CONVENTIONAL AND NO-TILLAGE SYSTEM EFFECTS ON PLANT COMPOSITION AND YIELD

By

GLENN ALLEN RAINES

B.S., Kansas State University, 1967

A MASTER'S THESIS

submitted in partial fulfillment of the

requirements of the degree

MASTER OF SCIENCE

Department of Agronomy

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1977

Approved By:

Major Professor

TABLE OF CONTENTS

LIST OF TABLES

INDEX OF ABBREVIATIONS

CROPPING SYSTEMS

COR/COR	CONTINUOUS CORN	
SOR/SOR	CONTINUOUS SORGHUM	
SOY/SOY	CONTINUOUS SOYBEANS	
WH/WH	CONTINUOUS WHEAT	
COR/SOY	CORN-SOYBEAN	(2YEAR ROTATION)
SOY/COR	SOYBEAN-CORN	" "
SOY/SOR	SOYBEAN-SORGHUM	" "
SOR/SOY	SORGHUM-SOYBEAN	" "
SOY/WH	SOYBEAN-WHEAT	" "
WH/SOY	WHEAT-SOYBEAN	" "
WH/WH/WH	CONTINUOUS WHEAT	(3YEAR ROTATION)
SOR/SOR/SOR	CONTINUOUS SORGHUM	" "
WH/SOR/WH	WHEAT-SORGHUM-WHEAT	" "
WH/SOR/FAL	WHEAT-SORGHUM-FALLOW	" "
SOR/WH/SOR	SORGHUM-WHEAT-SORGHUM	" "
SOR/FAL/WH	SORGHUM-FALLOW-WHEAT	" "
FAL/WH/SOR	FALLOW-WHEAT-SORGHUM	" "

FERTILIZER AND HERBICIDE APPLICATION METHODS

BAND	BAND APPLIED AT SEEDING
B'CST	BROADCAST ON THE SOIL SURFACE
B'CST STUBBLE	BROADCAST FOLLOWING HARVEST
KNIFE	KNIFED INTO SOIL-ANHYDROUS AMMONIA SHANKS
PP	PREPLANT APPLICATION
POST	POST PLANT-AFTER EMERGENCE
PRE	PRE-EMERGENCE APPLICATION
TOP DRESS	APPLIED BROADCAST EARLY SPRING
UAN	UREA-AMMONIA-NITRATE SOLUTION
NH3	ANHYDROUS AMMONIA

YIELD AND GRAIN

% C.P.	PERCENT CRUDE PROTEIN
% D.M.	PERCENT DRY MATTER
D.M.GM/UNIT	GRAMS OF DRY MATTER PER HARVEST UNIT
1 HARVEST UNIT:	
(CORN)	4 PLANTS FROM 2 ROWS 76CM APART
(SORGHUM)	6 PLANTS FROM 2 ROWS 76CM APART
(SOYBEAN)	12 PLANTS FROM 2 ROWS 76CM APART

ACKNOWLEDGEMENTS

The author wishes to express his sincere gratitude to Dr. Larry Murphy, major professor, for providing the opportunity to perform this series of studies.

Appreciation is extended to Farmland Industries, Phillips Petroleum, and Tennessee Valley Authority for their financial support of this investigation.

Special thanks is extended to Mr. Oliver Russ for providing assistance and guidance in performing a large part of the field work. Thanks is also expressed to Dr. Richard Vanderlip for his assistance in analyzing the data, and serving on the supervisory committee along with Mr. Russ.

Thanks is also expressed to Messers. Doug Karlen and Dave Scott for their assistance and moral support, and to Ms. Bev Hall, Anita Gravatt, and Martha Blocker for their assistance in the laboratory.

A note of thanks is also expressed to the field superintendents of the outlying experiment fields that have been involved in this study, for their assistance in the field work.

A special thanks to my parents, Mr. and Mrs. Clifford Raines, for their unceasing moral support and interest throughout the course of this study. My sincere thanks to Miss Martha George for the countless hours spent in typing and editing the manuscript.

To all of these people, the author is truly indebted.

This work is dedicated to those who have an interest in tomorrow's agriculture.

INTRODUCTION

Since man began to cultivate crops for food, various tillage practices have evolved. They range from the hoe to the complex tillage practices in use today, (Musick, 1973). During the past 25 years, we have seen great changes in tillage practices and in our understanding of tillage needs by crops and soils (Larson, 1972). The trend 25 years ago was to increase the amount of tillage of the soil--both by the number and intensity of operations (Larson, 1972). Researchers were already wondering whether all the trips over the fields were necessary. Concepts of soil compaction, available soil moisture, and wind and water erosion were of prime importance to researchers and concerned farmers alike.

In the semi-arid wheat lands of the Great Plains, use of stubble-mulch tillage marked the beginning of a trend toward minimum and no-tillage techniques. Along with the various reduced tillage techniques there were major changes occurring in the size and type of equipment and machinery. Also, new tillage terminology began to appear such as zero-tillage, no-tillage, minimum tillage, ecofallow, and chemical fallow to name a few. The term conservation tillage has been accepted as a broad term encompassing such tillage terminology. Farmer interest in tillage problems has increased substantially since 1974. Primary interest in these systems can be described as threefold: 1) to control erosion and water runoff; 2) to save fuel and thereby reduce farming expenses; 3) to enhance yields for larger profit returns.

Oschwald (1973) describes a tillage system as a set of interrelated components that constitute a subsystem of a higher order, the crop production system. The tillage system also interacts with other subsystems and with the environment. The overall objective of tillage is to improve soil conditions for crop production. These ideas form the basis of the following questions:

(a) Are all the customary tillage operations necessary?

