North Dakota State University * Dickinson Research Extension Center
1133 State Avenue, Dickinson, ND 58601 Voice: (701) 483-2348 FAX: (701) 483-2005

Crop Production Trials

AGRONOMIC INVESTIGATIONS at the DICKINSON RESEARCH CENTER

by
Mr. Thomas J. Conlon
Superintendent and Agronomist

Production of Cereal Cultivars, Corn, Sunflower, Safflower and Miscellaneous Minor and New Crops in Southwestern North Dakota

New crop cultivars and advanced experimentals from public and private agencies must be evaluated for their agronomic merit and usefulness in processed products as compared to varieties now grown. The North Dakota Agricultural Experiment Station is obligated to obtain information and make recommendations based on unbiased data and interpretations which the producer may use to choose cultivars for farm production. This project collects the necessary information on comparative performance of cultivars and cereals in southwestern North Dakota (1) To assist in evaluation of unnamed cultivars for possible release to North Dakota farmers; (2) To provide grain for quality analysis; and (3) to provide production recommendations of varieties released by both public and private sources.

The project includes three separate experimental categories for cereal cultivars, including (1) regional nursery trials to evaluate advanced experimental genotypes of cereal grains; (2) comparison trials of named cereal cultivars and advanced experimentals in the final testing stages preparatory to release as named varieties; (3) off-station testing of newly released varieties from both public and private sources.

Regional Nursery Trials

Each year regional testing is done by agronomists in the U.S. and Canada cooperating with regional project leaders in North Dakota, South Dakota, Montana and Minnesota. Nurseries presently under test include:

The Uniform Regional Hard Red Spring Wheat Nursery
The Uniform Regional Durum Nursery
The Western Spring Barley Nursery
The Western Dryland Barley Nursery
The Advanced Two Row Barley Nursery
The Early Oat Nursery
The Midseason Oat Nursery

Variety Comparison Trials

This project provided much of the early yield, quality and agronomic evaluation of crop varieties in North Dakota. Each year this project evaluates approximately 40 or more hard red spring wheat (Triticum aestivum L.), 25 to 30 durum wheat (Triticum turgidum L.), 10 to 15 oat (Avena sativa L.), 10 to 15 six-rowed barley (Hordeum vulgare L.), 10 to 15 two-rowed barley (Hordeum distichon L.) 8 to 12 winter wheat (Triticum aestivum L.) and 6 to 10 winter rye (Secale cereale L.) cultivars. Genotypes evaluated include both named cultivars and experimental lines from NDSU, and other public and private breeding programs in the United States and Canada. Evaluations are used to make varietal recommendations. The grain produced from the hard red spring wheat, durum wheat and both two and six rowed barley plots is important because it is used in quality evaluations. Quality evaluations of experimental lines are compared to cultivars now grown by producers. The quality and agronomic performance of a genotype at various locations are the major bases for the recommended release of that line as a named variety or its removal from consideration for further testing. Data from this project in part determine which cultivars of these major crops will be released by the experiment station for commercial production. Experimental lines from other state universities and private plant breeding companies also are evaluated for quality. Although data from this project are not instrumental in the eventual release or rejection of private varieties they provide information on genotype and agronomic characteristics prior to release and assist in making cultivar recommendations.

Off-Station Testing

The principal objective of off-station trials is to provide a wider base for interpretation of yield data as it relates to varied soil types and growing conditions over the 14 counties of the Missouri Slope area. While the soils at the Dickinson Branch Station are representative of a large percent of those of southwestern North Dakota they are not representative of all soil types being used for crop production in the region. Five different soil types are represented in the off-station trials. Local climatic differences also influence crop growth response. Data from these trials are combined with data from the off-station trials of the Hettinger Branch Station to provide a diverse test of crop performance at eleven locations in southwestern North Dakota.

Demonstration Plots

The same field plots used for yield and quality evaluations also serve as demonstration plots. This allows producers and scientists to observe the varieties and experimental lines of cereal crops grown in comparison trials for reaction to disease and insect pests.

Corn and Sunflower

Corn and sunflower are major crops in southwestern North Dakota.

