61	0.81	0.64

** Only receives phosphorus in wheat phase of each rotation.*

Table 37. Nitrate-N content of the soil profile at Planting for each crop during 2008-2009 crop year.

Site & Rotation	SUMMIT				SIDESLOPE				TOESLOPE			
	Crop and Time				Crop and Time				Crop and Time			
	Wheat Fall 2008	Corn S 2009	Millet S 2009		Wheat Fall 2008	Corn S 2009	Millet S 2009		Wheat S 2008	Corn S 2009	Millet S 2009	
	------------kg NO_3-N ha $^{-1}$------------				----------kg NO_3-N ha $^{-1}$------------				-------------kg NO_3-N ha $^{-1}$-----------			
STERLING												
WCF	21	116			23	99			22	64		
WCM	57	209	64		36	119	51		41	179	102	
W(W)CM	121	166	68		38	116	77		57	165	131	
OPP-C		205				47				161		
STRATTON												
WCF	130	50			138	50			107	63		
WCM	169	67	62		147	62	69		116	106	59	
W(W)CM	158	67	115		135	58	188		101	60	27	
OPP-C		49				37				75		
WALSH												
WSF	34	19			48	26			64	51		
WCM	42	21	22		37	43	22		34	73	62	
(W)WSB	40	41	9		26	39	15		46	60	13	
OPP-C		17				24				30		

Table 38. Available soil water by soil depth of the WHEAT phase in the WCF rotation at Sterling and Stratton, and the WSF rotation at Walsh in 2009.

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	30	14	16	6	15	(9)	21	25	(4)
45	44	4	40	33	36	(3)	49	31	18
75	40	12	28	22	24	(2)	35	24	11
105	32	21	11	63	44	19	28	32	(4)
135	-	-	-	-	-	-	9	18	(9)
155	-	-	-	-	-	-	0	10	(10)
TOTAL	**146**	**51**	**95**	**124**	**119**	**5**	**142**	**139**	**3**
STRATTON:									
15	18	22	(4)	21	0	21	49	49	0
45	34	10	24	31	0	31	75	24	51
75	31	8	23	26	0	26	68	14	54
105	27	12	15	14	0	14	74	39	35
135	30	20	10	11	0	11	74	30	44
155	21	20	1	5	0	5	76	44	32
TOTAL	**161**	**92**	**69**	**103**	**0**	**103**	**419**	**201**	**216**
WALSH:									
15	0	0	0	0	0	0	0	0	0
45	4	0	4	18	0	18	0	0	0
75	5	0	5	20	0	20	31	0	31
105	15	0	15	25	0	25	12	0	12
135	0	0	0	20	0	20	11	0	11
155	0	0	0	29	0	29	34	18	34
TOTAL	**24**	**0**	**24**	**112**	**0**	**112**	**88**	**18**	**70**

1. *To convert from millimeters of* $H_2$0/30 centimeters of soil to inches of $H_2$0/foot *of soil multiply by 0.04.*
2. *( ) Indicates a positive change in available soil water.*

Table 39. Available soil water by soil depth of the WHEAT phase in the WCM rotation at Sterling and Stratton, and the WSbM (Soybean) rotation at Walsh in 2009.

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	0	5	(5)	0	0	0	0	10	(10)
45	0	2	(2)	0	28	(28)	0	14	(14)
75	21	4	14	0	15	(15)	0	17	(17)
105	0	27	(27)	28	28	(28)	0	16	(16)
135	-	-	-	-	-	-	0	1	(1)
155	-	-	-	-	-	-	0	2	(2)
TOTAL	**21**	**38**	**(17)**	**28**	**71**	**(43)**	**0**	**60**	**(60)**
STRATTON:									
15	0	19	(19)	0	0	0	42	39	3
45	0	7	(7)	19	0	19	66	40	26
75	0	5	(5)	6	0	6	64	5	59
105	0	7	(7)	0	0	0	74	36	38
135	0	15	(15)	0	0	0	70	66	4
155	3	14	(11)	0	0	0	71	66	5
TOTAL	**3**	**68**	**(65)**	**25**	**0**	**25**	**387**	**252**	**135**
WALSH:									
15	0	0	0	6	0	6	3	0	3
45	4	0	4	21	0	21	35	0	35
75	1	0	1	10	0	10	33	0	33
105	0	0	0	8	0	8	12	0	12
135	3	0	3	9	0	9	20	0	20
155	15	0	15	27	0	27	26	0	26
TOTAL	**23**	**0**	**23**	**81**	**0**	**81**	**129**	**0**	**129**

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 40. Available soil water by soil depth of the WHEAT 1 phase in the WWCM rotation at Sterling and Stratton, and the WWSM rotation at Walsh in 2009.

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	13	15	(2)	0	10	(10)	0	32	(32)
45	13	4	9	0	15	(15)	0	24	(24)
75	20	6	14	0	17	(17)	0	20	(20)
105	27	27	0	0	38	(38)	0	21	(21)
135	-	-	-	-	-	-	0	16	(16)
155	-	-	-	-	-	-	0	8	(8)
TOTAL	**73**	**52**	**21**	**0**	**80**	**(80)**	**0**	**121**	**(121)**
STRATTON:									
15	13	24	(11)	10	No		32	12	20
45	4	5	(1)	5			70	24	46
75	0	3	(3)	0	Data		50	0	50
105	0	4	(4)	0			47	5	42
135	0	9	(9)	0			49	30	19
155	0	11	(11)	0			39	42	(3)
TOTAL	**17**	**57**	**(40)**	**15**			**287**	**113**	**174**
WALSH:									
15	0	0	0	13	0	13	0	0	0
45	5	0	5	16	0	16	21	0	21
75	5	0	5	1	0	1	5	0	5
105	7	0	7	0	0	0	0	0	0
135	0	0	0	0	0	0	0	0	0
155	0	0	0	3	0	3	6	0	6
TOTAL	**17**	**0**	**17**	**33**	**0**	**33**	**32**	**0**	**32**

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 41. Available soil water by soil depth of the WHEAT 2 phase in the WWCM rotation at Sterling and Stratton, and WWSM in the rotation at Walsh in 2009.

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	0	13	(13)	0	23	(23)	0	25	(25)
45	0	22	(22)	0	43	(43)	0	16	(16)
75	0	10	(10)	0	32	(32)	0	16	(16)
105	0	3	(3)	6	12	(12)	0	20	(20)
135	-	-	-	-	-	-	0	2	(2)
155	-	-	-	-	-	-	0	1	(1)
TOTAL	**0**	**48**	**(48)**	**6**	**110**	**(104)**	**0**	**80**	**(80)**
STRATTON:									
15	26	26	0	0	0	0	39	26	13
45	20	14	6	32	0	32	75	15	60
75	22	9	13	23	0	23	77	22	55
105	7	12	(5)	36	0	36	64	7	57
135	8	19	(11)	29	0	29	41	4	37
155	12	20	(8)	23	9	14	43	17	26
TOTAL	**95**	**100**	**(5)**	**143**	**9**	**134**	**339**	**91**	**248**
WALSH:									
15	0	0	0	0	0	0	0	0	0
45	4	0	4	26	0	26	28	0	28
75	3	0	3	22	0	22	36	0	36
105	5	0	5	31	0	31	34	0	34
135	6	0	6	24	0	24	40	0	40
155	16	0	16	26	0	26	27	0	27
TOTAL	**34**	**0**	**34**	**129**	**0**	**129**	**165**	**0**	**165**

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 42. Available soil water by soil depth of the CORN phase in the WCM rotation at Sterling and Stratton, and Sorghum in the WSM rotation at Walsh in 2009.

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	22			21			51		
45	32	No		30	No		49	No	
75	11	Data		15	Data		51	Data	
105	27			0			37		
135	-	-	-	-	-	-	5		
155	-	-	-	-	-	-	9		
TOTAL	**92**			**66**			**202**		
STRATTON:									
15	20			41			57		
45	53			34			64		
75	48	No		29	No		66	No	
105	48	Data		29	Data		49	Data	
135	46			59			60		
155	50			20			50		
TOTAL	**265**			**212**			**346**		
WALSH:									
15	22	20	2	33	27	6	39	31	8
45	24	13	11	39	28	11	44	37	7
75	30	25	5	23	9	14	55	56	(1)
105	28	27	1	14	0	14	44	28	16
135	22	10	12	10	5	5	58	50	8
155	7	7	0	22	30	(8)	68	70	(2)
TOTAL	**133**	**102**	**31**	**141**	**99**	**42**	**308**	**272**	**36**

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 43. Available soil water by soil depth of the CORN phase in the WCF rotation at Sterling and Stratton, and the Sorghum in the WCF rotation at Walsh in 2009.

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	41			30			48		
45	41	No		65	No		54	No	
75	27	Data		56	Data		47	Data	
105	35			32			33		
135	-	-	-	-	-	-	16		
155	-	-	-	-	-	-	14		
TOTAL	**144**			**183**			**212**		
STRATTON:									
15	29			46			37		
45	48			67			78		
75	46	No		48	No		58	No	
105	46	Data		46	Data		68	Data	
135	44			59			66		
155	47			57			39		
TOTAL	**260**			**323**			**346**		
WALSH:									
15	0	0	0	0	3	(3)	0	8	(8)
45	10	10	0	24	33	(9)	40	40	0
75	10	8	2	26	24	2	42	14	28
105	10	6	4	31	7	24	34	13	21
135	11	10	1	22	4	18	48	27	21
155	4	0	4	47	0	47	68	57	11
TOTAL	**45**	**35**	**11**	**150**	**71**	**79**	**231**	**159**	**72**

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 44. Available soil water by soil depth of the CORN phase in the WWCM rotation at Sterling and Stratton, and SORGHUM in the WWSM rotation at Walsh in 2009.

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	43			24			49		
45	40	No		65	No		29	No	
75	41	Data		72	Data		60	Data	
105	54			46			63		
135	-	-	-	-	-	-	18		
155	-	-	-	-	-	-	10		
TOTAL	**178**			**207**			**229**		
STRATTON:									
15	36			37			46		
45	50			52			70		
75	44			59			53		
105	45	No		57	No		52	No	
135	41	Data		53	Data		69	Data	
155	46			2			64		
TOTAL	**262**			**260**			**354**		
WALSH:									
15	0	8	(8)	9	16	(7)	0	15	(15)
45	7	7	0	26	19	7	44	27	17
75	7	6	1	25	12	13	34	3	31
105	13	2	11	29	12	17	30	5	25
135	12	0	12	18	18	0	22	8	14
155	13	0	13	41	12	29	24	1	23
TOTAL	**52**	**24**	**28**	**148**	**88**	**60**	**154**	**59**	**95**

1. *To convert from millimeters of* $H_2$0/30 centimeters of soil to inches of $H_2$0/foot *of soil multiply by 0.04.*
2. *( ) Indicates a positive change in available soil water.*

Table 45. Available soil water by soil depth of the CORN and Sorghum in the CC rotation at Walsh in 2009 Crop Year.

SITE & DEPTH (cm)	SLOPE POSITION								
	SUMMIT			SIDESLOPE			TOESLOPE		
	Planting	Harvest	Change	Planting	Harvest	Change	Planting	Harvest	Change
	-------------mm/30cm-------------			-------------mm/30cm-------------			------------mm/30cm-------------		
Walsh: Corn									
15	16	5	11	5	9	(4)	17	6	11
45	19	15	4	22	26	(4)	44	24	20
75	11	14	(3)	25	17	8	16	25	(9)
105	16	26	(10)	26	12	14	10	19	(9)
135	5	12	(7)	18	5	13	21	24	(3)
155	0	2	(2)	25	12	13	0	0	0
TOTAL	**67**	**74**	**(7)**	**121**	**81**	**40**	**108**	**98**	10
Walsh: Sorghum									
15	0	1	(1)	0	16	(16)	0	0	0
45	7	9	(2)	22	26	(4)	0	31	(31)
75	11	7	4	20	6	14	17	6	11
105	19	18	1	17	4	13	15	2	13
135	0	7	(7)	9	4	5	7	18	(11)
155	0	0		0	2	(2)	48	23	25
TOTAL	**37**	**42**	**(5)**	**68**	**58**	**10**	**87**	**80**	**7**

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 46. Available soil water by soil depth of the MILLET phase in the WCM rotation at Sterling and Stratton, and at Walsh in 2009.

SITE & DEPTH (cm)	SUMMIT			SIDESLOPE			TOESLOPE		
	Planting	Harvest	Change	Planting	Harvest	Change	Planting	Harvest	Change
	-------------mm/30cm-------------			-------------mm/30cm-------------			------------mm/30cm-------------		
STERLING:									
15	21	16	5	0	0	0	30		
45	31	3	28	39	1	38	45		
75	20	2	18	34	12	22	42	No	
105	17	16	1	29	17	12	45	Data	
135	-	-	-	-	-	-	1		
155	-	-	-	-	-	-	0		
TOTAL	**89**	**37**	**52**	**102**	**30**	**72**	**163**		
STRATTON:									
15	42	25	17	49	45	4	84	53	31
45	48	32	16	49	31	18	94	50	44
75	45	36	9	51	14	37	76	44	32
105	44	43	1	53	4	49	62	37	25
135	43	52	(9)	49	9	40	74	36	38
155	37	50	(13)	50	17	33	64	32	32
TOTAL	**259**	**238**	**21**	**301**	**120**	**181**	**454**	**252**	**202**
WALSH:									
15	0			0			0		
45	5	No		28	No		37	No	
75	6	Data		29	Data		24	Data	
105	15			28			25		
135	10			18			33		
155	10			6			0		
TOTAL	**46**			**110**			**119**		

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 47. Available soil water by soil depth of the MILLET phase in the WWCM rotation at Sterling and Stratton, and at Walsh in 2009.