(b) What effects will reduced tillage have on grain yield and quality?

(c) What types of problems can be expected to be encountered and of what magnitude of importance will they be?

This type of questioning from farmers and researchers led to the formulation of a set of tillage studies dealing with corn (*Zea mays*, L), grain sorghum (*Sorghum bicolor*, Moench), soybeans (*Glycine max*, L., Merr.), and wheat (*Triticum aestivum*, L). The objective of the first set of studies was to determine the effect of three tillage treatments on plant composition and grain yield. The second and concurrent study was designed to study the response of irrigated corn and dryland grain sorghum to four methods of nitrogen application, and three methods of phosphorus application under a no-tillage system.

LITERATURE REVIEW

Linford (1973) stated that since early man first disturbed the soil in an attempt to improve the environment for the seed he planted, he has been and is today, seeking more effective and efficient methods to do this job.

Wiese and Staniforth (1973) reported that Cates and Cox summarized 125 tests from 28 states in 1912 and concluded that cultivation of corn was only beneficial if it eliminated weeds. Oschwald (1973) stated that the overall objective of tillage is to improve soil conditions for crop production.

The possibility of eliminating both tillage and cultivation from crop production came about with the advent of herbicides. This concept was first evaluated in California orchards in 1944. Early attempts to eliminate tillage from cropland with herbicides were made in the western Great Plains. This practice, called chemical fallow, was viewed as an additional opportunity beyond stubble mulch according to Wiese and Staniforth (1973). Initial studies in Montana in 1948 concluded that when chemical fallow controlled weeds, grain yields were comparable to yields from conventional tillage.

Van Doren et al. (1976) reported that long term studies have shown few differences in tillage methods over a wide range of soil types, cropping systems and climates. It was also reported by Van Doren et al. (1976) that if no-tillage was to be effective on poorly drained soils, it should be accompanied by a crop rotation and techniques which provide for desirable plant density and weed control.

Tillage Equipment

The kind, quantity, and quality of residues, number of weeds present, moisture conditions, soil texture, length of fallow and time of operation should be considered when selecting tillage tools (Fenster, 1973). Specialized tillage equipment has been a major deterrent to widespread acceptance of the no-tillage systems. Specialized equipment is not only expensive but is not readily available to the consumer. Robertson et al. (1976) stated that high costs of labor, fuel and machinery are some of the factors considered in the trend towards no-tillage methods.

Management

Management, a major factor in any tillage system, is beginning to be looked upon as the key to the entire no-tillage concept. Sanford et al. (1973) noted that no-tillage in double cropping systems requires a high level of management and continuous supervision to anticipate unusual problems and to perform each operation at the most appropriate time. A grower will choose the best combination of crop rotation, tillage, cultivation, and herbicides that will allow him to get the greatest return from his farming operation (Wiese et al., 1973). Fink (1974) stated, "By utilizing proper

THIS BOOK CONTAINS NUMEROUS PAGES WITH THE ORIGINAL PRINTING BEING SKEWED DIFFERENTLY FROM THE TOP OF THE PAGE TO THE BOTTOM.

THIS IS AS RECEIVED FROM THE CUSTOMER.

cultural and management practices, the problems associated with zero-tillage corn can be overcome. Satisfactory yields can be produced by this method on a variety of soil types."

Environment

With more reduced tillage being practiced, Musick et al. (1973) noted that no-tillage agriculture will change the microenvironment of insects, weeds and plant diseases. Minor pests may suddenly become serious, while major pests may decrease in importance.

Soil Temperature:

Fenster (1973) reported that soil temperatures are lowered considerably at a depth of 2.5 cm under a stubble mulch system. Bennett (1973) reported soil temperatures in no-till corn averaged about 10°C less than under conventional tillage methods.

Soil Moisture:

Jones (1968) and Jones et al. (1969) showed that surface mulches effectively conserved soil water and reduced runoff. Their data also indicated that soil water in the major root zone area was the primary factor causing plant growth and yield differences among the four tillage treatments. Studies by Triplett et al. (1963) indicate that stover mulch had a beneficial effect on no-tillage corn yield and that the greater yields were associated with increased water infiltration and soil moisture.

Blevins et al. (1971) noted that under no-tillage conditions the decreased evaporation and greater ability of the soil to store moisture results in a water reserve which can carry the crop through periods of short-term drought without detrimental moisture stress developing in the plants. This phenomena was also observed and reported by Bennett (1973).

Fertilization Practices

Methods of fertilizer application have to be modified when operating with a no-tillage system. Most P and K fertilizers will be either surface broadcast and/or banded at planting time. Nitrogenous fertilizers may be broadcast or knifed into the soil either preplant, at planting or post-plant. The advent of nitrogen solutions further enhances the alternatives available for nitrogen application.

Moschler et al. (1972) applied equal amounts of N, P, and K fertilizer to the soil surface of a conventional and no-tillage corn culture. The results indicated the no-tillage culture was more efficient in utilizing the applied nutrients in that higher yields and some increase in residual soil nutrients were obtained. Lutz et al. (1973) and Moschler et al. (1972) established that P and K broadcast on the surface for no-tillage corn are just as available to the plant as when these elements are incorporated into the soil.

Movement of surface applied P and K was slow but sufficient to provide adequate nutrition for corn plants (Fink, 1974). Triplett et al. (1969) reported that most of the

P applied to the soil surface between rows of no-tillage treatments remained in the surface 2.5 cm of soil. Shear et al. (1969) also observed that surface applied phosphate tended to accumulate in the upper 5 cm of untilled soil. Also, K availability was not affected by tillage or method of application.