Corn acreage in the three southwestern crop reporting districts increased from 166,000 acres in 1980 to 207,000 acres in 1984, and averaged 194,500 acres for that 5 year period. Acreage in 1985 was 233,000, in 1986, 215,000 acres, and in 1989, 211,000 acres.

Average annual value of the corn crop in these districts for the five year period 1980-84 was $21,750,000.00, making the average per acre value $111.85. Using this value as a base, the value of the 1989 crop would be $23,600,350.00.

Sunflower acreage increased from 160,000 acres in 1980 to 460,000 acres in 1984, and averaged 307,600 acres annually in the three southwestern districts during that 5 year period. During that time the average annual value of the sunflower crop in those three districts was approximately $32,000,000.00, with the per acre value being $104.03.

Sunflower acreage dropped to 371,000 acres in these three districts in 1985. Production and marketing problems combined to further reduce the acreage in 1986 to 189,500 acres. By 1989 the sunflower acreage in the three southwestern districts had dropped to 127,000 acres. Without some form of price stabilization, acreage of sunflower will no doubt continue to decline.

Modern production technology demands new types of hybrids of both corn and sunflower which will withstand high plant densities, be adapted for narrow row spacing, use fertilizers effectively, be adapted to combine harvesting and be capable of economical and consistent grain production.

New hybrids of both crops are being developed by private seed companies and are evaluated for adaptation to southwestern North Dakota growing conditions. Production practices are also evaluated.

Farmers of this area use the data collected from these trials to decide which hybrids to grow.

Miscellaneous Minor and New Crops

Safflower, sorghum, proso millet, buckwheat and dry beans are minor crops in southwestern North Dakota. Agronomic evaluation of new varieties and experimental lines of these and other miscellaneous crops is needed. Producers and potential processors require information on these crops to assist in making management decisions. New and improved production techniques for use by producers need to be discovered and their impact determined.

Experimental Procedure

Seeding rates are calculated from 1000 kernel weights and germination percentages are adjusted to provide a seeding rate of 1,000,000 live seeds per acre for hard red spring wheat and durum and 750,000 live seeds per acre for oats and barley. These rates are approximately equivalent to 60 pounds of wheat and durum (1 bushel), 65 pounds of barley (1.3 bushel), and 48 pounds of oats (1.5 bushel) per acre.

All variety comparison trials and uniform regional nursery trials are seeded on summer fallow. Rotation and tillage trials follow appropriate cropping sequence. Soil tests are used to determine proper fertilizer application. Herbicide application follows current procedure as outlined in the agricultural weed control guide circular W253 as revised annually. All nursery and yield trials are machine planted with a K.E.M. four-row double disk cone seeder at appropriate rates for each species being tested. Trials are seeded in randomized complete block design in either three or four replications as requested by respective project leaders. Plot size for all regional tests are four by fourteen feet. Plant growth is monitored and agronomic information on planting date, time of emergence, seedling vigor, stand percent, heading date, height, disease and insect phenomena is recorded by station personnel as required by respective project leaders throughout the growing season. Grain yields are determined from hand-harvested plots. Grain samples for quality tests are supplied as requested by respective project leaders.

Variety comparison trials are seeded at the Dickinson Research Center each year. Trials consist of named cereal cultivars and advanced experimental in the final testing stages preparatory to release. All trials are seeded on summerfallow. Soil tests are used to determine proper fertilizer application for selected yield goals. Herbicide application follows current procedure as outlined in the NDSU agricultural weed control guide, circular W253 as revised annually. All trials are planted with a Melroe double disk drill at appropriate rates for each species. Drill row spacing is six inches. Plot size is five feet by one hundred thirty two feet. Trials are seeded in randomized complete block design using four replications. Plant growth is monitored as necessary to record agronomic, disease and insect phenomena occurring during the growing season. Grain yields are determined from combine harvest of the entire plot. Grain samples for quality tests are supplies as requested by the chairman of the Department of Agronomy, NDSU.

Off-station variety comparison trials of newly released varieties from both public and private sources are seeded on selected off-station sites in Golden Valley, Dunn, Morton, Oliver and Mercer Counties. Procedure described for the variety comparison trials is followed for off-station trials also.

All row crops to include corn, sunflower, dry beans and grain sorghum, are planted with an Allis row crop planter equipped with double disk furrow openers spaced 36 inches apart. Trials are planted at an excessive rate and thinned to the desired uniform stand.