SITE & DEPTH (cm)	SUMMIT			SIDESLOPE			TOESLOPE		
	Planting	Harvest	Change	Planting	Harvest	Change	Planting	Harvest	Change
	-------------mm/30cm-------------			-------------mm/30cm-------------			------------mm/30cm-------------		
STERLING:									
15	33	1	32	8	0	8	51	20	31
45	40	7	33	52	16	36	50	29	21
75	36	7	29	51	20	31	47	22	25
105	26	22	4	45	24	21	57	45	12
135	-	-	-	-	-	-	44	42	2
155	-	-	-	-	-	-	28	24	4
TOTAL	**135**	**37**	**98**	**156**	**60**	**96**	**277**	**182**	**95**
STRATTON:									
15	37	32	5	4	8	(4)	4	8	(4)
45	51	30	21	48	9	39	48	9	39
75	32	24	8	49	3	46	49	3	46
105	39	24	15	45	7	38	45	7	38
135	32	26	6	40	5	35	40	5	35
155	36	20	16	47	30	17	47	30	17
TOTAL	**227**	**156**	**71**	**233**	**62**	**171**	**233**	**62**	**171**
WALSH:									
15	0			0			0		
45	9			28			37		
75	9	No		22	No		30	No	
105	15	Data		24	Data		0	Data	
135	13			15			0		
155	16			0			44		
TOTAL	**63**			**116**			**111**		

1. *To convert from millimeters of* H_20/30 centimeters of soil to inches of H_20/foot *of soil multiply by 0.04.vailable soil water.*

Table 48. Crop residue weights at wheat planting in fall 2008.

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:	------------- kg/ha -------------		------------ kg/ha ------------		------------- kg/ha------------	
WCF	6755	6160	3405	4630	7690	7530
WCM	2470	1925	4030	3755	4220	3815
WWCM	1820	1525	3890	4750	2700	1025
W(W)CM	1305	1010	1790	1555	1295	2235
	N	**NP**	**N**	**NP**	**N**	**NP**
STRATTON:	------------- kg/ha ------------		------------ kg/ha ------------		------------- kg/ha------------	
WCF	1595	4370	1460	1590	4110	1960
WCM	1580	1880	1945	6670	1760	2525
WWCM	935	715	1065	625	1920	1825
W(W)CM	285	955	895	1565	890	1135
	N	**NP**	**N**	**NP**	**N**	**NP**
WALSH:	------------- kg/ha ------------		------------ kg/ha ------------		------------- kg/ha------------	
WSF	2085	2500	3080	3485	3805	4100
WCM	670	1020	940	1800	2415	2670
WWCM	2530	3040	2590	2800	3185	3870
W(W)CM	630	240	1540	510	1290	1100

- Only receives phosphorus in wheat phase of each rotation.

Table 49. Crop residue weights at Corn and Sorghum planting 2009.

	SLOPE POSITION					
	SUMMIT		SIDESLOPE		TOESLOPE	
SITE & ROTATION	*N Side**	*NP Side*	*N Side**	*NP Side*	*N Side**	*NP Side*
	N	NP	N	NP	N	NP
STERLING:	------------- kg/ha -------------		------------ kg/ha ------------		------------- kg/ha------------	
WCF	2935	2260	3775	4100	3305	1430
WCM	4235	1210	1695	1070	2030	1480
WWCM	350	185	920	875	1585	430
OPP-C	2005	1975	2310	2225	2150	2280
	N	NP	N	NP	N	NP
STRATTON:	------------- kg/ha ------------		------------ kg/ha ------------		------------- kg/ha------------	
WCF	1390	2610	2500	2855	2625	4095
WCM	1650	3420	2980	1380	2515	2780
WWCM	2860	1725	2450	1360	1005	2130
OPP-C	1480	2540	3215	2435	2480	1615
	N	NP	N	NP	N	NP
WALSH:	------------- kg/ha ------------		------------ kg/ha ------------		------------- kg/ha------------	
WSF	590	165	685	510	1285	1550
WCM	1880	770	1880	785	2510	1540
WWSM	2015	2140	1130	4290	2335	2065
OPP-C	800	1095	945	2305	1895	2250
CC-Sorghum	1595	1000	1435	1695	4645	4255
CC-Corn	1715	2830	1670	2810	3105	3410

*Only receives phosphorus in the wheat phase of the rotation.

Table 50. Crop residue weights at Millet planting in 2009.

	SLOPE POSITION					
	SUMMIT		SIDESLOPE		TOESLOPE	
SITE & ROTATION	***N Side****	***NP Side***	***N Side****	***NP Side***	***N Side****	***NP Side***
	N	**NP**	**N**	**NP**	**N**	**NP**
STERLING:	------------- kg/ha -------------		------------ kg/ha ------------		------------- kg/ha------------	
WCM	2950	2265	4865	3725	2400	5550
WWCM	3310	2940	2275	3190	6320	3030
	N	**NP**	**N**	**NP**	**N**	**NP**
STRATTON:	------------- kg/ha ------------		------------ kg/ha ------------		------------- kg/ha------------	
WCM	2130	1170	2560	3000	3080	3690
WWCM	610	1250	3340	2890	1705	690
	N	**NP**	**N**	**NP**	**N**	**NP**
WALSH:	------------- kg/ha ------------		------------ kg/ha ------------		------------- kg/ha------------	
WCM						
WWSM						

APPENDIX A
ANNUAL HERBICIDE PROGRAMS BY SITE

Table 1. Weed control methods including herbicide rate, cost and date applied at STERLING in 2008.

Crop	Herbicide/Tillage	Rate (English)	Rate (Metric)	Cost	Date Applied
		oz/acre	l/ha		
Rotation: Wheat-Corn-Fallow					
Wheat:	Ally Extra	0.4	0.03	$3.75	29-Apr-08
	2,4-D LV6	6.0	0.45	$0.00	29-Apr-08
(Stubble)	Roundup Weather Max	20.0	1.50	$0.00	1-Aug-08
	Brash	20.0	1.50	$0.00	1-Aug-08
	Roundup Weather Max	22.0	1.65	$0.00	4-Sep-08
Corn (RR):	Roundup Weather Max	22.0	1.65	$6.83	12-May-08
	Lumax	40.0	3.00	$16.80	12-May-08
(Post-Emerg)	Roundup Weather Max	22.0	1.65	$6.83	12-Jun-08
	Aim EC	2.0	0.15	$13.36	23-Jun-08
	Aim EC	1.0	0.08	$6.68	8-Jul-08
	Roundup Weather Max	32.0	2.40	$9.92	8-Jul-08
Fallow:	Roundup Weather Max	16.0	1.20	$4.96	12-Jun-08
	Weedmaster	16.0	1.20	$3.68	12-Jun-08
	Roundup Weather Max	20.0	1.50	$6.21	23-Jun-08
	Roundup Weather Max	22.0	1.65	$6.83	1-Aug-08
(Pre-Plant)	Roundup Weather Max	48.0	3.60	$14.88	23-Sep-08
Rotation: Wheat-Corn-Millet					
Wheat:	Ally Extra	0.4	0.03	$3.75	29-Apr-08
	2,4-D LV6	6.0	0.45	$3.75	29-Apr-08
(Stubble)	Roundup Weather Max	20.0	1.50	$6.21	1-Aug-08
	Brash	20.0	1.50	$4.65	1-Aug-08
	Roundup Weather Max	22.0	1.65	$6.83	4-Sep-08
Corn (RR):	Roundup Weather Max	22.0	1.65	$6.83	12-May-08
	Lumax	40.0	3.00	$16.80	12-May-08
(Post-Emerg)	Roundup Weather Max	22.0	1.65	$6.83	12-Jun-08
	Aim EC	2.0	0.15	$13.36	23-Jun-08
	Aim EC	1.0	0.08	$6.68	8-Jul-08
	Roundup Weather Max	32.0	2.40	$9.92	8-Jul-08
Millet: (Pre-Plant)	Roundup Weather Max	16.0	1.2	$4.96	12-May-08
	Brash	16.0	1.2	$3.68	12-May-08
(Post-Emerg)	Aim EC	2.0	0.2	$13.36	23-Jun-08
	Aim EC	1.0	0.1	$6.68	8-Jul-08

(Pre-Plant)	Roundup Weather Max	48.0	3.6	$14.88	23-Sep-08
Rotation: Wheat-Wheat-Corn-Millet					
Wheat:	Ally Extra	0.4	0.03	$3.75	29-Apr-08
	2,4-D LV6	6.0	0.45	$3.75	29-Apr-08
(Stubble)	Roundup Weather Max	20.0	1.50	$6.21	1-Aug-08
	Brash	20.0	1.50	$4.65	1-Aug-08
	Roundup Weather Max	22.0	1.65	$6.83	4-Sep-08
	Roundup Weather Max	48.0	3.60	$14.88	23-Sep-08
Wheat2:	Ally Extra	0.4	0.0	$3.75	29-Apr-08
	2,4-D LV6	6.0	0.5	$3.75	29-Apr-08
(Sprayed Out)	Roundup Weather Max	16.0	1.2	$4.96	12-Jun-08
	Brash	16.0	1.2	$3.68	12-Jun-08
	Roundup Weather Max	20.0	1.5	$6.21	1-Aug-08
	Brash	20.0	1.5	$4.65	1-Aug-08
	Roundup Weather Max	22.0	1.7	$6.83	4-Sep-08
Corn (RR):	Roundup Weather Max	22.0	1.65	$6.83	12-May-08
	Lumax	40.0	3.00	$16.80	12-May-08
(Post-Emerg)	Roundup Weather Max	22.0	1.65	$6.83	12-Jun-08
	Aim EC	2.0	0.15	$13.36	23-Jun-08
	Aim EC	1.0	0.08	$6.68	8-Jul-08
	Roundup Weather Max	32.0	2.40	$9.92	8-Jul-08
Millet: (Pre-Plant)	Roundup Weather Max	16.0	1.2	$4.96	12-May-08
	Brash	16.0	1.2	$3.68	12-May-08
(Post-Emerg)	Aim EC	2.0	0.2	$13.36	23-Jun-08
	Aim EC	1.0	0.1	$6.68	8-Jul-08
(Pre-Plant)	Roundup Weather Max	48.0	3.6	$14.88	23-Sep-08
Rotation: Opportunity					
Millet: (Pre-Plant)	Roundup Weather Max	16.0	1.2	$4.96	12-May-08
	Brash	16.0	1.2	$3.68	12-May-08
(Post-Emerg)	Aim EC	2.0	0.2	$13.36	23-Jun-08
	Aim EC	1.0	0.1	$6.68	8-Jul-08
(Pre-Plant)	Roundup Weather Max	48.0	3.6	$14.88	23-Sep-08

Table 2. Weed control methods including herbicide rate, cost and date applied at Stratton in 2008.

Crop	Herbicide/Tillage	Rate (English)	Rate (Metric)	Cost	Date Applied
		oz/acre	l/ha		
Rotation: Wheat-Corn-Fallow					
Wheat:	Ally Extra	0.4	0.03	$3.75	29-Apr-08
	2,4-D LV6	6.0	0.45	$3.75	29-Apr-08
(Stubble)	Roundup Weather Max	32.0	2.40	$9.92	29-Aug-08
	Brash	16.0	1.20	$3.68	29-Aug-08
Corn (RR):	Roundup Weather Max	22.0	1.65	$6.83	14-May-08
	Lumax	40.0	3.00	$16.80	14-May-08
(Post-Emerg)	Roundup Weather Max	22.0	1.65	$6.83	24-Jun-08
Fallow:	Roundup Weather Max	32.0	2.40	$9.92	3-Jun-08
	Assure II	16.0	1.20	$19.68	3-Jun-08
	Roundup Weather Max	22.0	1.65	$6.82	24-Jun-08
	Roundup Weather Max	32.0	2.40	$9.92	29-Aug-08
	Brash	16.0	1.20	$3.68	29-Aug-08
(Pre-Plant)	Roundup Weather Max	48.0	3.60	$14.88	23-Sep-08
Rotation: Wheat-Corn-Millet					
Wheat:	Ally Extra	0.4	0.03	$3.75	29-Apr-08
	2,4-D LV6	6.0	0.45	$0.00	29-Apr-08
(Stubble)	Roundup Weather Max	32.0	2.40	$9.92	29-Aug-08
	Brash	16.0	1.20	$3.68	29-Aug-08
Corn (RR):	Roundup Weather Max	22.0	1.65	$6.83	14-May-08
	Lumax	40.0	3.00	$16.80	14-May-08
(Post-Emerg)	Roundup Weather Max	22.0	1.65	$6.83	24-Jun-08
Millet: (Pre-Plant)	Roundup Weather Max	22.0	1.7	$6.82	14-May-08
	Brash	16.0	1.2	$3.68	14-May-08
(Post-Emerg)	Roundup Weather Max	25.0	1.9	$7.75	3-Jun-08
	Aim EC	2.0	0.2	$13.36	24-Jun-08
(Pre-Plant)	Roundup Weather Max	48.0	3.6	$14.88	23-Sep-08
Rotation: Wheat-Wheat-Corn-Millet					
Wheat:	Ally Extra	0.4	0.03	$3.75	29-Apr-08
	2,4-D LV6	6.0	0.45	$0.00	29-Apr-08
(Stubble)	Roundup Weather Max	32.0	2.40	$9.92	29-Aug-08
	Brash	16.0	1.20	$3.68	29-Aug-08
(Pre-Plant)	Roundup Weather Max	48.0	3.6	$14.88	23-Sep-08
Wheat2:	Ally Extra	0.4	0.03	$3.75	29-Apr-08
	2,4-D LV6	6.0	0.45	$0.00	29-Apr-08

(Stubble)	Roundup Weather Max	32.0	2.40	$9.92	29-Aug-08
	Brash	16.0	1.20	$3.68	29-Aug-08
Corn (RR):	Roundup Weather Max	22.0	1.65	$6.83	14-May-08
	Lumax	40.0	3.00	$16.80	14-May-08
(Post-Emerg)	Roundup Weather Max	22.0	1.65	$6.83	24-Jun-08
Millet: (Pre-Plant)	Roundup Weather Max	22.0	1.7	$6.82	14-May-08
	Brash	16.0	1.2	$3.68	14-May-08
(Post-Emerg)	Roundup Weather Max	25.0	1.9	$7.75	3-Jun-08
	Aim EC	2.0	0.2	$13.36	24-Jun-08
(Pre-Plant)	Roundup Weather Max	48.0	3.6	$14.88	23-Sep-08
Rotation: Opportunity					
Millet: (Pre-Plant)	Roundup Weather Max	22.0	1.7	$6.82	14-May-08
	Brash	16.0	1.2	$3.68	14-May-08
(Post-Emerg)	Roundup Weather Max	25.0	1.9	$7.75	3-Jun-08
	Aim EC	2.0	0.2	$13.36	24-Jun-08
(Pre-Plant)	Roundup Weather Max	48.0	3.6	$14.88	23-Sep-08

Table 3. Weed control methods including herbicide rate, cost and date applied at WALSH in 2008.