Findlay et al. (1964) noted that P concentrations in ear shoot leaves of hybrid corn were influenced by season, soil type, levels of applied N and P and method of placement (band/broadcast) of P, but not of N. Adriano et al. (1970) reported that banded applications of P resulted in higher plant concentrations of P than did broadcast P applications.

Work performed by Robertson et al. (1954) showed that nitrogen and potassium fertilization had a striking effect on fertilizer phosphorus utilization. The uptake of band applied P rapidly decreased as the season progressed. Bates (1971) reported that tillage and fertilizer placement interacted significantly, although the interactions were not consistent. Bates (1971) also observed that P banded with the seed increased seedling weight and initiated silking earlier than non-banded treatments.

Plant Responses

Plant analysis can be a powerful tool in the diagnosis of yield depressions. Generally, plant composition is a more sensitive indicator of crop response to environmental changes than is yield, and at the same time is much more difficult to interpret. Plant composition can vary widely, especially in the range of luxury consumption, without having any measurable or visible influence on growth and yield. (Melsted et al., 1969).

Shear et al. (1946) stated, "Leaf analysis is based on the functioning assimilating leaves as the central 'laboratories of nutrition.' The concentration of nutrients in leaves is regulated by the absorption power of the roots. The growth of the whole plant, including the formation of the seed, is controlled by the transformation of the nutrients proceeding in roots and leaves." All other factors being constant, plant growth is a function of two variables: 1) plant nutrition, 2) nutrient intensity and balance as they are reflected in the composition of leaves when the plants are in the same stages of growth and development (Shear et al., 1946).

According to Estes (1972), uptake of applied nutrients (N, P, K, Ca, Mg) could be efficient if the root system is near the surface. The growth rate of corn without tillage was significantly higher at all measuring dates than that of corn grown with conventional tillage (Moody, 1961). Further observations by Moody (1961) were that soil structure was destroyed by tillage and that runoff and evaporation was increased. Moschler and Martens (1975) observed that maturity was hastened by no-tillage culture, and that N, P, and K concentrations in the corn were not much changed by tillage methods. Other studies by Moody et al. (1961) showed no significent differences in plant population with different tillage treatments, i.e., conventional and no-till. Furthermore, the N, P, and K content of the leaves at silking showed no differences between treatments.

Garg and Welch (1967) found that additional P influenced the percent N in corn plants, to the extent that a positive relationship between percent N and percent P appeared in plant analysis. Belcher et al. (1972) reported that the percentage of P in the plants increased with increasing rates of applied P.

Triplett et al. (1969) reported that P and K concentrations in leaves of corn grown without tillage were equal to plants grown with conventional tillage when sampled at tasseling, and significantly higher when sampled at the 8 to 10 leaf stage. In the no-tillage system, broadcast applications of P and K tended to accumulate near the soil surface with K moving to a greater depth than P. Under these circumstances, immobile elements become positionally available to crop plants. Ellis et al. (1956) found that applied P was reflected primarily in the early growth stages. Also, the content of P in leaves decreased with plant aging.

Ellis et al. (1956) also reported a close relationship between the content of exchangeable K in soil and leaf content of K. Estes (1972) found higher levels of tissue K in a no-tillage system than in a conventional tillage system. This phenomena was explained by the fact that Ca and Mg uptake is governed by their movement and solubility. Since the no-tillage condition hindered these processes, the reduced Ca and Mg tissue concentrations may have resulted from the increased K uptake and represent an example of the classic K:Ca:Mg interaction.

Close relationships of N, P, and K concentrations in leaves and yield were observed by Tyner (1947), in that highly significant correlation and regression coefficients were obtained for the relation of yields to percentage of N, P, and K. Amer et al. (1964) and Fuehring (1966) both working with conventionally tilled corn, observed that with increasing amounts of nitrogen, the total P content of the leaves was increased significantly. Amer et al. (1964) found a linear relationship between yield and N content of leaves.

Simple correlations between nutrient concentrations and yield revealed that the concentrations of nitrate N or percent N in the whole plant at either date were as good or better predictors of grain yield as were N concentrations in the sixth leaf (Stangel, 1964). Work conducted by Viets et al. (1954) produced results showing that total N content of leaves selected prior to silking gave lower correlations with yield than those selected at silking.

Singh et al. (1966) reported early leaf tissue samplings (49 and 61 days after planting), gave significantly higher total phosphorus concentration than did later tissue samplings of 84 and 99 days after planting. They speculated that the low available phosphorus content of the soil might be responsible for low phosphorus content of the tissue. Adriano and Murphy (1970) stated that in the presence of adequate zinc, concentrations of P in young plant tissues were positively correlated with grain yields.

In research conducted by Miller et al., (1961), fertilizer (P and K) treatments were reflected in the content of P and K in soybean plant parts when grown on a soil that was low in available P and very low in exchangeable K. An increase in yield was more closely related to an increase in K content than to P content of the plant parts i.e., upper and lower leaves and petioles. Yields also were closely associated with P and K content of the upper leaves sampled in growth stage 7.

METHODS AND MATERIALS

CONSERVATION TILLAGE STUDY

Conservation tillage studies were initiated in 1974 to study the effects of three tillage systems (chemical, chemical/mechanical, mechanical) on continuous and rotation cropping systems. The crops being studied were soybeans, grain sorghum, wheat, and corn. Not all crops were used at all sites. Table 1 indicates the location, crop rotation and soil types of the various sites.