Plot size for all row crops are one-fiftieth acre with yield determined from hand-harvested samples of a one-hundredth acre portion of the plot. Grain or seed is weighed at harvest and moisture percentage determined. Yield is determined on a uniform moisture basis for the species being tested. Corn silage yields are determined on a 70%

moisture basis.

All small seeded crops are machine planted with a Melroe double disk drill set at 6 inch row spacing or a K.E.M. double disk cone seeder designed to plant from 3 to 7 rows set at 6 inch spacing, depending on amount of available seed and plot size.

Plot size for all small seeded crops is one-hundredth acre, seed supplies permitting. Yield determinations are from combine harvest. Grain samples for quality test are supplied as required to the Department of Cereal Science and Food Technology, NDSU.

Data are analyzed using statistical procedure for analysis of variance.

Growing Conditions 1988-1990

Severe drought prevailed during the year of 1988. Precipitation during the fall of 1988, September through December, was nearly an inch and a half below average and continued the deficit experienced throughout the summer. Above average precipitation in April, 1989, provided adequate soil water for germination and early season crop growth. Temperatures were moderate, and crop development was fairly good through May and June, even though precipitation was below average for both months. However, above average temperatures in July coupled with below average precipitation of .68 inch combined to create very poor growing conditions for the remainder of 1989.

Precipitation in the fall of 1989 was nearly average and provided adequate soil water for germination and establishment of winter wheat and winter rye, and some stored soil water in both re-crop and fallow. Marginal precipitation in April and May of 1990, provided sufficient soil water for germination and early crop growth of spring seeded crops. June was the month that made the crop, with a total of 5.80 inches of rainfall, well distributed during the month. Measurable precipitation was recorded on 14 days in June. However, luck ran out in July and August with total rainfall for the two months being 2.60 inches below average. Considering the droughty weather pattern of the past three years, yields recorded in 1990 are nothing short of phenomenal.

Weather Summary Table

Tan spot was the principal leaf disease of consequence. Common root rot was once again a problem of concern.

Miscellaneous Small Grains

Speltz has been grown at the Dickinson station since 1907. Triticale has been grown in production trials since its development in the 1950's and has also been used in feeding trials with beef cattle and swine. Spring rye has also been grown intermittently over the past fifty years.

Production trials with miscellaneous small grains continue on a limited basis to determine adaptability of newly developed varieties. Production of these miscellaneous species is often not equal to the more commonly grown cereal grains. However, they sometimes can be used as non-compliance crops in the federal farm program where acreage of the commonly grown types is restricted. For this reason, farmers are interested in comparative performance.

Miscellaneous Small Grain Trial Tables

Buckwheat Production in Southwestern North Dakota

Buckwheat can be grown successfully in Southwestern North Dakota. It has become popular with area farmers, and is considered to be a crop of minor importance in the Missouri Slope region.

Grain yields at various experiment locations in North Dakota over the past few years have varied depending on the growing season. Yields recorded in Dickinson station trials are equal or better than those recorded in other areas of the state.

Construction of the MinnDak elevator in Dickinson in 1988, belonging to a company which specializes in buckwheat and other specialty crops may help to increase the acreage of these crops in southwest North Dakota by providing a ready market for them.

Buckwheat Production Tables

Hybrid Corn Comparison Trial

As shown in Table 35, corn silage and grain yields were very good considering the severe drought that prevailed throughout the growing season of 1990. This once again emphasized the adaptability of corn as an alternative crop for southwest North Dakota and the advisability of utilizing it in the diversified crop-livestock production systems recommended for southwest North Dakota.

1990 Dickinson Hybrid Corn Comparison Trial Table

Dry Edible Bean Production

Dry edible bean production in the three southwestern agricultural statistics reporting districts increased from 3400 harvested acres in 1985 to 21000 acres in 1988, and dropped to 17000 acres in 1989. Production was highest in 1985, 1986 and 1987 averaging more than 1200 pounds per acre for that three year period. Yields of 240 and 427 pounds per acre in the drought years of 1988 and 1989 combined to reduce the five year average yield to 879 pounds per acre.