Crop	Herbicide/Tillage	Rate (English)	Rate (Metric)	Cost	Date Applied
		oz/acre	l/ha	$/acre	
Rotation: Wheat-Sorghum-Fallow					
Wheat:	Express XP	0.30	0.04	$0.05	26-Mar-08
	LowVol	8.00	0.96	$1.68	26-Mar-08
(Stubble)	Glystar	24.00	2.88	$7.20	25-Jul-08
	LowVol	10.00	1.20	$2.10	25-Jul-08
	Banvil	4.00	0.48	$1.88	25-Jul-08
	Glystar	24.00	2.88	$7.20	16-Sep-08
	LowVol	10.00	1.20	$2.10	16-Sep-08
	Banvil	4.00	0.48	$1.88	16-Sep-08
Grain Sorghum:	Glystar	24.00	2.88	$7.20	16-May-08
	LowVol	16.00	1.92	$3.36	16-May-08
	Banvil	4.00	0.48	$1.88	16-May-08
	Banvil	8.00	0.96	$3.76	12-Jun-08
	Atrazine	24.00	2.88	$2.64	25-Jul-08
	Banvil	3.00	0.36	$1.41	25-Jul-08
	Glystar	24.00	2.88	$7.20	16-Sep-08
	LowVol	10.00	1.20	$2.10	16-Sep-08
	Banvil	4.00	0.48	$1.88	16-Sep-08
Fallow:	Glystar	24.00	2.88	$7.20	16-May-08
	LowVol	16.00	1.92	$3.36	16-May-08
	Banvil	4.00	0.48	$1.88	16-May-08
	Glystar	20.00	2.40	$6.00	12-Jun-08
	LowVol	10.00	1.20	$2.10	12-Jun-08
	Banvil	4.00	0.48	$1.88	12-Jun-08
	Glystar	24.00	2.88	$7.20	25-Jul-08
	LowVol	10.00	1.20	$2.10	25-Jul-08
	Banvil	4.00	0.48	$1.88	25-Jul-08
	Glystar	24.00	2.88	$7.20	16-Sep-08
	LowVol	10.00	1.20	$2.10	16-Sep-08
	Banvil	4.00	0.48	$1.88	16-Sep-08
Rotation: Wheat-Corn-Millet					
Wheat:	Express XP	0.30	0.04	$0.05	26-Mar-08
	LowVol	8.00	0.96	$1.68	26-Mar-08
(Stubble)	Glystar	24.00	2.88	$7.20	25-Jul-08
	LowVol	10.00	1.20	$2.10	25-Jul-08
	Banvil	4.00	0.48	$1.88	25-Jul-08
	Glystar	24.00	2.88	$7.20	16-Sep-08
	LowVol	10.00	1.20	$2.10	16-Sep-08
	Banvil	4.00	0.48	$1.88	16-Sep-08
Corn (RR):	Glystar	24.00	2.88	$7.20	16-May-08
	LowVol	16.00	1.92	$3.36	16-May-08
	Banvil	4.00	0.48	$1.88	16-May-08
	Banvil	8.00	0.96	$3.76	12-Jun-08
	Roundup Weather Max	24.00	2.88	$7.44	25-Jul-08
Proso Millet:	Glystar	20.00	2.40	$6.00	12-Jun-08

	LowVol	10.00	1.20	$2.10	12-Jun-08
	Banvil	4.00	0.48	$1.88	12-Jun-08
	Glystar	24.00	2.88	$7.20	25-Jul-08
	LowVol	10.00	1.20	$2.10	25-Jul-08
(Stubble)	Banvil	4.00	0.48	$1.88	25-Jul-08
	Glystar	24.00	2.88	$7.20	16-Sep-08
	LowVol	10.00	1.20	$2.10	16-Sep-08
	Banvil	4.00	0.48	$1.88	16-Sep-08
Rotation: Wheat-Wheat-Sorghum-Millet					
Wheat:	Express XP	0.30	0.04	$0.05	26-Mar-08
	LowVol	8.00	0.96	$1.68	26-Mar-08
(Stubble)	Glystar	24.00	2.88	$7.20	25-Jul-08
	LowVol	10.00	1.20	$2.10	25-Jul-08
	Banvil	4.00	0.48	$1.88	25-Jul-08
	Glystar	24.00	2.88	$7.20	16-Sep-08
	LowVol	10.00	1.20	$2.10	16-Sep-08
	Banvil	4.00	0.48	$1.88	16-Sep-08
Wheat2:	Express XP	0.30	0.04	$0.05	26-Mar-08
	LowVol	8.00	0.96	$1.68	26-Mar-08
(Stubble)	Glystar	24.00	2.88	$7.20	25-Jul-08
	LowVol	10.00	1.20	$2.10	25-Jul-08
	Banvil	4.00	0.48	$1.88	25-Jul-08
	Glystar	24.00	2.88	$7.20	16-Sep-08
	LowVol	10.00	1.20	$2.10	16-Sep-08
	Banvil	4.00	0.48	$1.88	16-Sep-08
Grain Sorghum:	Glystar	24.00	2.88	$7.20	16-May-08
	LowVol	16.00	1.92	$3.36	16-May-08
	Banvil	4.00	0.48	$1.88	16-May-08
	Banvil	8.00	0.96	$3.76	12-Jun-08
	Atrazine	24.00	2.88	$2.64	25-Jul-08
	Banvil	3.00	0.36	$1.41	25-Jul-08
	Glystar	24.00	2.88	$7.20	16-Sep-08
	LowVol	10.00	1.20	$2.10	16-Sep-08
	Banvil	4.00	0.48	$1.88	16-Sep-08
Proso Millet:	Glystar	20.00	2.40	$6.00	12-Jun-08
	LowVol	10.00	1.20	$2.10	12-Jun-08
	Banvil	4.00	0.48	$1.88	12-Jun-08
	Glystar	24.00	2.88	$7.20	25-Jul-08
	LowVol	10.00	1.20	$2.10	25-Jul-08
(Stubble)	Banvil	4.00	0.48	$1.88	25-Jul-08
	Glystar	24.00	2.88	$7.20	16-Sep-08
	LowVol	10.00	1.20	$2.10	16-Sep-08
	Banvil	4.00	0.48	$1.88	16-Sep-08

Table 2. Weed control methods including herbicide rate, cost and date applied at STERLING in 2009.

Crop	Herbicide/Tillage	Rate (English)	Rate (Metric)	Cost	Date Applied
		oz/acre	l/ha		
Rotation: Wheat-Corn-Fallow					
Wheat:	Ally Extra	0.4	0.03	$3.75	29-Apr-09
	2,4-D LV6	10.0	0.75	$2.16	29-Apr-09
(Stubble)	Roundup Weather Max	20.0	1.50	$6.82	27-Jul-09
	2,4-D LV6	10.0	0.75	$2.16	27-Jul-09
	Banvel	4.0	0.30	$4.65	27-Jul-09
	Glystar Plus	24.00	2.88	$7.20	9-Sep-09
Corn (RR):	Roundup Weather Max	22.0	1.65	$6.82	29-Apr-09
	Lumax	40.0	3.00	$16.80	29-Apr-09
(Post-Emerg)	Roundup Weather Max	32.0	2.40	$9.92	9-Jun-09
	2,4-D LV6	10.0	0.75	$2.16	1-Jul-09
Fallow:	Roundup Weather Max	22.0	1.65	$6.82	29-Apr-09
	Roundup Weather Max	32.0	2.40	$9.92	9-Jun-09
	2,4-D LV6	10.0	0.75	$2.16	9-Jul-09
	Roundup Weather Max	20.0	1.50	$6.82	27-Jul-09
	2,4-D LV6	10.0	0.75	$2.16	27-Jul-09
	Banvel	4.0	0.30	$4.65	27-Jul-09
(Pre-Plant)	Glystar Plus	24.00	2.88	$7.20	9-Sep-09
Rotation: Wheat-Corn-Millet					
Wheat:	Ally Extra	0.4	0.03	$3.75	29-Apr-09
	2,4-D LV6	10.0	0.75	$2.16	29-Apr-09
(Stubble)	Roundup Weather Max	20.0	1.50	$6.82	27-Jul-09
	2,4-D LV6	10.0	0.75	$2.16	27-Jul-09
	Banvel	4.0	0.30	$4.65	27-Jul-09
	Glystar Plus	24.00	2.88	$7.20	9-Sep-09
Corn (RR):	Roundup Weather Max	22.0	1.65	$6.82	29-Apr-09
	Lumax	40.0	3.00	$16.80	29-Apr-09
(Post-Emerg)	Roundup Weather Max	32.0	2.40	$9.92	9-Jun-09
	2,4-D LV6	10.0	0.75	$2.16	1-Jul-09
Millet: (Pre-Plant)	Roundup Weather Max	22.0	1.65	$6.82	29-Apr-09
	Roundup Weather Max	32.0	2.4	$9.92	9-Jun-09
	2,4-D LV6	10.0	0.8	$2.16	9-Jul-09
	2,4-D Amine	12.0	0.9	$2.16	27-Jul-09
	Glystar Plus	24.00	2.88	$7.20	9-Sep-09
Rotation: Wheat-Wheat-Corn-Millet					
Wheat:	Ally Extra	0.4	0.03	$3.75	29-Apr-09
	2,4-D LV6	10.0	0.75	$2.16	29-Apr-09
(Stubble)	Roundup Weather Max	20.0	1.50	$6.82	27-Jul-09
	2,4-D LV6	10.0	0.75	$2.16	27-Jul-09

	Banvel	4.0	0.30	$4.65	27-Jul-09
	Glystar Plus	24.00	2.88	$7.20	9-Sep-09
Wheat2:	Ally Extra	0.4	0.0	$3.75	29-Apr-09
	2,4-D LV6	10.0	0.8	$2.16	29-Apr-09
(Stubble)	Roundup Weather Max	20.0	1.5	$6.82	27-Jul-09
	2,4-D LV6	10.0	0.8	$2.16	27-Jul-09
	Banvel	4.0	0.3	$4.65	27-Jul-09
	Glystar Plus	24.00	2.88	$7.20	9-Sep-09
Corn (RR):	Roundup Weather Max	22.0	1.65	$6.82	29-Apr-09
	Lumax	40.0	3.00	$16.80	29-Apr-09
(Post-Emerg)	Roundup Weather Max	32.0	2.40	$9.92	9-Jun-09
	2,4-D LV6	10.0	0.75	$2.16	1-Jul-09
Millet: (Pre-Plant)	Roundup Weather Max	22.0	1.65	$6.82	29-Apr-09
	Roundup Weather Max	32.0	2.4	$9.92	9-Jun-09
	2,4-D LV6	10.0	0.8	$2.16	9-Jul-09
	2,4-D Amine	12.0	0.9	$2.16	27-Jul-09
	Glystar Plus	24.00	2.88	$7.20	9-Sep-09
Rotation: Opportunity					
Corn(RR):(Pre-Plant)	Roundup Weather Max	22.0	1.65	$6.82	29-Apr-09
	Lumax	40.0	3.0	$16.80	29-Apr-09
(Post-Emerg)	Roundup Weather Max	24.0	0.70	$7.44	9-Jun-09
	2,4-D LV6	10.0	0.8	$2.16	1-Jul-09

Table 2. Weed control methods including herbicide rate, cost and date applied at STRATTON in 2009.

Crop	Herbicide/Tillage	Rate (English)	Rate (Metric)	Cost	Date Applied
		oz/acre	l/ha		
Rotation: Wheat-Corn-Fallow					
Wheat:	Ally Extra	0.4	0.03	$3.75	29-Apr-09
	2,4-D LV6	10.0	0.75	$2.16	29-Apr-09
(Stubble)	Roundup Weather Max	20.0	1.50	$6.82	27-Jul-09
	2,4-D LV6	10.0	0.75	$2.16	27-Jul-09
	Banvel	4.0	0.30	$4.65	27-Jul-09
	Roundup Weather Max	20.0	1.50	$6.82	14-Sep-09
Corn (RR):	Roundup Weather Max	22.0	1.65	$6.82	29-Apr-09
	Lumax	40.0	3.00	$16.80	29-Apr-09
(Post-Emerg)	Roundup Weather Max	32.0	2.40	$9.92	9-Jun-09
	2,4-D LV6	10.0	0.75	$2.16	1-Jul-09
Fallow:	Roundup Weather Max	22.0	1.65	$6.82	29-Apr-09
	Roundup Weather Max	32.0	2.40	$9.92	9-Jun-09
	2,4-D LV6	10.0	0.75	$2.16	9-Jul-09
	Roundup Weather Max	20.0	1.50	$6.82	27-Jul-09
	2,4-D LV6	10.0	0.75	$2.16	27-Jul-09
	Banvel	4.0	0.30	$4.65	27-Jul-09
(Pre-Plant)	Roundup Weather Max	20.0	1.50	$6.82	14-Sep-09
Rotation: Wheat-Corn-Millet					
Wheat:	Ally Extra	0.4	0.03	$3.75	29-Apr-09
	2,4-D LV6	10.0	0.75	$2.16	29-Apr-09
(Stubble)	Roundup Weather Max	20.0	1.50	$6.82	27-Jul-09
	2,4-D LV6	10.0	0.75	$2.16	27-Jul-09
	Banvel	4.0	0.30	$4.65	27-Jul-09
	Roundup Weather Max	20.0	1.50	$6.82	14-Sep-09
Corn (RR):	Roundup Weather Max	22.0	1.65	$6.82	29-Apr-09
	Lumax	40.0	3.00	$16.80	29-Apr-09
(Post-Emerg)	Roundup Weather Max	32.0	2.40	$9.92	9-Jun-09
	2,4-D LV6	10.0	0.75	$2.16	1-Jul-09
Millet: (Pre-Plant)	Roundup Weather Max	22.0	1.65	$6.82	29-Apr-09
	Roundup Weather Max	32.0	2.4	$9.92	9-Jun-09
	2,4-D LV6	10.0	0.8	$2.16	9-Jul-09
(Post-Emerg)	2,4-D Amine	12.0	0.9	$2.16	27-Jul-09
(Pre-Plant)	Roundup Weather Max	20.0	1.5	$6.82	14-Sep-09
Rotation: Wheat-Wheat-Corn-Millet					
Wheat:	Ally Extra	0.4	0.03	$3.75	29-Apr-09
	2,4-D LV6	10.0	0.75	$2.16	29-Apr-09