The study was replicated four times with seven contiguous plots each being 18.3 meters square. Each plot involved one crop, either continuous cropping or rotation, with three subplots (6.1 m by 18.3 m) representing the randomly situated tillage treatments. The seven main plots were randomized with respect to crop within, but not across replicates.

Initial soil samples were collected to a depth of 15 cm, forced air dried at 60°C, ground to a uniform fineness of 2 mm, and analyzed for pH, available P, exchangeable K, and organic matter. Procedures used for ammonium and nitrate were those of Bremner (1965a). Extractable phosphorus was determined by the Bray-1 method developed by Bray and Kurtz (1945). Extractable potassium was determined by measuring the K concentration in a 1 N ammonium acetate extract. Organic matter was determined with the modified Walkley-Black chromic acid method of determining oxidizable carbon. All

ILLEGIBLE DOCUMENT

THE FOLLOWING DOCUMENT(S) IS OF POOR LEGIBILITY IN THE ORIGINAL

THIS IS THE BEST COPY AVAILABLE

TABLE 1. DESCRIPTION OF EXPERIMENTAL SITES

LOCATION	YEAR INITIATED	TYPE OF STUDY	SOIL TYPE	CROPS STUDIED	CROP ROTATION
BROWN CO. POWHATTAN EXPT.FLD.	1974	CONS./ TILLAGE	GRUNDY SILT LOAM	CORN SOYBEAN SORGHUM	COR-COR,COR-SOY SOY-SOY,SOY-COR,SOY-SOR SOR-SOR,SOR-SOY
RENO CO. HUTCHINSON EXPT.FLD.	1974	CONS./ TILLAGE	CLARK-OST COMPLEX	WHEAT SORGHUM (FALLOW)*	WH-WH , WH-SOR-WH,WH-SOR-FAL SOR-SOR,SOR-WH-SOR,SOR-FAL-WH FAL-WH-SOR
REPUBLIC CO. BELLEVILLE FLD.STA.	1974	CONS./ TILLAGE	CRETE SILT LOAM	WHEAT SOYBEAN SORGHUM	WH-WH , WH-SOY SOY-SOY,SOY-WH ,SOY-SOR SOR-SOR,SOR-SOY
RILEY CO. ASHLAND AGRON. FARM	1974	CONS./ TILLAGE	READING SILT LOAM	WHEAT SOYBEAN SORGHUM	WH-WH , WH-SOY SOY-SOY,SOY-WH ,SOY-SOR SOR-SOR,SOR-SOY
FRANKLIN CO. OTTAWA FLD.STA.	1975	CONS./ TILLAGE	WOODSON SILT LOAM **	WHEAT SOYBEAN SORGHUM	WH-WH , WH-SOY SOY-SOY,SOY-WH ,SOY-SOR SOR-SOR,SOR-SOY
FRANKLIN CO. OTTAWA FLD.STA.	1974	NO-TILLAGE	WOODSON SILT LOAM **	DRYLAND SORGHUM	CONTINUOUS
LABETTE CO. PARSONS EXPT.FLD.	1974	NO-TILLAGE	PARSONS SILT LOAM	DRYLAND SORGHUM	CONTINUOUS
STAFFORD CO. SANDYLAND EXPT.FLD.	1974	NO-TILLAGE	PRATT-CARWILE COMPLEX	IRRIGATED CORN	CONTINUOUS

* FALLOW FROM SORGHUM HARVEST TO WHEAT PLANTING, FOLLOWING YEAR.
** TENTATIVE CLASSIFICATION (1977).

analyses were performed by the Kansas State University Soil Testing Laboratory.

Field Procedures:

Seedbed preparation and seeding practices were those recommended for the respective areas. Fertilizer and herbicides were applied as recommended for the specific crop and area. Additional applications of herbicides were applied to "trouble-spots" as necessary. Tables 2 to 6 indicate fertilizer and herbicide rates.

Wheat was sown using a Tye (three point tractor mounted) drill at the Republic and Riley County sites. A McCormick-Deering hoe drill was used in Reno County. Row crops in Reno, Riley, Franklin and Brown Counties were planted with a Buffalo No-Till planter spaced on 76.2 cm centers.

Tissue samples were taken during the growing season as prescribed by Jones et al. (1971). The samples were forced air dried for 120 hours at 60°C and ground in a Wiley mill to pass a 1 mm stainless steel screen. Samples were stored in plastic vials for N, P, and K analysis at a later date.

Whole plant samples were collected at the Brown County site in 1976 and 1977. Four stalks of corn (Stage 8), six stalks of grain sorghum (Stage 5.5), and twelve soybean plants (Stage 5.5) were randomly selected and cut at ground level. The number of plants sampled per crop was arbitrarily set to represent one unit for that crop in expressing the grams of N, P, and K contained in the total sample.

TABLE 2.

CONSERVATION TILLAGE
FERTILIZER AND HERBICIDE RATES

LOCATION: BROWN CO. POWHATTAN EXPERIMENT FIELD

-------- FERTILIZER-------------

CROP	RATE KG/HA	ANALYSIS %N %P %K	APPLICATION METHOD
CORN	112	UREA(45%)	PP
	112	18-20-0	BAND
SOYBEAN	73	8-14-13	BAND
SORGHUM	112	UREA(45%)	PP
	73	UREA(45%)	SIDE DRESS

------------- HERBICIDE ----------------

CROP	RATE KG/HA	CHEMICALS	APPLICATION METHOD
CORN	3.4	CYANAZINE	PRE
	2.2+1.7	ALACHLOR+ATRAZINE	PP
SOYBEAN	3.4	CYANAZINE	PP
	2.2+0.8	ALACHLOR+METRIBUZIN	PRE
SORGHUM	3.4	CYANAZINE	PP
	6.7	PROPACHLOR+ATRAZINE	PRE

TABLE 3.