1990 Dickinson Bean Variety Trial Table

Millet

Foxtail and Proso millets are among the oldest hay crops grown at the Dickinson Branch Station. Results of comparison trials with millets and other crop species used as annual hay crops are recorded in the station's first annual report dated 1907. One of the millet varieties grown that year, Siberian, was also included in the 1990 trials, and continues to be one of the better yielding varieties most years. However, growing conditions were unfavorable for millet in 1990 and while there was some grazing possible on fields of millet, poor growth prevented cutting for hay, in many plantings.

The proso millets, both red and white, are grown principally for grain. Hay from Proso and German foxtail is inferior in quality to that made from Siberian millet. Grain yields from the Proso millets usually are less than yields from cereal grain species. In 1990 Red Proso produced 521 lbs/A and White Proso 561 lbs/A, compared to 2024 lbs/A of Monida oats grown in the same comparison trial.

Dickinson Millet Variety Trial Table

Root Rot Control & Fungus Trial Tables

Wheat Yield With Alga Min Seed Treatment Table

Cooperative Small Grain Nursery Trials

Plantings in 1990 included: Uniform Regional Hard Red Spring Wheat, Project leader Dr. Robert Busch, University of Minnesota; Uniform Regional Durum, Project leader Dr. R.G. Cantrell, North Dakota State University; Uniform Early and Midseason Oats, Project leader Dr. Howard Rines, University of Minnesota; Western Spring Barley and Western Dryland Spring Barley, Project leader Dr. E.A. Hockett, Montana State University; and Advanced Two-row Barley Nursery, cooperator Dr. Jerry Franckowiak, North Dakota State University. Field performance reports are furnished to respective project leaders for evaluation and compilation into composite regional reports. Required samples for quality analysis are furnished to appropriate state or USDA cereal chemistry laboratories upon request of respective project leaders. Trials included 32 varieties and experimental lines in the Uniform Regional Hard Red Spring Wheat trial; 26 lines in the Uniform Regional Durum Nursery; 79 varieties and experimentals in three barley nurseries; and 69 varieties and experimental cultivars in the Uniform Early and Midseason Oat nurseries.

Small Grain Nursery Trial Tables

MINIMUM TILLAGE AND SEEDING, DOUBLE DISKING AND CONVENTIONAL SEEDING ON RECROP

In 1976, there was no significant difference in wheat production between minimum tillage and conventional tillage on second cropping. Growing conditions were excellent in 1976.

In 1977, hot, dry spring weather conditions were not particularly favorable to germination and early crop growth because of dry surface soil. Because of the small diameter of the rotation coulters on the John Deere 1500 Power till seeder, it was not possible to place seed deep enough to get it into moist soil. As a consequence, germination was spotty and delayed until later rainfall came. Excessive weed growth was also a problem on this treatment. Penetration of the surface soil and satisfactory seed placement was not as difficult with the Melroe 701 minimum tillage drill. Germination and growth was satisfactory and production was double that for the Power till seeder. Conventional disking and seeding was the best production method in the 1977 comparison.

In 1978 and 1979, only the Melroe 701 and the conventional tillage and seeding treatments were compared. Initial growth was slower on the minimum tillage treatment. This may be partly due to lower surface temperatures caused by the reflective and insulating effects of the straw and stubble on the field surface. Weed problems were also greater problems on the minimum tillage treatment.

In 1980, the Melroe 701 drill and conventional seeding was compared once again. Because of severe drought, production was zero for both treatments.

In 1981, the John Deere hoe drill was used for seeding the minimum tillage treatment. A good stand of wheat resulted from both the minimum tillage seeding and the conventional seeding, with the minimum tillage treatment producing slightly higher yields for the first time since the trial was begun.

In 1982 the John Deere hoe drill was once again used for seeding the minimum tillage treatment, with the conventional treatment consisting of double disking, and seeding with the double disk press drill. Excellent growing conditions produced the highest yields recorded in this trial over the past seven year period.

In 1983 the Lilliston no-till drill was used for seeding the minimum tillage treatment. The conventional treatment once again consisted of double disking the land in preparation for seeding, then seeding with double disk press drill. Ample stored soil water from heavy fall precipitation, and otherwise excellent growing conditions produced the highest yields recorded in the trial over the past 8 year period, with no advantage shown for either cropping method in this trial this year. Two additional trials in 1983 comparing no-till, conventional disking and seeding and the plow-packer-press drill on recrop land produced the following results. Barley yields were 49.6 bushels per acre for the plow-packer-press drill treatment, 28.1 for the no-till treatment and 27.9 for conventional disking and seeding.