(Stubble)	Roundup Weather Max	20.0	1.50	$6.82	27-Jul-09
	2,4-D LV6	10.0	0.75	$2.16	27-Jul-09
	Banvel	4.0	0.30	$4.65	27-Jul-09
(Pre-Plant)	Roundup Weather Max	20.0	1.50	$6.82	14-Sep-09
Wheat2:	Ally Extra	0.4	0.0	$3.75	29-Apr-09
	2,4-D LV6	10.0	0.8	$2.16	29-Apr-09
(Stubble)	Roundup Weather Max	20.0	1.5	$6.82	27-Jul-09
	2,4-D LV6	10.0	0.8	$2.16	27-Jul-09
	Banvel	4.0	0.3	$4.65	27-Jul-09
	Roundup Weather Max	20.0	1.5	$6.82	14-Sep-09
Corn (RR):	Roundup Weather Max	22.0	1.65	$6.82	29-Apr-09
	Lumax	40.0	3.00	$16.80	29-Apr-09
(Post-Emerg)	Roundup Weather Max	32.0	2.40	$9.92	9-Jun-09
	2,4-D LV6	10.0	0.75	$2.16	1-Jul-09
Millet: (Pre-Plant)	Roundup Weather Max	22.0	1.65	$6.82	29-Apr-09
	Roundup Weather Max	32.0	2.4	$9.92	9-Jun-09
	2,4-D LV6	10.0	0.8	$2.16	9-Jul-09
(Post-Emerg)	2,4-D Amine	12.0	0.9	$2.16	27-Jul-09
(Pre-Plant)	Roundup Weather Max	20.0	1.5	$6.82	14-Sep-09
Rotation: Opportunity					
Corn(RR):(Pre-Plant)	Roundup Weather Max	22.0	1.65	$6.82	29-Apr-09
	Lumax	40.0	3.0	$16.80	29-Apr-09
(Post-Emerg)	Roundup Weather Max	32.0	2.4	$9.92	9-Jun-09
	2,4-D LV6	10.0	0.8	$2.16	1-Jul-09

Table 3. Weed control methods including herbicide rate, cost and date applied at WALSH in 2009.

Crop	Herbicide/Tillage	Rate (English)	Rate (Metric)	Cost	Date Applied
		oz/acre	l/ha	$/acre	
Rotation: Wheat-Sorghum-Fallow					
Wheat:	Express XP	0.50	0.04		4-April-09
	LowVol	8.00	0.96	$1.68	4-April-09
	Glystar Plus	24.0	2.88	$7.20	14-Aug-09
	LowVol	10.00	1.20	$2.10	14-Aug-09
	Banvel	6.00	0.18	$2.82	14-Aug-09
(Stubble)	Honcho	20.0	0.60		8-April-009
	Low Vol Ester	10.0	0.30	$2.10	8-April-009
	Banvel	4.0	0.12	$2.82	8-April-009
	Glystar	24.00	2.88	$7.20	12-June-09
Grain Sorghum:	Honcho	20.0	0.60		8-April-009
	Low Vol Ester	10.0	0.30		8-April-009
	Banvel	4.0	0.12		8-April-009
	Glystar	24.00	2.88	$7.20	12-June-09
Fallow:	Honcho	20.0	0.60		8-April-009
	Low Vol Ester	10.0	0.30	$2.10	8-April-009
	Banvel	4.0	0.12	$1.88	8-April-009
	Glystar	24.00	2.88	$7.20	12-June-09
	Glystar Plus	24.0	2.88	$7.20	14-Aug-09
	LowVol	10.00	0.30	$2.10	14-Aug-09
	Banvel	6.00	0.18	$2.82	14-Aug-09
	Glystar Plus	24.00	2.88	$7.20	9-Sep-09
Rotation: Wheat-Corn-Millet					
Wheat:	Express XP	0.50	0.04		4-April-09
	LowVol	8.00	0.96	$1.68	4-April-09
	Glystar Plus	24.0	2.88	$7.20	14-Aug-09
	LowVol	10.00	1.20	$2.10	14-Aug-09
	Banvel	6.00	0.18	$2.82	14-Aug-09
Stubble	Honcho	20.0	0.60		8-April-009
	Low Vol Ester	10.0	0.30	$2.10	8-April-009
	Banvel	4.0	0.12	$2.82	8-April-009
	Glystar	24.00	2.88	$7.20	12-June-09
Corn (RR):	Honcho	20.0	0.60		8-April-009
	Low Vol Ester	10.0	0.30		8-April-009
	Banvel	4.0	0.12		8-April-009
	Roundup Weather Max	24.00	2.88	$7.44	19-Jun-09
Proso Millet:	Honcho	20.0	0.60		8-April-009

	Low Vol Ester	10.0	0.30	$2.10	
	Banvel	4.0	0.12	$2.82	
	Glystar	24.00	2.88	$7.20	12-June-09
(Stubble)	Honcho	20.0	0.60		8-April-09
	Low Vol Ester	10.0	0.30	$2.10	8-April-09
	Banvel	4.0	0.12	$2.82	8-April-09
	Glystar	24.00	2.88	$7.20	12-June-09
	Glystar Plus	24	2.88	$7.88	14-Aug-09
	Low Vol 2,4-D Ester	10.0	1.20	$2.10	14-Aug-09
	Banvel	6.0	0.18	$2.82	14-Aug-09
Rotation: Wheat-Wheat-Sorghum-Millet					
Wheat:	Express XP	0.50	0.04		4-April-09
	LowVol 2,4-D Ester	8.00	0.96	$1.68	4-April-09
	Glystar Plus	24	2.88	$7.88	14-Aug-09
	Low Vol 2,4-D Ester	10.0	1.20	$2.10	14-Aug-09
	Banvel	6.0	0.18	$2.82	14-Aug-09
Stubble	Honcho	20.0	0.60		8-April-09
	Low Vol Ester	10.0	0.30	$2.10	8-April-09
	Banvel	4.0	0.12	$2.82	8-April-09
	Glystar	24.00	2.88	$7.20	12-June-09
Wheat2:	Express XP	0.50	0.04		4-April-09
	LowVol 2,4-D Ester	8.00	0.96	$1.68	
	Glystar Plus	24	2.88	$7.88	14-Aug-09
	Low Vol 2,4-D Ester	10.0	1.20	$2.10	14-Aug-09
	Banvel	6.0	0.18	$2.82	14-Aug-09
Stubble	Honcho	20.0	0.60		8-April-09
	Low Vol Ester	10.0	0.30	$2.10	8-April-09
	Banvel	4.0	0.12	$2.82	8-April-09
	Glystar	24.00	2.88	$7.20	12-June-09
Grain Sorghum:	Honcho	20.0	0.60		8-April-09
	Low Vol Ester	10.0	0.30	$2.10	8-April-09
	Banvel	4.0	0.12	$2.82	8-April-09
	Glystar	24.00	2.88	$7.20	12-June-09
Proso Millet:	Honcho	20.0	0.60		8-April-009
	Low Vol Ester	10.0	0.30		
	Banvel	4.0	0.12		
	Glystar	24.00	2.88	$7.20	12-June-09
(Stubble)	Honcho	20.0	0.60		8-April-009
	Low Vol Ester	10.0	0.30		
	Banvel	4.0	0.12		

APPENDIX B
PROJECT PUBLICATIONS

Papers in Scientific Journals:

Kitchen, N. R., L. A. Sherrod, C. W. Wood, G. A. Peterson and D. G. Westfall. 1990. Nitrogen contamination of soils from sampling bags. Agron. J. 82:354-356.

Kitchen, N. R., J. L. Havlin and D. G. Westfall. 1990. Soil sampling under no-till banded phosphorus. Soil Sci. Soc. Am. J. 54:1661-1665.

Wood, C. W., D. G. Westfall, G. A. Peterson and I. C. Burke. 1990. Impacts of cropping intensity on carbon and nitrogen mineralization under no-till agroecosystems. Agron. J. 82: 1115-1120.

Wood, C. W., D. G. Westfall and G. A. Peterson. 1991. Soil carbon and nitrogen changes upon initiation of no-till cropping systems in the West Central Great Plains. Soil Sci. Soc. Am. J. 55:470-476.

Wood, C. W., G. A. Peterson, D. G. Westfall, C. V. Cole and W. F. Willis. 1991. Nitrogen balance and biomass production of newly established no-till dryland agroecosystems. Agron. J. 83:519-526.

Moore, I.D., P.E. Gessler, G.A. Nielsen, and G.A. Peterson. 1993. Soil attribute prediction using terrain analysis. Soil Sci. Soc. Am. J. 57:443-452.

Peterson, G.A., D.G. Westfall, and C.V. Cole. 1993. Agroecosystem approach to soil and crop management research. Soil Sci. Soc. Am. J. 57:1354-1360.

Evans, S.D., G.A. Peterson, D.G. Westfall and E. McGee. 1994. Nitrate leaching in dryland agroecosystems as influenced by soil and climate gradients. J. Environ. Qual. 23:999-1005.

Peterson, G.A., A.J. Schlegel, D.L. Tanaka, and O.R. Jones. 1996. Precipitation use efficiency as affected by cropping and tillage systems. J. of Prod. Agric. 9:180-186.

Westfall, D.G., J.L. Havlin, G.W. Hergert, and W.R. Raun. 1996. Nitrogen management in dryland cropping systems. J. of Prod. Agric. 9:192-199.

Paustian, K.A., E.T. Elliott, G.A. Peterson, and K. Kendrick. 1996. Modeling climate, CO_2 and management impacts on soil carbon in semi-arid agroecosystems. Plant and Soil 187:351-365.

Kolberg, R.L., N.R. Kitchen, D.G. Westfall, and G.A. Peterson. 1996. Cropping intensity and nitrogen management impact on dryland no-till rotations in the semi-arid western Great Plains. J. Prod. Agric. 9:517-522.

Follett, R.F., E.A. Paul, S.W. Leavitt, A.D. Halvorson, D. Lyon, and G.A. Peterson. 1997. Carbon isotope ratios of Great Plains soils in wheat-fallow systems. Soil Sci. Soc. Am. J. 61:1068-1077.

Paul, E.A., R.F. Follett, S.W. Leavitt, A.D. Halvorson, G.A. Peterson, and D. Lyon. 1997. Carbon isotope ratios of Great Plains soils in wheat-fallow systems. Soil Sci. Soc. Am. J. 61:1058-1067.

Kolberg R.L., B. Roupett, D.G. Westfall, and G.A. Peterson. 1997. Evaluation of an *in situ* net nitrogen mineralization method in dryland agroecosystems. Soil Sci. Soc. Am. J. 61:504-508.

McGee, E.A., G.A. Peterson, and D.G. Westfall. 1997. Water storage efficiency in no-till dryland cropping systems. J. Soil and Water Cons. 52:131-136.

Peterson, G.A., A.D Halvorson, J.L. Havlin, O.R. Jones, D.J. Lyon, and D.L. Tanaka. 1998. Reduced tillage and increasing cropping intensity in the Great Plains conserves soil carbon. Soil and Tillage Res. 47:207-218.

Farahani, H.J., G.A. Peterson, D.G. Westfall, and L.R. Ahuja. 1998. Soil water storage in dryland cropping systems: The significance of cropping intensification. Soil Sci. Soc. Am. J. 62:984-991.

Power, J.F. and G.A. Peterson. 1998. Nitrogen transformations, utilization, and conservation as affected by fallow tillage method. Soil and Tillage Res. 49:37-47.

Farahani, H.J., G.W. Buchleiter, L.R. Ahuja, G.A. Peterson, and L. Sherrod. 1999. Season evaluation of the root zone water quality model in Colorado. Agron. J. 91:212-219.

Ma, L., G.A. Peterson, L.R. Ahuja, L. Sherrod, M.J. Shafer, and K.W. Rojas. 1999. Decomposition of surface crop residues in long-term studies of dryland agroecosystems. Agron. J. 91:401-409.

Frey, S.D., E.T. Elliott, K. Paustian, and G.A. Peterson. 2000. Fungal translocation as a mechanism for soil nitrogen inputs to surface residue decomposition in a no-tillage agroecosystem. Soil Biol. and Biochem. 32:689-698.

Del Grosso, S., Parton, W.J. Mosier, A.R., Hartman, M.D., Keough, C.A., Peterson, G.A., Ojima, D.S., and Schimel, D.S. 2001. Simulated effects of land use, soil texture, and precipitation on N gas emissions using DAYCENT. p. 413-431. In: Follett, R.F. and Hatfield, J.L. (eds.) Nitrogen in the Environment: Sources, Problems, and Management. Elsevier, Amsterdam.

Del Grosso, S., Ojima, D.S., Parton, W.J. Mosier, and Peterson, G.A. 2002. Regional assessment of net greenhouse gas fluxes from agricultural soils in the USA Great Plains under current and improved management. p. 469-474. In:Van Ham and Williams-Jacobse (eds.) Non-CO2 Greenhouse Gases. Millpress, Rotterdam.

Del Grosso, S., Ojima, D.S. Parton, W.J. Mosier, A.R., Peterson, G.A., and Schimel, D.S. 2002. Simulated effects of dryland cropping intensification on soil organic matter and greenhouse gas exchanges using the DAYCENT ecosystem model. Environmental Pollution 116:S75-S83.