CONSERVATION TILLAGE
FERTILIZER AND HERBICIDE RATES

LOCATION: FRANKLIN CO. OTTAWA EXPERIMENT FIELD

---------- FERTILIZER -------------

CROP	RATE KG/HA	ANALYSIS %N %P %K	APPLICATION METHOD
WHEAT	112	8-14-13	BAND
	50	UREA(45%)	TOP DRESS
SOYBEAN	112	8-14-13	BAND
SORGHUM	112	18-20-0	BAND
	124	UREA(45%)	B'CST PP

-------------- HERBICIDE --------------------

CROP	RATE KG/HA	CHEMICALS	APPLICATION METHOD
WHEAT	0.6	PARAQUAT	PP
SOYBEAN	0.6	PARAQUAT	PP
	0.6+1.7	METRIBUZIN+ORYZALIN	PRE
SORGHUM	0.6	PARAQUAT	PP
	6.7	PROPACHLOR+ATRAZINE	PRE

TABLE 4.

CONSERVATION TILLAGE
FERTILIZER AND HERBICIDE RATES

LOCATION: RILEY CO. ASHLAND AGRONOMY FARM

CROP	RATE KG/HA	ANALYSIS %N %P %K	APPLICATION METHOD
		FERTILIZER	
WHEAT	134	33.5-0-0	B'CST PP
	123	18-20-0	B'CST PP
SOYBEANS	134	33.5-0-0	B'CST PP
	123	18-20-0	B'CST PP
SORGHUM	134	33.5-0-0	B'CST PP
	123	18-20-0	B'CST PP

CROP	RATE KG/HA	CHEMICALS	APPLICATION METHOD
		HERBICIDE	
WHEAT	1.1	2,4-D	B'CST-STUBBLE
	1.1	GLYPHOSATE	PP
SOYBEANS	1.1	2,4-D	PP
	1.1	GLYPHOSATE	PP
	2.2+0.6	ALACHLOR+METRIBUZIN	PRE
SORGHUM	1.1	2,4-D	PP
	1.1	GLYPHOSATE	PP
	6.7	PROPACHLOR+ATRAZIN	PRE

TABLE 5.

CONSERVATION TILLAGE
FERTILIZER AND HERBICIDE RATES

LOCATION: RENO CO. HUTCHINSON EXPERIMENT FIELD

--------- FERTILIZER -------------

CROP	RATE KG/HA	ANALYSIS %N %P %K	APPLICATION METHOD
WHEAT	224	16-8-0	B'CST PP
SORGHUM	NONE		

--------------- HERBICIDES -------------------

CROP	RATE KG/HA	CHEMICALS	APPLICATION METHOD
WHEAT	3.4	CYANAZINE	B'CST STUBBLE
	0.8	2,4-D	B'CST STUBBLE
	0.8	GLYPHOSATE	PP
SORGHUM	3.4	CYANAZINE	PP
	0.8	2,4-D	PP
	0.8	GLYPHOSATE	PP

TABLE 6.

CONSERVATION TILLAGE
FERTILIZER AND HERBICIDE RATES
LOCATION: REPUBLIC CO. BELLEVILLE EXPERIMENT FIELD

-------- FERTILIZER ------------

CROP	RATE KG/HA	ANALYSIS %N %P %K	APPLICATION METHOD
WHEAT	112	10-8-0	BAND
	240	28-0-C	TOP DRESS
SCYBEAN	NONE		
SCRGHUM	240	28-0-0	B'CST PP
	112	10-8-0	BAND

------------- HERBICIDE -------------------

CROP	RATE KG/HA	CHEMICALS	APPLICATION METHOD
WHEAT	3.4	CYANAZINE	PRE
SCYBEAN	3.4	CYANAZINE	PP
	2.2+0.8	ALACHLOR+METRIBUZIN	PRE
SORGHUM	3.4	ATRAZINE	PP
	3.4	CYANAZINE	PP
	6.7	PROPACHLOR+ATRAZINE	PRE

Bulk sample weights were recorded, the sample shredded and subsampled, weighed and dried as previously described. Dry matter was computed and the subsamples were analyzed for N, P, and K content by the following procedures.

Laboratory Procedures:

Ground tissue samples were oven dried at 40°C for 24 hours prior to weighing. A 0.25 gram sample was weighed into test tubes to be digested in concentrated sulfuric acid and hydrogen peroxide in an aluminum block heater. Kjeldahl N distillation of sulfuric acid digested plant material procedures was used (Bremner, 1965b) until June, 1977. Phosphorus was determined colorimetrically by the ammonium vanadomolybdate procedure as outlined by Chapman and Pratt (1961). Both of these procedures were later changed to a colorimetric process using the Technicon Auto-Analyzer procedure (Technicon Industrial Systems, 1977). Potassium was determined on a 0.5 ml aliquot of the concentrated sulfuric acid digest diluted to 5 ml with distilled, deionized water and analyzed by a Perkin-Elmer model 460 atomic absorption spectrophotometer.

Grain yields were obtained by mechanical harvest and corrected to 12.5 percent moisture except for corn, which was corrected to 15.5 percent.

Crude protein was determined in milled grain by the same analytical procedures used for tissue nitrogen. Grain N values were then converted to crude protein by using a factor of 5.85.