Wheat seeded in a similar comparison trial produced 22.3 bushels per acre on plowing, 19.2 bushels per acre on conventional disking, and 17.7 bushels per acre on the no-till treatment.

Equipment and seeding method for the 1984 trial was the same as described for 1983. The fall of 1983 was drier than average with less than two and one-half inches of precipitation in the four month period, September through December. Precipitation continued below average from January until April 27 when a thirty inch snowfall provided enough soil water to carry the crop through the driest May in 93 years of record. Excellent distribution of five inches of rainfall in June was followed by a very dry July.

In 1985, a Lilliston no-till drill was used again for seeding the minimum tillage treatment. The preceding fall and winter precipitation was 1.12 inches below average. April precipitation was considerably lower than average. May rainfall of 4.31 inches was the most effective for crop growth. June rains were less than average but were well distributed. Cool temperatures in June promoted excellent growth of small grain crops.

In 1986, the same Lilliston no-till drill was used for seeding the minimum tillage treatment. The conventional treatment once again consisted of double-disking in preparation for seeding, followed by seeding with a double disk press drill. Effective weed control was provided by the use of Hoelon-bromoxynil tank mix applied at recommended rates.

Fall precipitation during the last four months of 1985 was two inches above average and provided good residual soil water for fallow and recrop stubble. Above average precipitation was well distributed during the growing season except for a dry period starting on May 25 and extending through June. While total precipitation for June was above average, 3.30 inches of that total fell during the last four days of the month.

In 1987, the Lilliston no-till drill was used once again for seeding the minimum tillage treatment. The conventional treatment consisted of double-disking in preparation for seeding, followed by seeding with a double disk press drill. Effective weed control was provided by the use of Hoelon-bromoxynil tank mix applied at recommended rates.

Total precipitation for the twelve month period, September, 1986, through August, 1987, was 21.19 inches which was slightly higher than for the preceding twelve month period. However, distribution of precipitation this year was much less favorable for crop growth than that of a year ago, resulting in considerably lower yields. Precipitation in April was only 0.17 inches, in May 1.87 inches, and in June 2.32 inches, totaling 4.36 inches for the three month period. This was nearly 3.00 inches below normal. Coupled with below average precipitation were above average temperatures. Average temperature for April was 7^{o}F, for May 3^{o}F, and for June 5^{o}F higher than for the 94-year average.

High temperatures had a major effect on crops. From April through June the number of wheat growing degree days - the sum of daily degrees above 32^{o}F - ranged from 500 to 700 more than normal across the state. This means that by July 1 the growing season for perennial plants and early-seeded crops was 14 to 17 days more advanced than usual. Above normal heat combined with a dry spell in April and May to reduce crop yields.

In 1988, the Lilliston no-till drill was used once again for seeding the minimum tillage treatment. The conventional treatment consisted of double-disking in preparation for seeding, followed by seeding with a double disk press drill. Effective weed control was provided by the use of Hoelon-bromoxynil tank mix applied at recommended rates. Severe drought prevailed throughout the growing season of 1988.

Total precipitation for the twelve month period, September, 1987, through August, 1988, was 8.63 inches as compared to the 94 year average of 15.89 inches.

Low rainfall throughout the entire growing season was coupled with temperatures that were far above average. The month of June was the most devastating in terms of adverse weather temperatures 14^{o}F higher than the 94 year norm, and with precipitation 2 inches below average. Evaporation for June, July, and August was 34.9 inches compared to the norm of 21.3 inches. High temperature, low precipitation, and excessive wind combined to create the worst growing conditions experienced in this region for the past fifty years.

Precipitation during the fall of 1988, September through December, was nearly an inch and a half below average and continued the deficit experienced throughout the summer. The well above average precipitation in April 1989, provided adequate soil water for germination and early season crop growth. Temperatures were moderate, and crop development was fairly good through May and June, even though precipitation was below average for both months. However, well above average temperatures in July (see weather data summary) coupled with well below average precipitation of 0.68 inch combined to create very poor growing conditions for the remainder of the growing season.