Grant, C.A., Peterson, G.A., and Campbell, C.A. 2002. Nutrient considerations for diversified cropping systems in the Northern Great Plains. Agron. J. 94:186-198.

Sherrod, L.A., Dunn, G., Peterson, G.A., and Kolberg, R.L. 2002. Inorganic carbon analysis by modified pressure-calcimeter method. Soil Sci. Soc. Am. J. 66:299-305.

Shaver, T.M., Peterson, G.A., Ahuja, L.R., Westfall, D.G., Sherrod, L.A., and Dunn, G. 2002. Surface soil physical properties after twelve years of dryland no-till management. Soil Sci. Soc. Am. J. 66:1296-1303.

Ortega, R.A., Peterson, G.A., and Westfall, D.G. 2002. Residue accumulation and changes in soil organic matter as affected by cropping intensity in no-till dryland agroecosystems. Agron. J. 94:944-954.

Halvorson, A.D., Peterson, G.A., and Reule, C.A. 2002. Tillage system and crop rotation effects on dryland crop yields and soil carbon in the Central Great Plains. Agron. J. 94:1429-1436.

Del Grosso, S., Parton, W.J. Mosier, A.R., Hartman, M.D., Keough, C.A., Peterson, G.A., Ojima, D.S., and Schimel, D.S. 2001. Simulated effects of land use, soil texture, and precipitation on N gas emissions using DAYCENT. p. 413-431. In: Follett, R.F. and Hatfield, J.L. (eds.) Nitrogen in the Environment: Sources, Problems, and Management. Elsevier, Amsterdam.

Del Grosso, S., Ojima, D.S., Parton, W.J. Mosier, and Peterson, G.A. 2002. Regional assessment of net greenhouse gas fluxes from agricultural soils in the USA Great Plains under current and improved management. p. 469-474. In:Van Ham and Williams-Jacobse (eds.) Non-CO2 Greenhouse Gases. Millpress, Rotterdam.

Del Grosso, S., Ojima, D.S. Parton, W.J. Mosier, A.R., Peterson, G.A., and Schimel, D.S. 2002. Simulated effects of dryland cropping intensification on soil organic matter and greenhouse gas exchanges using the DAYCENT ecosystem model. Environmental Pollution 116:S75-S83.

Grant, C.A., Peterson, G.A., and Campbell, C.A. 2002. Nutrient considerations for diversified cropping systems in the Northern Great Plains. Agron. J. 94:186-198.

Sherrod, L.A., Dunn, G., Peterson, G.A., and Kolberg, R.L. 2002. Inorganic carbon analysis by modified pressure-calcimeter method. Soil Sci. Soc. Am. J. 66:299-305.

Shaver, T.M., Peterson, G.A., Ahuja, L.R., Westfall, D.G., Sherrod, L.A., and Dunn, G. 2002. Surface soil physical properties after twelve years of dryland no-till management. Soil Sci. Soc. Am. J. 66:1296-1303.

Ortega, R.A., Peterson, G.A., and Westfall, D.G. 2002. Residue accumulation and changes in soil organic matter as affected by cropping intensity in no-till dryland agroecosystems. Agron. J. 94:944-954.

Halvorson, A.D., Peterson, G.A., and Reule, C.A. 2002. Tillage system and crop rotation effects on dryland crop yields and soil carbon in the Central Great Plains. Agron. J. 94:1429-1436.

Shaver, T.M., Peterson, G.A., and Sherrod, L.A. 2003. Cropping intensification in dryland systems improves soil physical properties: regression relationships. Geoderma 116:149-164.

Sherrod, L.A., Peterson, G.A., Westfall, D.G., and Ahuja, L.R. 2003. Cropping intensity enhances soil organic carbon and nitrogen in a no-till agroecosystem. Soil Sci. Soc. Am. J. 67:1533-1543.

Johnson, C.K., Eskridge K.M., Wienhold, B.J., Doran, J.W., Peterson, G.A., and Buchleiter, G.W. 2003. Using electrical conductivity classification and within-field variability to design field-scale research. Agron. J. 95:602-613.

Andales, A.A., Ahuja, L.R., and Peterson, G.A. 2003. Evaluation of GPFARM for dryland cropping systems in eastern Colorado. Agron. J. 95:1510-1524.

Peterson, G. A., and D. G. Westfall. 2004. Managing precipitation use in sustainable dryland agroecosystems. Ann. Appl. Biol. 144:127-138.

Campbell, C.A., H.H. Janzen, K. Paustian, E.G. Gregorich, L. Sherrod, B.C. Liang, and R.P. Zentner. 2005**.** Carbon Storage in Soils of the North American Great Plains: Effect of Cropping Frequency. Agron. J. 97:349-363.

Mosier, A.R., A.D. Halvorson, G.A. Peterson, G.P. Robertson, and L.A. Sherrod**.** 2005. Measurement of net global warming potential in three agroecosystems. Nutrient Cycling in Agroecosystems 7:67-76.

Sherrod, L. A., G. A. Peterson, D. G. Westfall, and L. R. Ahuja. 2005. Soil carbon pools after 12 years in no-till dryland Agroecosystem. Soil Sci. Soc. Am. J. 69:1600-1608.

Ortega. R. A., D. G. Westfall, and G. A. Peterson. 2005. Climactic gradient, cropping system, and crop residue effects on carbon and nitrogen mineralization in no-till soils. Comm. Soil Sci. Plant Anal. 36:2875-2888.

Cantero-Martinez, C., D. G. Westfall, L. A. Sherrod, and G. A. Peterson. 2006. Long-term crop residue dynamics in no-till cropping systems under semi-arid conditions. J. of Soil and Water Cons. 61:84-95.

Ascough II, J.C., G.S. McMaster, A.A. Andales, N.C. Hansen, L.R. Ahuja, L.A. Sherrod. 2007. Evaluating GPFARM for No-Tillage Dryland Experimental Sites in Eastern Colorado. Transactions of the ASABE 50:1565-1578.

Stromberger, Mary, Zahir Shah, and D. G. Westfall. 2007. Soil microbial communities of no-till dryland cropping systems across an evapotranspiration gradient. Appl. Ecology 35:94-106.

Ascough II, J.C., A.A. Andales, L.A. Sherrod, G.S. McMaster, N.C. Hansen, K.C. Dejonge, E.M. Fathelrahman, L.R. Ahuja, G.A. Peterson, D.L. Hoag. 2010. Simulating Landscape Catena Effects in No-Till Dryland Agroecosystems Using GPFARM. Agric.Sys. 103:569-584.

Westfall, D. G., G. A. Peterson, and N. C. Hansen. 2010. Conserving and optimizing limited water for crop production. J. Crop Improvement. 24: 70-84.

Stromberger, Mary E., Zahir Shah, and Dwayne G. Westfall. 2011. High specific activity in low microbial biomass soils across a no-till evapotranspiration gradient in Colorado. Soil Biology & Biochemistry 43:97-105.

Sherrod, L.A., J.D. Reeder, W. Hunter, L.R. Ahuja. 2012. A Rapid and Cost Effective Method for Soil Carbon Mineralization in Static Laboratory Incubations. Comm. Soil Sci. Plant Anal 43:958-972.

Shaver, T. M., G. A. Peterson, L. R. Ahuja, and D. G. Westfall. 2013. Soil sorptivity enhancement with crop residue accumulation in semiarid dryland no-till agroecosystems. Geoderma 192:254-258

Chapters in Books or Monographs:

Peterson, G.A. 1994. Interactions of surface residues with soil and climate. p. 9-12. IN: W.C. Moldenhauer and A.L. Black (eds.) Crop residue management to reduce erosion and improve soil quality: Northern Great Plains. USDA/ARS Cons. Res. Report No. 38. Washington, D.C.

Westfall, D.G., W.R. Raun, J.L. Havlin, G.V. Johnson, J.E. Matocha, and F.M. Hons. 1994. Fertilizer management. p. 33-36. IN: B.A. Stewart and W.C. Moldenhauer (eds.) Crop residue management to reduce erosion and improve soil quality: Southern Great Plains. USDA/ARS Cons. Res. Report No. 37. Washington, D.C.

Metherell, A.K., C.A. Cambardella, W.J. Parton, G.A. Peterson, L.A. Harding, and C.V. Cole. 1995. Simulation of soil organic matter dynamics in dryland winter wheat-fallow cropping systems. p.259-270. *IN:* Soil management and greenhouse effect. R. Lal, J. Kimble, E. Levine, and B.A. Stewart. (eds.) Lewis Publishers, Boca Raton, FL.

Peterson, G.A. and D.G. Westfall. 1997. Management of dryland agroecosystems in the Central Great Plains of Colorado. p.371-380. *IN:* Soil organic matter in temperate agroecosystems. Paul, E.A., K.A. Paustian, E.T. Elliot, and C.V. Cole. (eds.) Lewis Publishers, Boca Raton, FL.

Halvorson, A.D., M.F. Vigil, G.A. Peterson, and E.T. Elliott. 1997. Long-term tillage and crop residue management study at Akron, Colorado. p.361-370. *IN:* Soil organic matter in temperate agroecosystems. Paul, E.A., K.A. Paustian, E.T. Elliot, and C.V. Cole. (eds.) Lewis Publishers, Boca Raton, FL. Farahani, H.J., G.A. Peterson, and D.G. Westfall. 1998. Dryland cropping intensification: A fundamental solution to efficient use of precipitation. Advances in Agron. 64:197-223.

Bradford, J.M. and G.A. Peterson. 1999. Conservation Tillage. p. G247-G270 *IN:* M.E. Sumner (ed.) Handbook of Soil Science. CRC Press, Boca Raton, FL.

Westfall, D. G., G.A. Peterson, and N.C. Hansen. 2010. Conserving and optimizing limited water for crop production. p. 43-55. In Water and Agricultural Sustainability Strategies. M. S. Kang (Ed.) Taylor and Francis Publishing.

Peterson, G.A., D.G. Westfall, and N.C. Hansen. 2012. Enhancing Precipitation Use Efficiency in the World's Dryland Agroecosystems. Adv. in Soil Sci. CRC Press, Boca Raton, FL.

Publications in Proceedings:

Peterson, G. A. and D. G. Westfall. 1987. Integrated research in soil and crop management. p. 3-5. IN: Proc. Western Phosphate Conf. March 1987. Corvallis, OR.

Kitchen, N. R. , D. G. Westfall and G. A. Peterson. 1988. Nitrogen fertilizer use efficiency in dryland no-till crop rotations. p. 172-179. IN: 1988 Symposium Proc. Fluid Fertilizer Research as a Basis for Efficient Crop Production. March 15-17, 1988.

Wood, C. W., D. G. Westfall and J. M. Ward. 1988. Phosphorus placement in dryland winter wheat. IN: Proc. Great Plains Soil Fert. Workshop 2:79-83.

Peterson, G. A., D. G. Westfall and W. O. Willis. 1988. Systems research: a necessity for the future of agronomic research. p. 739-740. IN: Proc. Int. Conf. Dryland Farming, Aug. 15-19, 1988. Amarillo, TX.

Kitchen, N. R., D. G. Westfall and G. A. Peterson. 1988. Nitrogen fertilizer use efficiency in dryland no-till crop rotations. p. 223-229. IN: Proc. Fluid Fert. Found. Symp., March, 1988, Scottsdale, AZ.

Westfall, D. G. and G. A. Peterson. 1989. Long-term dryland cropping systems research for the Central Great Plains. p. 1. IN: Proc. Western Soc. Soil Sci. Bozeman, MT, June 20-22, 1989.

Peterson, G. A. and D. G. Westfall. 1990. Long-term soil-crop management research for the 21st century. p. 132-136. IN: Proc. Great Plains Soil Fert. Conf., Denver, CO, March 6-7, 1990.

Kitchen, N. R., D. G. Westfall, G. A. Peterson and J. L. Havlin. 1990. Soil sampling under no-till banded phosphorus fertilizer. p. 159-164. IN: Proc. Great Plains Soil Fert. Conf., Denver, CO, March 6-7, 1990.

Kitchen, N. R., D. G. Westfall and G. A. Peterson. 1990. Fertilizer use efficiency in dryland no-till crop rotations. p. 218-227. IN: Proc. Fluid Fert. Found., Scottsdale, AZ, March 13-15, 1990.

Peterson, G. A. and D. G. Westfall. 1990. Dryland cropping systems to enhance water quality. p. 93-104. IN: Proc. Non-point Water Quality Symp., Colorado Springs, CO, March 22-23, 1990.

Westfall, D. G. and G. A. Peterson. 1990. Nitrogen efficiency in dryland agroecosystems. p. 155-163. IN: Proc. Great Plains Conserv. Tillage Symp. Great Plains Agricultural Council Bulletin No. 131. Bismarck, ND, August 21-23, 1990.

Peterson, G. A. and D. G. Westfall. 1990. Sustainable dryland agroecosystems. p. 23-29. IN: Proc. Great Plains Conserv. Tillage Symp. Great Plains Agricultural Council Bulletin No. 131. Bismarck, ND, Aug. 21-23, 1990.

Peterson, G.A.. 1991. Soil and crop management as a driving variable. p. 255. IN: J.D. Hanson, M.J. Shaffer, D.A. Ball and C.V. Cole (eds.), Sustainable Agriculture for the Great Plains, Symposium Proceedings. USDA-ARS, ARS-89.

Westfall, D.G. and G.A. Peterson. 1991. Optimum production and nitrogen fertilizer use in dryland no-till crop rotations. p.48. IN: Proc. Pacific Div. AAAS, June 23-27, 1991, Logan, UT.

Westfall, D.G., R.L. Kolberg, N.R. Kitchen, and G.A. Peterson. 1991. Nitrogen fertilizer use efficiency in dryland no-till crop rotations. p. 260-270. IN: Proc. Fluid Fert. Found. Symp., March 1991, Scottsdale, AZ.

Peterson, G.A., D.G. Westfall, and A.D. Halvorson. 1992. Economics of dryland crop rotations for efficient water and nitrogen use. p. 47-53. IN: Proc. Great Plains Soil Fert. Conf., Denver, CO, March 3-4, 1992.