Soil moisture was measured in selected plots of replicates 1 and 3 in 1977 at the Riley County site. Neutron probe access tubes were installed in the chemical and mechanical treatments of all crops to a depth of 152.4 cm. Readings were taken at depth intervals of 15.2 cm and total soil moisture calculated.

Statistical Analyses:

All statistical analyses were performed on an IBM 370/158-J computer at the Kansas State University Computing Center using preprogrammed statistical packages. Least significant differences (LSD) were calculated according to the procedures given by Snedecor and Cochran (1967). Regression and correlation analyses were performed via "AARDVARK," a statistical analysis package as described by Hemmerle (1967) and modified by the Statistical Laboratory, Department of Statistics, Kansas State University.

NO-TILLAGE CORN STUDY

A no-tillage irrigated corn study was initiated in 1974 in Stafford County, Kansas, at the Sandyland Experiment Field, on a Pratt-Carwile complex soil.

The study consisted of twelve, nitrogen-phosphorus combination treatments replicated three times. Two nitrogen sources with four application methods combined with one phosphorus source and three methods of application, comprised the study. Individual plots measured 3.1 meters by 9.1 meters.

Soil samples were taken at five graduated increments to a depth of 61 cm from selected treatments. Soil samples were handled as previously described.

Field Procedures:

The no-tillage concept was followed by planting corn in the existing previous years' rows with a four row Buffalo No-Till planter. Anhydrous ammonia was applied with a three-point tractor mounted applicator. Urea-ammonium nitrate (UAN) solution was broadcast on the soil surface by a spray boom attached to the tool bar of the anhydrous ammonia applicator. An ammonium polyphosphate (APP) solution was either knifed into the soil via the anhydrous ammonia shanks, broadcast with the spray boom or banded with the seed, using a ground driven John Blue "squeeze pump" attached to the planter. The banded solution was placed 5 cm to one side and 5 cm below the seed. Fertilizer rates and methods of application are indicated in Table 7.

The study was irrigated with a center pivot irrigation system as deemed necessary by the field personnel at the site.

Tissue samples were collected at the 8 to 10 leaf stage, i.e., growth stage 2 (Hanway, 1971) and handled the same as described earlier. Whole plant samples were collected in 1976 and 1977. Four stalks of corn selected from each plot during growth stage 7 were shredded with a portable chopper and analyzed for N, P, and K in the same manner described earlier.

TABLE 7.

ST. JOHN NO-TILLAGE CORN STUDY
STAFFORD COUNTY, KANSAS
SANDYLAND EXPERIMENT FIELD

	PHOSPHORUS TREATMENT				N-RATE	N	METHOD OF APPLICATION	
	----- %P KG/HA -----							
	1974	1975	1976	1977	KG/HA	MATERIAL	N	P
1	0	0	0	0	0	---	---	---
2	0	0	0	0	224	NH3	KNIFE PP	---
3	0	0	0	0	224	UAN	B'CST PP	---
4	0	0	0	0	224	UAN	B'CST POST	---
5	76	0	0	0	224	NH3	KNIFE PP	KNIFE PP
6	76	0	0	0	224	UAN	B'CST PP	B'CST PP
7	19	19	19	19	224	NH3	KNIFE PP	KNIFE PP
8	19	19	19	19	224	UAN	B'CST PP	B'CST PP
9	19	19	19	19	224	NH3	KNIFE PP	BAND
10	19	19	19	19	224	UAN	B'CST PP	BAND
11	19	19	19	19	224	NH3	KNIFE POST	BAND
12	19	19	19	19	224	UAN	B'CST POST	BAND

Yields were obtained by hand harvesting one row, 9.1 meters in length, shelling the grain with a hand operated John Deere corn sheller, and correcting the weights to 15.5 percent moisture content. Analytical procedures for determining grain crude protein were the same as described previously.

NO-TILLAGE DRYLAND GRAIN SORGHUM STUDIES

A no-tillage dryland grain sorghum study was initiated in 1974 at locations in Franklin County (Ottawa Experiment Field), and Labette County (Southeast Kansas Branch Experiment Station). The no-tillage study at Ottawa was situated on a Woodson (tentative classification) silt loam soil, and the Parsons site is on a Parsons silt loam.

Ottawa:

This study included 12 nitrogen-phosphorus combination treatments replicated four times with individual plots measuring 3 m (4 rows) by 0.1 m in length.

The study involved the same two nitrogen sources (anhydrous ammonia and UAN) and phosphorus source (APP) as described for the no-tillage irrigated corn study. The N rates differed as shown in Table 8.

Soil samples were collected in April (1976-1977) at five incremented depths to 61 cm on selected treatments. The samples were handled and analyzed as previously described.

TABLE 8.

OTTAWA NO-TILLAGE SORGHUM STUDY
OTTAWA EXPERIMENT FIELD
FRANKLIN COUNTY,KANSAS

	PHOSPHORUS TREATMENT ----- %P KG/HA -----				N-RATE	N	METHOD OF APPLICATION	
	1974	1975	1976	1977	KG/HA	MATERIAL	N	P
1	0	0	0	0	0	---	---	---
2	0	0	0	0	134	NH3	KNIFE PP	---
3	0	0	0	0	134	UAN	B'CST PP	---
4	0	0	0	0	134	UAN	B'CST POST	---
5	76	0	0	0	134	NH3	KNIFE PP	KNIFE PP
6	76	0	0	0	134	UAN	B'CST PP	B'CST PP
7	19	19	19	19	134	NH3	KNIFE PP	KNIFE PP
8	19	19	19	19	134	UAN	B'CST PP	B'CST PP
9	19	19	19	19	134	NH3	KNIFE PP	BAND
10	19	19	19	19	134	UAN	B'CST PP	BAND
11	19	19	19	19	134	NH3	KNIFE POST	BAND
12	19	19	19	19	134	UAN	B'CST POST	BAND

Parsons:

The study included the same 12 nitrogen-phosphorus combination treatments as Ottawa in addition to one potassium source (KCl) with three methods of application. Table 9 shows fertilizer rates and methods of application.