In 1989, the Lilliston no-till drill was used once again for seeding the minimum tillage treatment. The conventional treatment was double disking in preparation for seeding followed by seeding with a double disk press drill. Excellent weed control on both treatments followed use of Hoelon-bromoxynil tank mix applied at recommended rates. Heavy rainfall following seeding caused some soil crusting which was much more severe on the conventional treatment and was the principal cause for lower yields on that treatment.

In 1990 the Tye no-till drill was used for seeding the minimum tillage treatment. The conventional treatment and weed control on both treatments was identical to that described for 1989. Growing conditions did not favor high yields from re-crop in 1990.

Minimum Tillage & Double Disking Yield Table

WHEAT PRODUCTION ON FALLOW AND SECOND CROPPING

In 1976, an excellent year for small grain production on stubble land in southwestern North Dakota, yields on conventional summerfallow were 43 bushels per acre, on second cropping 27 bushels per acre, and on continuous cropping 22 bushels per acre. In 1977, a year when hot, dry spring weather conditions were not particularly favorable to germination and early growth of the crop, yields were appreciably reduced, even though rainfall in late May and June provided ample soil water for satisfactory crop growth. Yields on fallow were 26.9 bushels per acre, on second cropping 11.5, and on continuous cropping 5.5 bushels per acre. Relative differences between production methods were remarkably similar for both years.

In 1978, wheat on summerfallow averaged 38.5 bushels per acre in this trial compared with 31.4 on second cropping and 30.6 on continuous cropping. High yields on stubble land were a result of the excellent soil water recharge provided by the well above average precipitation coming in the fall of 1977, plus adequate seasonal moisture and cool growing season temperatures.

In 1978, fall precipitation was only 4.58 inches compared to more than 10 inches in 1977. In addition, a late spring planting date and a very dry period, extending from April 20 to June 18 was unfavorable for good, uniform germination and early crop growth. The effectiveness of stored soil water in fallow under stressed conditions is readily evident in the harvested yields.

In 1980, severe drought conditions prevailed through the third week of June. Grain production was reduced on summerfallow and was zero on the recrop and continuous cropping treatments.

In 1981, early seeded small grain crops were severely frosted by a severe freeze on May 9th, but seemed to recover very well. The most severe weather affecting crop production occurred the first ten days in July when temperatures of

93^{o}F and above were recorded on 7 days, with a maximum reading of 110^{o}F. Evaporation measured 3.93 inches during this ten day period.

Precipitation during the last four months of 1981 was above average, providing good soil water recharge. Snowfall was above average throughout the winter months, providing nearly three inches of precipitation from January through March. Above average rainfall through the growing season was well distributed.

The growing season of 1982 is best characterized as cool, wet, and late.

Rainfall in September and October 1982, was well above average, providing an excellent soil water recharge. Total fall precipitation from September through December 1982, was 9.4 inches compared to the 90-year average of 3.16 inches. Precipitation of 4.9 inches during April through June was below average, but for the rest of the year was nearly normal. The combination of stored rainfall in September and October 1982, and nearly normal seasonal precipitation provided ample water for good crop growth.

Mean temperatures for April, May, and June in 1983 were well below the 71-year average. Hot spells of several days in July and August when temperatures exceeded 90^{o}F affected late-seeded grain, but early-seeded crops escaped serious damage from high temperatures.

The fall of 1983 was drier than average with less than two and one-half inches of precipitation in the four-month period September through December. Precipitation from January through March, 1984, was also below average, and the dry period extended well into April, with the largest amount of precipitation during the month coming in the form of thirty inches of snowfall on the 27th. May was the driest in 93 years of record. Excellent distribution of five inches of rain in June was followed by a very dry July.

In 1985, the fall and winter precipitation was 1.12 inches below average. April precipitation was considerably lower than average. May rainfall of 4.31 inches was the most effective for crop growth. June rains were less than average but were well distributed. Cool temperatures in June, which included a freeze on the 12th, promoted excellent growth of small grain crops.