Westfall, D.G., R.L. Kolberg, and G.A. Peterson. 1992. Nitrogen fertilizer use efficiency in dryland no-till crop rotations. p. 244-257. IN: Proc. Fluid Fert. Found. Symp., March 1992, Scottsdale, AZ.

Peterson, G.A., and C.V. Cole. 1993. Productivity of Great Plains soils: Past, present and future. IN: Proceedings of the Great Plains Ecosystems Symposium. Kansas City, MO. 7-9 April 1993.

Moore, I.D., P.E. Gessler, G.A. Nielsen, and G.A. Peterson. 1993. Soil attribute prediction using terrain analysis. p. 27-55. IN: Robert, P.C., et al. (eds.) Proc. of Workshop: Soil Specific Crop Management. Minneapolis, MN. 14-16 April 1992. Am. Soc. of Agron. Madison, WI.

Westfall, D.G., R.L. Kolberg, and G.A. Peterson. 1993. Nitrogen fertilizer use efficiency in dryland no-till crop rotations. p. 153-163. IN: Proc. Fluid Fert. Found. Symp. March 1993. Scottsdale, AZ.

Westfall, D.G., G.A. Peterson, and R.L. Kolberg. 1994. Fluid systems for dryland agriculture. p. 129-134. IN: Proc. Fluid Fert. Found. Symp. "Research for Tomorrow" February 1994. Scottsdale, AZ.

Westfall, D.G., R.L. Kolberg, and G.A. Peterson. 1994. Nitrogen management for intensified dryland agroecosystems. p. 12-17. IN: Proc. Great Plains Soil Fertility Conference. 7-9 March 1994. Denver, CO.

Peterson, G.A., D.G. Westfall, N.E. Toman, and R. E. Anderson. 1994. Sustainable dryland cropping systems: Economic analysis. p. 30-35. IN: Proc. Great Plains Soil Fertility Conference. 7-9 March 1994. Denver, CO.

Rouppet, B., R.L. Kolberg, R.L. Waskom, D.G. Westfall, and G.A. Peterson. 1994. In-situ soil nitrogen mineralization methodology. p. 30-35. IN: Proc. Great Plains Soil Fertility Conference. 7-9 March 1994. Denver, CO.

Peterson, G.A. and D.G. Westfall. 1994. Intensified cropping systems: The key to environmental and economic sustainablity in the Great Plains. p. 73-84. IN: Proc. Intensive Wheat Management Conference. 10-11 March 1994. Denver, CO.

Peterson, G.A. and D.G. Westfall. 1994. Economic and environmental impact of intensive cropping systems - Semiarid region. p. 145-158. IN: Proc. Nutrient Management on Highly Productive Soils Conference. 16-18 May 1994. Atlanta, GA.

Westfall, D.G., G.A. Peterson, and R.L. Kolberg. 1994. Nitrogen and phosphorus management of dryland cropping systems. p. 35-41. IN: Proc. Great Plains Residue Management Conference. GPAC Bull. No. 150. 15-17 August 1994. Amarillo, TX.

Peterson, G.A., D.G. Westfall, and L. Ahuja. 1995. Sustainable dryland agroecosystems for the Great Plains. IN: Proc. Planning for a Sustainable Future: The case of the North American Great Plains Symposium. 8-10 May 1995. Lincoln, NE.

Peterson, G.A., D.G. Westfall, and R.L. Kolberg. 1995. Fertilidad en trigo y otros cultivos en areas secas. p. 119-130. IN: Fertilidad de Suelos, Fertilizacion y Siembra Directa. III Jornadas Regionales Symposium. September 1995. Sierra la Ventana, Argentina.

Westfall, D.G., G.A. Peterson, and R.L. Kolberg. 1995. Fluid systems for dryland agriculture. p. 127-140. IN: 1995 Fluid Forum Proc. Sponsored by Fluid Fertilizer Foundation. February 1995, Scottsdale, AZ.

Westfall, D.G., G.A. Peterson, and R.L. Kolberg. 1995. Sustainable dryland cropping systems. IN: Proc. Western Nutrient Management Conf. 1:101-105. 9-10 March 1995. Salt Lake City, UT.

Peterson, G.A. 1996. Nitrogen fertilizer management for Great Plains dryland cropping systems: A review. p.19-25. IN: Proc. Great Plains Soil Fertility Conference. 5-6 March 1996. Denver, CO.

Westfall, D.G., G.A. Peterson, and R.L. Kolberg. 1996. Fluid systems for dryland agriculture. p.102-112. IN: 1996 Fluid Forum Proc. Sponsored by Fluid Fertilizer Foundation. February 1996, Scottsdale, AZ.

Westfall, D.G. and G.A. Peterson. 1996. Post CRP nitrogen management in dryland cropping systems. p.6 IN CRP Conference Proceedings. CRP Conference. Amarillo, TX.

Ortega, R.A., D.G. Westfall, and G.A. Peterson. 1996. Crop residue distribution and activity in soils as affected by cropping intensity in no-till dryland agroecosystems. p.75-82. IN Proc. Great Plains Soil Fertility Conference. 5-6 March 1996. Denver, CO.

Westfall, D.G., R.L. Kolberg, and G.A. Peterson. 1996. Nitrogen fertilization of intensive cropping systems. p.48-57. IN: 1996 Proc. AgriFuture Farm Technology Expo and Convention Workshop. February 1996. Red Deer, Alberta.

Westfall, D.G. and G.A. Peterson. 1996. Managing the move to more intensive cropping. p.14-22. IN: 1996 Proc. AgriFuture Farm Technology Expo and Convention Workshop. February 1996. Red Deer, Alberta.

Peterson, G.A. and D.G. Westfall. 1997. Benefits of zero till and rotations in the North American Great Plains. p. 5-16. IN: Proc. of the 19th Annual Manitoba-North Dakota Zero Tillage Workshop. 27-29 Jan. 1997, Brandon, Manitoba, Canada.

Ortega, R. A., D.G. Westfall, and G.A. Peterson. 1997. Using natural soil variability to calibrate soil tests. p. 14-31. *IN*: 1997 Fluid Forum Proc. Sponsored by the Fluid Fertilizer foundation, February, 23-25, 1997, Scottsdale, AZ.

Ortega, R. A., D.G. Westfall, and G.A. Peterson. 1997. Spatial variability of soil P and its impact on dryland winter wheat yields. p. 150-159. *IN*: Proc. of the Western Nutrient Management Conf. March 6-7, 1997. Salt Lake City, UT.

Peterson, G. A. and D.G. Westfall. 1997. Crop water extraction patterns across soil types. p. 41-48. *IN*: Proc. of the Ninth Ann. Conf. of the Colorado Cons. Tillage Assn. February 4-5, 1997. Sterling, CO.

Westfall, D.G., M. Amrani, and G.A. Peterson. 1998. Availability of zinc in fertilizers as influenced by water-solubility. p. 7-12. IN: Great Plains Soil Fertility Conference Proceedings. Schlegel, A.J. (Ed.) Great Plains Soil Fertility Conference. March 1998. Denver, CO.

Sherrod, A.L., G.A. Peterson, and D.G. Westfall. 1998. No-till rotational residue dynamics across an ET gradient. p. 61-66. IN: Great Plains Soil Fertility Conference Proceedings. Schlegel, A.J. (Ed.) Great Plains Soil Fertility Conference. March 1998. Denver, CO.

Ortega, R.A., D.G. Westfall, and G.A. Peterson. 1998. Using natural soil variability in landscapes: Site specific management of nitrogen on dryland corn. p. 98-113. *IN*: 1998 Fluid Forum Proc. Sponsored by the Fluid Fertilizer foundation, February, 22-25, 1998, Scottsdale, AZ.

Westfall, D.G., R.A. Ortega, and G.A. Peterson. 1998. Landscape variability and wheat managment. p. 1-8. *IN:* Proc. Intensive Wheat Mgt. Conf. Mar 4-5, 1998, Denver, CO. Sponsored by The Potash and Phosphate Institute.

Peterson, G.A. and D.G. Westfall. 1998. Efficient nutrient use in no-till intensively cropped dryland systems. p. 57-66. Proceedings of the 6th Congresso Nacional de AAPRESID. 19-21 August. Mar del Plata, Argentina.

Westfall, D.G., R.A. Ortega, and G.A. Peterson. 1998. Spatial variability of soil P and its impact on dryland winter wheat yields. V. 1, p. 301. *IN:* Proc 16th World Congress of Soil Science. August 20-26, 1998. Montpellier, France.

Ortega, R.A., D.G. Westfall, G.A. Peterson, and W.J. Gangloff . 1999. Using natural variability in landscapes to calibrate soil tests. p. 64-77. IN: Proc. Fluid Forum. 21-23 Feb. 1999. Scottsdale, AZ.

Peterson, G.A. and D.G. Westfall.1999. Adapt versus adopt: If it works in Saskatchewan why won't it work here?. Proceedings of the 11th Annual Conference of the Colorado Tillage Association. 2-3 February 1999. Sterling, Colorado.

Sherrod, A.L., G.A. Peterson, D.G. Westfall, and L.R. Ahuja. 2000. Carbon sequestration rates after 12 years under no-till dryland cropping systems rotations. p. 75-81. IN: Great Plains Soil Fertility Conference Proceedings. Schlegel, A.J. (Ed.) Great Plains Soil Fertility Conference. March 2000. Denver, CO.

Peterson, G.A., D.G. Westfall, L.A. Sherrod, and T.M. Shaver. 2000. Dryland agroecosystem management for the Central Great Plains. Proceedings of Farming and Ranching for Profit, Stewardship, and Community Conference. 7-9 March 2000. Portland, OR.

Mosier, A.R., G.A. Peterson, L.A. Sherrod. 2003. Mitigating net Global Warming Potential (CO_2, CH_4, and N_2O Emissions) in upland Crop Production. Methane and Nitrous Oxide International Workshop Proceedings, Nov. 17-21, Beijing, China. p. 273-280.

Sherrod, L.A., G.A. Peterson, D.G. Westfall, and L.R. Ahuja. 2004. Carbon Budget in Dryland Agroecosystems after 12 Years in No-till as Affected by Climate Gradient, Slope Position, and Cropping Intensity. *In* Proceedings of the 2004 Great Plains Soil Fertility Conference, Denver, CO. March 2nd & 3rd. pgs. 234-239.

Westfall, D. G., Carlos Cantero, G. A. Peterson, and L. Sherrod. 2006. Effect of no-till dryland cropping systems and evapotranspiration gradient on the retention of crop residue in semi-arid environments. Proc. Soil and Water Cons. Society Conf. July 22-26, 2006. Keystone, CO. Pg. 9-10.

Del Grosso, S.J., L.A. Sherrod, A. Mosier, G.A. Peterson, L.R. Ahuja, and N.C. Hansen. 2008**.** Impacts of Cropping Intensity on Soil C and Net Greenhouse Gas Fluxes for Dryland Cropping in Northeastern Colorado. Proc. Great Plains Soil Fertility Conference. Vol. 12, pp. 40-44.

Sherrod, L.A., L.R. Ahuja, N.C. Hansen. 2010. No-Till Cropping System Effects on Soil Profile Organic Carbon (0-24 inch) and Total Nitrogen after 7 Years of Drought. Proc. Great Plains Fertility Conf. Denver, CO. March 2-3, 2010. pp. 156-162.

Hansen, N.C., J.G. Pritchett, D.G. Westfall, J.R. Herman, and L.A. Sherrod. 2010. Irrigated Cropping Systems in a Water Limited Environment. Proc. Great Plains Fertility Conf. Denver, CO. March 2-3, 2004. pp. 59-64.

Reyes-Fox, M.A., S.J. Del Grosso, L.A. Sherrod, G.A. Peterson, L.R. Ahuja, and N.Hansen. 2012**.** Can DAYCENT Represent Impacts of Slope and Cropping Intensity on Soil C and Yields For Dryland Systems in Eastern Colorado? Proc. Great Plains Soil Fertility Conference. Vol. 14, pp. 246-251.

Technical bulletins or other reports:

Peterson, G. A., D. G. Westfall, W. Wood and S. Ross. 1988. Crop and soil management in dryland agroecosystems. Tech. Bull. LTB88-6. Colorado State University and Agricultural Experiment Station. Ft. Collins, CO.

Peterson, G. A., D. G. Westfall, C. W. Wood, L. Sherrod and E. McGee. 1989. Crop and soil management in dryland agroecosystems. Tech. Bull. TB89-3. Colorado State University and Agricultural Experiment Station. Ft. Collins, CO.

Peterson, G. A., D. G. Westfall, C. W. Wood, L. Sherrod and E. McGee. 1990. Crop and soil management in dryland agroecosystems. Tech. Bull. TB90-1. Colorado State University and Agricultural Experiment Station. Ft. Collins, CO.

Peterson, G. A., D. G. Westfall, L. Sherrod, E. McGee and R. Kolberg. 1991. Crop and soil management in dryland agroecosystems. Tech. Bull. TB91-1. Colorado State University and Agricultural Experiment Station. Ft. Collins, CO.

Peterson, G.A., D.G. Westfall, L. Sherrod, E. McGee and R. Kolberg. 1992. Crop and soil management in dryland agroecosystems. Tech. Bul.TB92-2. Colorado State University and Agricultural Experiment Station. Ft. Collins, CO.

Croissant, R.L., G.A. Peterson, and D.G. Westfall. 1992. Dryland cropping systems in eastern Colorado. Service in Action No. 516. Cooperative Extension. Colo. State Univ. Fort Collins, CO.

Peterson, G.A., D.G. Westfall, N.E. Toman, and R.L. Anderson. 1993. Sustainable dryland cropping systems: Economic analysis. Tech. Bul. TB93-3. Colorado State University and Agricultural Experiment Station. Ft. Collins, CO.

Peterson, G.A., D.G. Westfall, L. Sherrod, R. Kolberg, and B. Rouppet. 1993. Sustainable dryland agroecosystem management. Tech. Bul. TB93-4. Colorado State University and Agricultural Experiment Station. Ft. Collins, CO.