Soil samples were collected during April 1974 at four incremented depths to 45.7 cm. The samples were handled and analyzed as previously described.

Field Procedures:

Preplant and post-plant treatments were applied with the tractor mounted applicator described earlier. Sorghum was seeded into the previous years' residue with a two row Buffalo No-Till planter. A John Blue positive displacement pump metered the banded P applications into the fertilizer application shoe of the planter, 5 cm to the side and 5 cm below the seed.

Herbicide and insecticide applications were applied by field personnel as necessary.

Tissue samples were collected at growth stage 3, i.e., 7 to 10 leaves (Vanderlip, 1972), and stage 5, i.e., boot stage. Handling and analysis of the samples was identical to that described earlier.

Grain was mechanically harvested and yields were corrected to 12.5 percent moisture. Subsamples were analyzed for crude protein as previously described.

TABLE 9.

PARSONS NO-TILLAGE SORGHUM STUDY
PARSONS EXPERIMENT FIELD
LABETTE COUNTY, KANSAS

	TREATMENT KG/HA									METHOD OF APPLICATION		
	1974		1975		1976		1977		N-RATE			
	%P	%K	%P	%K	%P	%K	%P	%K	KG/HA	N	P	K
1	0	0	0	0	0	0	0	0	---	---	---	---
2	0	0	0	0	0	0	0	0	134	KNIFE PP	---	---
3	0	0	0	0	0	0	0	0	134	B'CST PP	---	---
4	0	0	0	0	0	0	0	0	134	B'CST POST	---	---
5	76	149	0	0	0	0	0	0	134	KNIFE PP	KNIFE PP	KNIFE PP
6	76	149	0	0	0	0	0	0	134	B'CST PP	B'CST PP	B'CST PP
7	19	0	19	0	19	0	19	0	134	KNIFE PP	KNIFE PP	---
8	19	0	19	0	19	0	19	0	134	B'CST PP	B'CST PP	---
9	19	0	19	0	19	0	19	0	134	KNIFE PP	BAND	---
10	19	19	19	19	19	19	19	19	134	KNIFE PP	KNIFE PP	KNIFE PP
11	19	19	19	19	19	19	19	19	134	B'CST PP	B'CST PP	B'CST PP
12	19	19	19	19	19	19	19	19	134	KNIFE PP	BAND	BAND
13	19	19	19	19	19	19	19	19	134	B'CST PP	BAND	BAND
14	19	19	19	19	19	19	19	19	134	KNIFE POST	BAND	BAND
15	19	19	19	19	19	19	19	19	134	B'CST POST	BAND	BAND

RESULTS AND DISCUSSION

CONSERVATION TILLAGE STUDIES

Brown County: Powhattan Experiment Field.

The study was established on a Grundy silt loam (Aquic Argiudolls) soil in the spring of 1975. Two years of yield data and three years of tissue data from the continuous corn, sorghum, and soybean cultures are presented in Tables 10 to 12. The yield and tissue data for the crop rotations are presented in Tables 13 to 15, with the initial crop listed, e.g., (<u>cor</u>/soy), of the rotation being the crop reported. Soil samples were collected in the spring of 1976 and 1977. Some variation in available phosphorus within the site was noted from the initial samples. Table 16 depicts the variables analyzed.

Soil available P, exchangeable K, organic matter, and pH differences were all highly significant among rotations for the two years sampled. Available soil P had essentially the same distribution in 1977 as in 1976, only with higher values. Indications are that soil P levels were adequate with evidence of a small buildup. The chemical tillage treatment in the continuous corn was the only plot with available P being significantly higher than the remaining tillage treatments.

Exchangeable K fluctuated little over two years with respect to tillage treatments. The sorghum/soybean, and soybean/sorghum rotations differed significantly in 1976

TABLE 10.

CONSERVATION TILLAGE
BROWN COUNTY-POWHATTAN EXPERIMENT FIELD
YIELD AND TISSUE ANALYSIS 1975

CONTINUOUS CROPPING	TILLAGE	YIELD KG/HA	TISSUE DATE 1 %N	%P	%K
COR/COR					
	CHEM.	3449	2.24	.26	2.48
	CHEM/MECH	3272	2.46	.29	2.46
	MECH.	2817	2.36	.28	2.36
	MEAN=	3179	2.35	.28	2.43
	LSD(.05)=	NS	NS	NS	NS
SOY/SOY					
	CHEM.	3060	4.18	.44	1.84
	CHEM/MECH	2986	4.29	.44	1.91
	MECH.	2814	4.24	.43	1.88
	MEAN=	2960	4.24	.44	1.88
	LSD(.05)=	NS	NS	NS	NS
SOR/SOR					
	CHEM.	4413	2.38	.28	1.60
	CHEM/MECH	4415	2.58	.30	1.66
	MECH.	4465	2.70	.33	1.61
	MEAN=	4431	2.55	.30	1.62
	LSD(.05)=	NS	NS	.02*	NS

* DENOTES SIGNIFICANCE AT 0.01

TABLE 11.