Fall precipitation during the last four months of 1985 was two inches above average and provided residual soil water for fallow and recrop stubble. Above average precipitation was well distributed during the growing season except for the dry period starting May 25 and extending through June. While total precipitation for June was above average, 3.30 inches of that total fell during the last four days of the month. The growing season was generally cool with temperatures in April, May, July, and August, well below the 94 year average.

Total precipitation for the twelve month period, September 1986, through August 1987, was 21.19 inches which was slightly higher than for the preceding twelve month period. However, distribution of precipitation this year was much less favorable for crop growth than that of a year ago, resulting in considerably lower yields. Precipitation in April was only 0.17 inches, in May 1.87 inches, and in June 2.32 inches, totaling 4.36 inches for the three month period. This was nearly 3.00 inches below normal. Coupled with below-average precipitation was above-average temperatures. Temperature for April was 7^{o}F, for May 3^{o}F, and for June 5^{o}F higher than the 94-year average.

High temperatures had a major effect on crops. From April through June, the number of wheat growing degree days – the sum of daily degrees above 32 – ranged from 500 to 700 more than normal across the state. This means that by July 1 the growing season for perennial plants and early-seeded crops was 14 to 17 days more advanced than usual. Above normal heat combined with a dry spell in April and May to reduce crop yields.

Severe drought prevailed throughout the growing season of 1988. Total precipitation for the twelve-month period, September 1987 through August 1988, was 8.63 inches as compared to the 94-year average of 15.89 inches.

Low rainfall throughout the entire growing season was coupled with temperatures that were far above average. The month of June was the most devastating in terms of adverse weather with average temperatures 14^{o}F higher than the 94-year norm, and with precipitation 2 inches below average. Evaporation for June, July, and August was 34.9 inches compared to the norm of 21.3 inches. High temperatures, low precipitation and excessive wind combined to create the worst growing conditions experienced in this region for the past fifty years.

Precipitation during the fall of 1988, September through December, was nearly an inch-and-a-half below average and continued the deficit experienced throughout the summer. The well above-average precipitation in April 1989 provided adequate soil water for germination and early season crop growth. Temperatures were moderate, and crop development was fairly good through May and June, even though precipitation was below average for both months. However, well above-average temperatures in July (see weather data summary) coupled with well below-average precipitation of 0.68 inch combined to create very poor growing conditions for the remainder of the growing season.

Nearly average fall and winter precipitation, and marginal rainfall in April and May provided sufficient soil water for germination and early growth. June, with a total of 5.80 inches of well distributed rainfall, was not enough to counteract a July and August which was 2.60 inches below average. The low yields for both treatments were a result of the cumulative effect of three years of below average precipitation.

Wheat Production on Fallow and Recrop Table

CROPPING SYSTEMS RESEARCH

This trial is designed to include a comparison of several crop rotation sequences as follows:

Treatment1: Compares a two-year rotation of wheat and corn with a two-year fallow-wheat rotation. Early corn varieties for grain production will be used in this comparison.

Treatment 2: Compares a two-year rotation of wheat and sunflowers with a two-year fallow-wheat rotation.

Treatment 3: Records production in a four-year cropping sequence of sunflower on wheat stubble, barley on sunflower stubble, fallow on barley stubble, and wheat on fallow.

Treatment 4: Compares wheat on fallow, wheat on continuous cropping and wheat on no-till recrop.

In 1983, fertilizer was applied on all recrop, corn, and sunflowers at the rate of 80 lbs./A N, 30lbs./A P_2O_5, and no K_2O. All wheat on fallow received 40 lbs./A N, 30 lbs./A P_2O_5, and no K_2O. All land to be fallowed was not fertilized. In 1984, fertilizer was applied to all corn, sunflower, and small grain recrop at the rate of 60 lbs. N, 30 lbs. P_2O_5, and no K_2O. All wheat on fallow received 30 lbs. N, 30 lbs. P_2O_5, and no K_2O. Land to be fallowed was not fertilized. In 1985 and 1986, 60 lbs. N and 30 lbs. P_2O_5 were applied to all corn, sunflower, and small grain recrop. Fallow land was treated with 30 lbs. N and 30 lbs. P_2O_5.