Kolberg, R.L., D.G. Westfall, G.A. Peterson, N.R. Kitchen, and L. Sherrod. 1993. Nitrogen fertilization of dryland cropping systems. Tech. Bul. TB93-6. Colorado State University and Agricultural Experiment Station. Ft. Collins, CO.

Peterson, G.A., D.G. Westfall, L. Sherrod, R. Kolberg, and B. Rouppet. 1994. Sustainable dryland agroecosystem management. Tech. Bul. TB94-1. Colorado State University and Agricultural Experiment Station. Ft. Collins, CO.

Peterson, G.A., D.G. Westfall, L. Sherrod, R. Kolberg, and D. Poss. 1995. Sustainable dryland agroecosystem management. Tech. Bul. TB95-1. Colorado State University and Agricultural Experiment Station. Ft. Collins, CO.

Peterson, G.A., D.G. Westfall, L. Sherrod, R. Kolberg, and D. Poss. 1996. Sustainable dryland agroecosystem management. Tech. Bul. TB96-1. Colorado State University and Agricultural Experiment Station. Ft. Collins, CO.

Nielsen, D., G.A. Peterson, R. Anderson, V. Ferreira, W. Shawcroft, and K. Remington. 1996. Estimating corn yields from precipitation records. Cons. Tillage Fact Sheet 2-96. USDA/ARS and USDA/NRCS. Akron, CO.

Peterson, G.A., D.G. Westfall, L. Sherrod, D. Poss, K. Larson, D.Thompson, D. 1997. Sustainable dryland agroecosystem management. Tech. Bull. TB97-3. Colorado State University and Agricultural Experiment Station, Fort Collins, CO.

Peterson, G.A., D.G. Westfall, L. Sherrod, D. Poss, K. Larson, D. Thompson, and L.R. Ahuja. 1998. Sustainable dryland agroecosystem management. Tech. Bull. TB98-1. Agric. Exp. Stn., Colo. State Univ., Fort Collins, CO.

Peterson, G.A., D.G. Westfall, F.B. Peairs, L. Sherrod, D. Poss, W. Gangloff, K. Larson, D. Thompson, L.R. Ahuja, M.D. Koch, and C.B. Walker. 1999. Sustainable dryland agroecosystem management. Tech. Bull. TB99-1. Agric. Exp. Stn., Colo. State Univ., Fort Collins, CO.

Peterson, G.A., D.G. Westfall, F.B. Peairs, L. Sherrod, D. Poss, W. Gangloff, K. Larson, D. Thompson, L.R.. Ahuja, M.D. Koch, and C.B. Walker. 2000. Sustainable dryland agroecosystem management. Tech. Bull. TB00-3. Agric. Exp. Stn., Colo. State Univ., Fort Collins, CO.

Kaan, D.A., O'Brien, D.M., Burgener, P.A., Peterson, G.A., and Westfall, D.G. 2002. An economic evaluation of alternative crop rotations compared to wheat-fallow in Northeastern Colorado. Tech. Bull. TB02-1. Agric. Exp. Stn., Colo. State Univ., Fort Collins, CO. Kaan, D.A., O'Brien, D.M., Burgener, P.A., Peterson, G.A., and Westfall, D.G. 2002. An economic evaluation of alternative crop rotations compared to wheat-fallow in Northeastern Colorado. Tech. Bull. TB02-1. Agric. Exp. Stn., Colo. State Univ., Fort Collins, CO.

Westfall, D.G., Peterson, G.A., Peairs, F.B., Sherrod, L., Poss, D., Shaver, T., Larson, K., Thompson, D., Ahuja, L.R., Koch, M.D., and C.B. Walker. 2004. Sustainable dryland agroecosystem management. Tech. Bull. TB04-05. Agric. Exp. Stn., Colo. State Univ., Fort Collins, CO.

Davis, J. G. and D. G. Westfall. 2009. Corn Fertilization.. CSU Service-In-Action Sheet No. 0.538.

Westfall, D.G., G.A. Peterson, F.B. Peairs, L.A. Sherrod, D.J. Poss, T. Shaver, K. Larson, D.L. Thompson, L.R. Ahuja, M.D. Koch, and C.B. Walker, 2004. Sustainable dryland agroecosystem management. Experiment Station Technical Bulletin TB04-05.

D.G. Westfall, L. Sherrod, F. B. Peairs, D. Poss, N.C. Hansen, G.A. Peterson, T. Shaver, K. Larson, D.L. Thompson, L.R. Ahuja, M.D. Koch, and C. B. Walker. 2012. Sustainable dryland agroecosystem management. Experiment Station Technical Bulletin TB12-01.

Peairs, F.B., N. C. Hansen, D. Poss, D. G. Westfall, G. A. Peterson, J. C. Herman, L. Sherrod, T. M. Shaver, T. Randolph, and J. Rudolph. 2013. Agronomic & Entomological Results from 7 years of Dryland Cropping Systems Research at Briggsdale, Colorado. Experiment Station Technical Bulletin TB13-xx (In press).

Published Abstracts:

Peterson, G. A. and D. G. Westfall. 1987. Integrated research: a necessity for the future of soil and crop management. Agron. Abstracts p. 213. Amer. Soc. of Agron., Madison, WI.

Peterson, G. A., C. W. Wood and D. G. Westfall. 1988. Building a crop residue base in no-till cropping systems. Agron. Abstracts p. 246. Amer. Soc. of Agron., Madison, WI.

Kitchen, N. R., D. G. Westfall and G. A. Peterson. 1989. Potential N and C mineralization in dryland no-till cropping soils as influenced by N fertilization management. Agron. Abstracts p. 244. Amer. Soc. of Agron., Madison, WI.

Peterson, G. A., D. G. Westfall. 1989. Long-term soil-crop management research for the 21st century. Agron. Abstracts p. 249. Amer. Soc. of Agron., Madison, WI.

Westfall, D. G., N. R. Kitchen and J. L. Havlin. 1989. Soil sampling procedures under no-till banded phosphorus fertility. Agron. Abstracts p. 256. Amer. Soc. of Agron., Madison, WI.

Wood, C. W., G. A. Peterson and D. G. Westfall. 1989. Potential C and N mineralization in dryland agroecosystems as affected by landscape position and crop rotation. Agron. Abstracts p. 256. Amer. Soc. of Agron., Madison, WI.

Follett, R. H., G. A. Peterson, C. W. Wood and D. G. Westfall. 1989. Developing a crop residue base to decrease erosion potential. Abstract of the Annual Meeting of the Soil and Water Conservation Society. 30 July 1989. Edmonton, Canada.

Kitchen, N. R., D. G. Westfall and G. A. Peterson. 1990. Nitrogen fertilization management in no-till dryland cropping systems. Agron. Abstracts p. 272. Amer. Soc. of Agron., Madison, WI.

Peterson, G. A., C. W. Wood and D. G. Westfall. 1990. Cumulative biomass production and N utilization in no-till dryland agroecosystems. Agron. Abstracts p. 322. Amer. Soc. of Agron., Madison, WI.

Wood, C. W., D. G. Westfall and G. A. Peterson. 1990. Impact of cropping intensity under no-till on soil C and N. Agron. Abstracts. p. 328. Amer. Soc. of Agron., Madison, WI.

Evans, S.D., G.A. Peterson, D.G. Westfall, and E.A. McGee. 1991. Nitrate leaching in dryland agroecosystems as influenced by soil and climate gradients. Agron. Abstracts. p.330. Amer. Soc. of Agron., Madison, WI.

McGee, E.A., G.A. Peterson, and D.G. Westfall. 1991. Water-use efficiency of dryland no-till cropping systems in the west central Great Plains. Agron. Abstracts. p.336. Amer. Soc. of Agron., Madison, WI.

McMaster, G.S., J.A. Morgan, and G.A. Peterson. 1991. Wheat yield components for different cropping systems, climates, and catenas. Agron. Abstracts. p.153. Amer. Soc. of Agron., Madison, WI.

Peterson, G.A., D.G. Westfall, and E.A. McGee. 1992. Increasing productivity and sustainability of dryland agroecosystems. Abstracts of the First International Crop Science Congress. 14-22 July, 1992. Ames, Iowa. Crop Science Society of America. Madison, WI.

Westfall, D.G., and G.A. Peterson. 1992. Sustainable dryland agroecosystems. Agron. Abstracts. p. 86. Amer. Soc. of Agron., Madison, WI.

McGee, E.A., G.A. Peterson, and D.G. Westfall. 1992. Water-use efficiency as affected by cropping intensity, slope, and evaporative gradient in no-till dryland agroecosystems. Agron. Abstracts. p. 331. Amer. Soc. of Agron., Madison, WI.

Iremonger, C.J., D.G. Westfall, and G.A. Peterson. 1992. Fertilizer phosphorus and cropping intensity effects on P availability. p. 86-92. IN: Proc. Western Phosphorus/Sulfur Workshop. Aug. 6-8, 1992. Anchorage, AK.

Peterson, G.A., D.G. Westfall, N.E. Toman, and R.L. Anderson. 1993. Sustainable dryland cropping systems: Economic analysis. Agron. Abstracts p. 325. Amer. Soc. of Agron., Madison, WI.

Kolberg, R.L., B. Rouppet, D.G.Westfall, and G.A. Peterson. 1993. In situ soil nitrogen mineralization methodology. Agron. Abstracts p. 276. Amer. Soc. of Agron., Madison, WI.

Halvorson, A.D., G.A. Peterson, and S.E. Hinkle. 1993. Tillage and cropping system effects on dryland wheat and corn production. Agron. Abstracts p. 316. Amer. Soc. of Agron., Madison, WI.

Mrabet, R., A. Bouzza, and G.A. Peterson. 1993. Potential reduction in soil erosion in Morocco using no-till systems. Agron. Abstracts p. 323. Amer. Soc. of Agron., Madison, WI.

Rouppet, B., D.G. Westfall, and G.A. Peterson. 1994. In-situ nitrogen mineralization in no-till dryland agroecosystems. Agron. Abstracts p. 316. Amer. Soc. of Agron., Madison, WI.

Peterson, G.A., A.J. Schlegel, D.L. Tanaka, and O.R. Jones. 1994. Precipitation use efficiency as related to cropping systems and tillage. Agron. Abstracts p. 356. Amer. Soc. of Agron., Madison, WI.

Ortega, R.A., G.A. Peterson, and D.G. Westfall. 1994. Net nitrogen mineralization as affected by cropping systems and residue production. Agron. Abstracts p. 372. Amer. Soc. of Agron., Madison, WI.

Peterson, G.A., D.G. Westfall, N.E. Toman and R.L. Anderson. 1994. Sustainable dryland cropping systems on the Colorado High Plains: Economic analysis. AAAS-WSSA Meeting Abstract. 20-23 April 1994.

Sherrod, L., G.A. Peterson, D.G. Westfall, and R.L. Kolberg. 1995. Carbon and nitrogen dynamics as affected by rotation intensity in the Great Plains. Agron. Abstracts p. 25. Amer. Soc. of Agron., Madison, WI.

Peterson, G.A., A.L. Black, A.D. Halvorson, J.L. Havlin, O.R. Jones, and D.J. Lyon. 1995. North American agricultural soil organic matter network: The American Great Plains. Agron. Abstracts p. 25. Amer. Soc. of Agron., Madison, WI.

Ortega, R.A., G.A. Peterson, and D.G. Westfall. 1995. Phosphorus test calibration using spatial variability of a landscape in eastern Colorado. Agron. Abstracts p. 268. Amer. Soc. of Agron., Madison, WI.

Rodriguez, J.B., J.R. Self, G.A. Peterson, and D.G. Westfall. 1995. Sodium bicarbonate-DTPA test for macro and micro nutrients in soils. Agron. Abstracts p. 317. Amer. Soc. of Agron., Madison, WI.

Farahani, H.J., L.A. Ahuja, G.W. Buchleiter, and G.A. Peterson. 1995. Mathematical modeling of irrigated and dryland corn production in eastern Colorado. Abstract for Clean Water-Clean Environment-21st Century Symposium. March 1995. Kansas City, MO.

Farahani, H.J., L.A. Ahuja, G.A. Peterson, R. Mrabet, and L. Sherrod. 1995. Root zone water quality model evaluation of dryland/no-till crop production in eastern Colorado. Abstract of International Symposium on Water Quality Modeling. April 1995. Kissimmee, FL.

Peterson, G.A. and D.G. Westfall. 1995. Post-CRP land use-alternative systems. Abstract of Symposium on Converting CRP-Land to Cropland and Grazing: Conservation Technologies of the Transition. Sponsored by Soil and Water Cons. Soc. of Amer. 6-8 June 1995. Lincoln, NE.Sherrod, L., G.A.Peterson, and D.G. Westfall. 1996. No-till rotational residue dynamics across an ET gradient. Agron. Abstracts p. 282. Amer. Soc. of Agron., Madison, WI.

Poss, D.J, G.A. Peterson, and D.G. Westfall. 1996. Growing annual legumes in dryland agroecosystems in northeastern Colorado. Agron. Abstracts p. 283. Amer. Soc. of Agron., Madison, WI.

Halvorson, A.D., C.A. Reule, and G.A. Peterson. 1996. Long-term N fertilization effects on soil organic C and N. Agron. Abstracts p. 276. Amer. Soc. of Agron., Madison, WI.

Kolberg, R.L., D.G. Westfall, and G.A. Peterson. 1996. Influence of cropping intensity and nitrogen fertilizer rates on *In situ* nitrogen mineralization. Agron. Abstracts p. 247. Amer. Soc. of Agron., Madison, WI.

Farahani, H.J., G.A. Peterson, D.G. Westfall, L.A. Sherrod, and L.A. Ahuja. 1996. The inefficiency of summer fallow in dryland no-till cropping systems. Agron. Abstracts p. 295. Amer. Soc. of Agron., Madison, WI.

Iremonger, C.J., D.G. Westfall, G.A. Peterson, and R.L. Kolberg. 1997. Nitrogen fertilizer induced soil pH drift in a no-till dryland cropping system. Agron. Abs. p.225. Amer. Soc. of Agron., Madison, WI.

Ortega, R.A., D.G. Westfall, and G.A. Peterson, G.A. 1997. Spatial variability of soil P and its impact on dryland winter wheat yields. Agron. Abs. p.231. Amer. Soc. of Agron., Madison, WI..