In both 1983 and 1984, weed control was accomplished with: alachlor at 2 lbs./A and dicamba at 0.25 lbs./A in a tank mix on corn; trifluralin at 0.5 lbs./A preplant incorporated on sunflower; and, diclofop at 0.75 lbs/A and bromoxynil at 0.25 lbs./A in a tank mix on small grain. 1985 and 1986, wheat and barley were sprayed with a tank mix of Hoelon at 2 pints/A plus Buctril at 1 pint/A. Weeds in sunflowers were controlled with 0.5 lbs./A Trifluralin preplant incorporated.

Varieties used in the 1983 cropping systems trial were: Alex wheat, Morex barley, Keltgen 582 corn, and Interstate 777S sunflower. In 1984, Alex wheat and Morex barley were used, along with Jacques JX21 corn and Interstate 7111 sunflowers. Stoa wheat, Bowman barley, Jacques JX21 corn, and Interstate 7111 sunflower were seeded in 1985. Stoa wheat, Bowman barley, and Interstate 7111 sunflower were used again in 1986 along with Dahlgren DC408 corn.

Tillage on fallow to prepare a seedbed was with a spring tine cultivator and harrow. Continuous crop stubble, sunflower stubble, and corn stubble land were double disked in preparation for seeding, as was all wheat stubble planted to corn or sunflowers. Excellent yields were recorded in 1983 for all crops in all rotation systems were the result of a combination of high fertility, ample reserve soil water, adequate seasonal precipitation, reasonably good growing conditions, and satisfactory cropping management. Because of considerably drier growing conditions in 1984, yields were reduced with small grains showing the most reduction on all treatments. May 1985 rainfall was well above average. Cool temperatures in June slowed development of row crops but promoted excellent growth of small grains.

The excellent yields for all crops in 1986 was the result of above average precipitation and satisfactory growing conditions during most of the growing season. One period of dry weather extending from May 25 through June 25 resulted in soil water stress under recrop.

High temperatures had a major effect on crops in 1987. From April through June, the number of wheat growing degree days – the sum of daily degrees above 32 – ranged from 500 to 700 more than normal across the state. This means that by July 1 the growing season for perennial plants and early-seeded crops was 14 to 17 days more advanced than usual. Above normal heat combined with a dry spell in April and May to reduce crop yield.

In 1988, tillage and seeding procedures, fertilizer application, and weed control were the same as was used in previous years.

Severe drought prevailed throughout the growing season of 1988.

Total precipitation for the twelve month period, September 1987 through August 1988, was 8.63 inches as compared to the 94-year average of 15.89 inches.

Low rainfall throughout the entire growing season was coupled with temperatures that were far above average. The month of June was the most devastating in terms of adverse weather with average temperatures 14^{o}F higher than the 94-year norm, and with precipitation 2 inches below average. Evaporation for June, July, and August was 34.9 inches compared to the norm of 21.3 inches. High temperatures, low precipitation, and excessive wind combined to create the worst growing conditions experienced in this region for the past fifty years.

Precipitation during the fall of 1988, September through December, was nearly an inch-and-a-half below average and continued the deficit experienced throughout the summer. The well above -average precipitation in April 1989 provided adequate soil water for germination and early season crop growth. Temperatures were moderate and crop development was fairly good through May and June, even though precipitation was below average for both months. However, well above average temperatures in July (see weather data summary) coupled with well below-average precipitation of 0.68 inch combined to create very poor growing conditions for the remainder of the growing season. Lack of residual soil water because of the severe drought of 1988 contributed to the low yields in 1989. Row crops were affected more than small grain by the unfavorable growing conditions in July. Sunflower and corn grain production was zero with corn silage yields the lowest recorded in the past twenty years.

Precipitation in the fall and winter period of 1989-90 was nearly average and combined with marginal April and May rainfall provided sufficient soil water for germination and early season growth of spring seeded crops. June, with a total of 5.80 inches of well distributed rainfall provided excellent growing conditions. This was counteracted by a July and August when recorded precipitation was 2.60 inches below average. The cumulative effect of three years of below average precipitation was too much for the favorable June conditions to overcome. Row crops were affected more than small grains by the unfavorable late season conditions, with sunflowers being more seriously affected than corn. Re-cropping which was totally dependent on seasonal rainfall was seriously affected as well.

Data from the cropping systems comparison for the years 1983-1990 are summarized in table 52.

Table 52. Cropping systems trial yields 1983 to 1990