Peterson, G.A., D.G. Westfall, H.J. Farahani, L.A. Sherrod, and L.R. Ahuja. 1997. Enhancing productivity of central Great Plains dryland agroecosystems. Agron. Abs. p.261. Amer. Soc. of Agron., Madison, WI..

Westfall, D. G., R.A. Ortega, and G.A. Peterson. 1997. Spatial variability of soil properties and wheat yields over landscapes. p. 11-12. *IN*: Abstracts of 1st European Conf. on Precision Agr. Sept. 7-10, 1997. Warwick University.

Ortega, R.A., W.J. Gangloff, D.g. Westfall, and G.A. Peterson. 1998. Multivariate approach to nitrogen recommendations for dryland corn in eastern Colorado. Agron. Abs. p.55. Amer. Soc. of Agron., Madison, WI.

Peterson, G.A., L.A. Sherrod, D.G. Westfall, and L.R. Ahuja. 1998. Intensive dryland cropping systems increase soil organic matter. Agron. Abs. p.276. Amer. Soc. of Agron., Madison, WI.

Guzman, J., G.A. Peterson, D.G. Westfall, and P.L. Chapman. 1998. Dryland corn yields as a function of weather and soil variables. Agron. Abs. p.277. Amer. Soc. of Agron., Madison, WI.

Lyon, D.J. and G.A. Peterson. 1999. Three crops in three years with no-till dryland systems in the semiarid Great Plains. Agron. Abs. p.100. Amer. Soc. of Agron., Madison, WI.

Grant, C.A., G.A. Peterson and C. A. Campbell. 1999. Nutrient considerations for diversified cropping systems in the Northern Great Plains. Agron. Abs. p.101. Amer. Soc. of Agron., Madison, WI.

Kruger, H.K. G.A. Peterson, and D.G. Westfall. 1999. Below ground dry matter production and nitrogen content of four legumes in dryland agroecosystems. Agron. Abs. p.245. Amer. Soc. of Agron., Madison, WI.

Poss, D.J., G.A. Peterson, and D.G. Westfall. 1999. Austrian winter pea in dryland systems in Northeastern Colorado. Agron. Abs. p.279. Amer. Soc. of Agron., Madison, WI.

Sherrod, L.A.,G.A. Peterson, D.G. Westfall, and L.R. Ahuja. 1999. Carbon sequestration rates after 12 years under no-till dryland cropping systems rotations. Agron. Abs. p.280. Amer. Soc. of Agron., Madison, WI.

Shaver, T.M., G.A. Peterson, D.G. Westfall, and L.R. Ahuja. 1999. Surface soil properties after 12 years of dryland no-till management. Agron. Abs. p.280. Amer. Soc. of Agron., Madison, WI.

Berrada, A. and G.A.Peterson. 2000. Development of a sustainable dryland cropping systems in SW Colorado and SE Utah. Agron. Abs. p.132. Amer. Soc. of Agron., Madison, WI.

Gangloff, W., D.G. Westfall, and G.A. Peterson. 2000. Availability of organic and inorganic zinc fertilizers. Agron. Abs. p.277. Amer. Soc. of Agron., Madison, WI..

Gangloff, W., R. Ortega, R.M. Reich, D.G. Westfall, and G.A.Peterson. 2000. Statistical analysis of the management zone concept. Agron. Abs. p.358. Amer. Soc. of Agron., Madison, WI..

McMaster, G.S., L.A. Deer-Ascough, J.C. Ascough, G.A. Peterson, G. Dunn, C. Palic, M. Shaffer, and M.A. Welz. 2000. Using the GPFARM DDS for evaluating dryland cropping system production and economics in the west central Great Plains. Agron. Abs. p.22. Amer. Soc. of Agron., Madison, WI.

Peterson, G.A., D.G. Westfall, L.R. Ahuja, L.A. Sherrod, and D.J. Poss. 2000. Advances in dryland agroecosystems: Results of 15 years of research. Agron. Abs. p.310 Amer. Soc. of Agron., Madison, WI..

Shaver, T.M., G.A. Peterson, D.G. Westfall, L.A, Sherrod, L.R. Ahuja, and G. Dunn. 2000. No-till cropping system effects on organic carbon content of surface soil aggregates, POM, and mineral fractions. Agron. Abs. p.311. Amer. Soc. of Agron., Madison, WI.

Sherrod, L.A., G. Dunn, G.A. Peterson, and R.L. Kolberg. 2000. Total inorganic carbon analysis by modified pressure calcimeter. Agron. Abs. p.365 Amer. Soc. of Agron., Madison, WI..

Sorge, G.M., G.A. Peterson, D.G. Westfall, and J.M. Krall. 2000. Incorporating legumes in semiarid, no-till agroecosystems: Soil quality effects. Agron. Abs. p.317 Amer. Soc. of Agron., Madison, WI..

Andales, A.A., Ahuja, L.R., and Peterson, G.A. 2002. A modeling approach to the evaluation of altenative cropping systems. Agron. Abs. Amer. Soc. of Agron., Madison, WI. Indianapolis, IN 10-14 Nov. 2002.

Andales, A.A., Ahuja, L.R., and Peterson, G.A. 2002. A modeling approach to the evaluation of altenative cropping systems. Agron. Abs. Amer. Soc. of Agron., Madison, WI. Indianapolis, IN 10-14 Nov. 2002.

Halvorson, A.D., Del Grosso, S.J., Mosier, A.R., Parton, W.J., Peterson, G.A., and Robertson, G.P. 2003. Measurement and modeling of soil atmosphere N2O and CO2 exchange for global warming potential in agroecosystems. Agron. Abs. Amer. Soc. of Agron., Madison, WI. Denver, CO 2-6 Nov. 2003.

Reeder, S.J., L.A. Sherrod, C.A. Cambardella. 2003. Direct analysis of POM-C using loss-on-ignition to correct for sand weight. Agron. Abs. Amer. Soc. Agron. Madison, WI. Denver, CO 2-6 Nov. 2003.

Sherrod, L.A., Peterson, G.A., Westfall, D.G. and Ahuja, L.R. 2003. Soil organic carbon pools after 12 years in a no-till agroecosystem as impacted by PET gradient, topography, and cropping system intensity. Agron. Abs. Amer. Soc. of Agron., Madison, WI. Denver, CO 2-6 Nov. 2003.

Johnson, C.K., Eskridge K.M., Wienhold, B.J., Doran, J.W., Peterson, G.A., Buchleiter, G.W. and Corwin, D.L. 2003. Designing field scale experiments using apparent soil electrical conductivity. Agron. Abs. Amer. Soc. of Agron., Madison, WI. Denver, CO 2-6 Nov. 2003.

Andales, A.A., Ahuja, L.R., Green, T.R., Erskine, R.H., and Peterson, G.A. 2003. Spatial and temporal correlations among dryland grain yield and soil water content in a sloping field. Agron. Abs. Amer. Soc. of Agron., Madison, WI. Denver, CO 2-6 Nov. 2003.

Koch, M.D., Peairs, F.B., and Peterson, G.A. 2003. Integrating pest management with dryland cropping rotations. Agron. Abs. Amer. Soc. of Agron., Madison, WI. Denver, CO 2-6 Nov. 2003.

Poss, D.J., Peterson, G.A., and Peairs, F.B. 2003. Dryland cropping systems in a low precipitation high evapotranspiration environment. Agron. Abs. Amer. Soc. of Agron., Madison, WI. Denver, CO 2-6 Nov. 2003.

Sherrod, L. A., G. A. Peterson, D. G. Westfall, and L. R. Ahuja. 2003. Soil organic carbon pools after 12 years in no-till agroecosystems as impacted by PET gradient, topography and cropping systems intensity. Agron. Abs. Amer. Soc. of Agron., Madison, WI.

Ma, L., L.A. Sherrod, G.A. Peterson, N. Hansen, L.R. Ahuja, L.R. 2006**.** Soil organic carbon pool changes under long-term no-till and cropping intensity regimes across an evapotranspiration gradient in Eastern Colorado, USA. Inter. Soil Tillage Res. Org. Proc. Kiel, Germany. 8/28-9/23 2006.

Peterson, G. A. and Westfall. D.G. 2004. Landscapes, soil and water conservation, and diversity in Great Plains agroecosystems. Agron Abs. Amer. Soc. of Agron., Madison, WI.

Peterson, G.A., D.G. Westfall, and L.R. Ahuja. 2006. Managing precipitation use in dryland systems to enhance productivity and sustainability. (Invited paper) Abstract [37-2] of the 18th World Congress of Soil Science. Philadelphia, PA.

Westfall, D. G., Carlos Cantero, G. A. Peterson, and L. Sherrod. 2006. Crop residue levels over a 12-yr period of no-till cropping systems in a semi-arid environment. Abstract 1555a of the18th World Congress of Soil Science. Philadelphia, PA.

Lloyd, G., L.A. Sherrod, N.C. Hansen, L. Ahuja and D.G. Westfall. 2009. Biomass Production Potential of Wheat, Corn, and Sorghum in Dryland Cropping Environments. Agron. Abs. Amer. Soc. of Agron., Madison, WI.

Sherrod, L.A**.**, J.D. Reeder, W. Hunter, and L.R. Ahuja. 2009. A Rapid and Cost Effective Soil Carbon Mineralization Method for Static Incubations. Agron. Abs. Amer. Soc. Agron. Madison, WI. Pittsburgh, PA 1-5 Nov. 2009.

Sherrod, L.A**.**, Ahuja, L.R., Hansen, N.C., Westfall, D.G., and Peterson, G.A. 2009. Impact of Precipitation Timing on Soil Water at Planting on Wheat and Corn Yields in the Central Great Plains. Agron. Abs. Amer. Soc. Agron. Madison, WI. Pittsburgh, PA 1-5 Nov. 2009.

Sherrod, L.A., L.R. Ahuja, N.C. Hansen, G.A. Peterson, and D.G. Westfall. 2010. Drought and Cropping Intensity Impact on Soil Organic Carbon and Total N Across a Catena Sequence. Agron. Abs. Amer. Soc. Agron. Madison, WI. Long Beach, CA. 31 Oct.-4 Nov. 2010.

Lloyd, G. and N. Hansen. 2010. Limitations to residue harvest in semi-arid cropping systems. Agron. Abs. Amer. Soc. Agron. Madison, WI. Long Beach, CA. 31 Oct – 4 Nov 2010.

Peterson, G.A. and D.G. Westfall. 2012. Charting the Future for Soil Management with an Eye to our History. Agron. Abs. Amer. Soc. Agron. Madison, WI. Cincinnati, OH. 21 -24 Oct 2012.

Non-technical papers:

Westfall, D. G. and G. A. Peterson. 1990. Improving your dryland performance. Solutions 34(5):32-34 and 49.

Wood, C. W., G. A. Peterson and D. G. Westfall. 1990. Greater crop management intensity increases soil quality. Better Crops 74(3):20-22.

Westfall, D.G., G.A. Peterson, and J.L. Sanders. 1992. Phosphorus reduces stress in intensive dryland no-till crop rotations. Better Crops with Plant Food. Vol. 76. Fall 1992. pp. 20-21.

Westfall, D.G., G.A. Peterson, R.L. Kolberg, and L. Sherrod. 1994. Extra crop is payoff in dryland no-till intensified cropping system. Fluid Journal 2:18-20.

Peterson, G.A. 1996. Nitrogen: The vital nutrient in the Great Plains. Fluid Journal Vol.4, No.3, p.18-21.

Peterson, G.A. and D.G. Westfall. 1996. Maximum water conservation after wheat harvest. Cons. Tillage Digest Vol.3. No.5, p.9.

Ortega, R.A., D.G. Westfall, and G.A. Peterson. 1997. Variability of phosphorus over landscapes and dryland winter wheat yields. Better Crops: 81(2) 24-27.

Peterson, G.A. and D.G. Westfall. 1998. No-till practices in the Central Great Plains make summer fallow unnecessary. Conservation Tillage Digest 5:(No. 5)14-16.

Ortega, R.A., D.G. Westfall, G.A. Peterson, and W.J. Gangloff. 1998. Soil variability in landscapes affects nitrogen management. Fluid Journal. Vol. 6: (No. 3) 23-26.

Sherrod, L.A. and G.A. Peterson. 2002. Eliminating Summer Fallow Maximizes Carbon Sequestration in Dryland Cropping Systems. From The Ground Up Agronomy News, Cooperative Extension, Colorado State University. Pages 9-10. May 2002 Vol. 22 Issue 2.

Helm, A., and N. Hansen. 2008. Crop Rotation That Reduce Fallow Frequency in Dryland Crop Rotations. From The Ground Up: Agronomy News 27 (4): 3-5.

Norvell,K. N.C. Hansen, D.G. Westfall, and L.R. Ahuja. 2008. Runoff and Erosion Estimates for Great Plains Dryland Agroecosystems. Proceedings of AGU Hydrology Days 2008: 79-87.

Sherrod, L.A**.**, L.R. Ahuja, N.C. Hansen, K. Larson, D. Thompson, D. Harn, C. Thompson. 2010. Water Storage and Precipitation Impacts on Wheat and Sorghum Yields Over 22 Years at Stonington (Bill Wright Farm). TR10-02 January 2009; Plainsman Research Center 2009 Research Reports; Agricultural Experiment Station, Colorado State University, pp 101-105.

Barbarick, K., N. Hansen, and J. McDaniel. 2010. Biosolids Application to No-Till Dryland Rotations: 2008 Results. TR 10-04. Agric. Exp. Stn., Colo. State Univ., Fort Collins, CO.

Barbarick, K., N. Hansen, and J. McDaniel. 2011. Biosolids Application to No-Till Dryland Rotations: 2009 Results. TR 11-06. Agric. Exp. Stn., Colo. State Univ., Fort Collins, CO.

Barbarick, K., N. Hansen, and J. McDaniel. 2012. Biosolids Application to No-Till Dryland Rotations: 2010 and 2011 Results. TR 12-06. Agric. Exp. Stn., Colo. State Univ., Fort Collins, CO.