CONSERVATION TILLAGE
BROWN COUNTY-POWHATTAN EXPERIMENT FIELD
YIELD AND TISSUE ANALYSIS 1976

CONTINUOUS CROPPING	TILLAGE	YIELD KG/HA	TISSUE DATE 1 %N	%P	%K	WHOLE PLANT %N	%P	%K
COR/COR								
	CHEM.	3633	2.89	.28	1.85	1.68	.22	1.52
	CHEM/MECH	3392	3.00	.29	1.90	1.70	.21	1.38
	MECH.	3444	3.02	.29	1.86	1.72	.22	1.47
	MEAN=	3490	2.97	.29	1.87	1.70	.22	1.46
	LSD(.05)=	NS	.05	NS	NS	NS	NS	NS
SOY/SOY								
	CHEM.	1356	4.55	.45	2.19	3.61	.32	1.82
	CHEM/MECH	1473	4.54	.45	2.37	3.80	.32	1.89
	MECH.	1437	4.67	.46	2.35	3.65	.31	1.97
	MEAN=	1422	4.59	.45	2.30	3.69	.32	1.89
	LSD(.05)=	NS	NS	NS	NS	NS	NS	NS
SOR/SOR								
	CHEM.	6707	3.26	.38	2.22	2.31	.32	2.35
	CHEM/MECH	6471	3.33	.38	2.12	2.54	.30	2.46
	MECH.	6756	3.04	.35	2.42	2.12	.29	2.37
	MEAN=	6646	3.21	.37	2.25	2.32	.30	2.39
	LSD(.05)=	NS	NS	NS	NS	.12*	NS	NS

* DENOTES SIGNIFICANCE AT 0.01

TABLE 12.

CONSERVATION TILLAGE
BROWN COUNTY-POWHATTAN EXPERIMENT FIELD
TISSUE AND WHOLE PLANT ANALYSIS
1977

CONTINUOUS CROPPING	TISSUE DATE 1			TISSUE DATE 2			WHOLE PLANT		
TILLAGE	%N	%P	%K	%N	%P	%K	%N	%P	%K
COR/COR									
CHEM.	3.22	.32	1.82	2.84	.32	1.57	1.79	.27	1.59
CHEM/MECH	3.17	.32	1.69	2.81	.32	1.46	1.80	.28	1.49
MECH.	3.20	.30	1.87	2.80	.31	1.50	1.85	.24	1.56
MEAN=	3.20	.31	1.79	2.82	.32	1.51	1.81	.26	1.55
LSD(.05)=	NS	.02	NS	NS	NS	NS	NS	NS	NS
SOY/SOY									
CHEM.	4.29	.46	2.50	5.03	.56	2.12	3.27	.28	1.75
CHEM/MECH	4.20	.42	2.46	4.94	.56	2.14	3.24	.31	1.93
MECH.	3.86	.40	2.59	4.96	.58	2.11	3.18	.29	1.92
MEAN=	4.12	.43	2.52	4.98	.57	2.13	3.23	.29	1.87
LSD(.05)=	NS	.04	NS	NS	NS	NS	NS	NS	NS
SOR/SOR									
CHEM.	3.57	.44	1.95	3.21	.42	1.87	2.25	.38	2.45
CHEM/MECH	3.27	.39	1.88	3.28	.44	1.85	2.01	.34	2.16
MECH.	3.33	.39	1.88	3.22	.43	1.83	1.96	.33	2.07
MEAN=	3.39	.41	1.90	3.23	.43	1.85	2.07	.35	2.23
LSD(.05)=	NS	.03	NS	NS	NS	NS	.20	.03	.25

TABLE 12, CONTINUED.

WHOLE PLANT ANALYSIS
1977

CONTINUOUS CROPPING	TILLAGE	BULK WT GM	% D.M.	D.M. GM/ UNIT	GRAMS PER UNIT@@ N	P	K
COR/COR							
	CHEM.	665	19.4	851	15.1	2.26	13.4
	CHEM/MECH	563	19.0	769	13.8	2.15	11.4
	MECH.	643	19.5	760	14.2	1.82	11.9
	MEAN=	624	19.3	794	14.4	2.08	12.2
	LSD(.05)=	NS	NS	NS	NS	NS	NS
SOY/SOY							
	CHEM.	670	23.7	159	5.2	0.45	2.8
	CHEM/MECH	829	22.9	189	6.1	0.58	3.6
	MECH.	760	22.2	168	5.3	0.49	3.3
	MEAN=	753	22.9	172	5.5	0.51	3.2
	LSD(.05)=	NS	NS	62	NS	NS	NS
SOR/SOR							
	CHEM.	714	16.4	282	6.3	1.06	6.9
	CHEM/MECH	737	19.4	337	6.8	1.14	7.3
	MECH.	850	19.9	368	7.2	1.23	7.6
	MEAN=	777	18.6	329	6.8	1.14	7.3
	LSD(.05)=	NS	.1*	48	NS	NS	NS

* DENOTES SIGNIFICANCE AT 0.01

@@ GRAMS PER UNIT= THE AMOUNT OF NUTRIENTS,EXPRESSED IN GRAMS, FOR A SPECIFIED HARVEST AREA.

TABLE 13.

CONSERVATION TILLAGE
BROWN COUNTY-POWHATTAN EXPERIMENT FIELD
YIELD AND TISSUE ANALYSIS 1975

ROTATION CROPPING	TILLAGE	YIELD KG/HA	TISSUE DATE 1 %N	%P	%K
COR/SOY					
	CHEM.	3561	2.40	.28	1.98
	CHEM/MECH	3764	2.25	.27	2.01
	MECH.	3763	2.54	.29	2.14
	MEAN=	3696	2.39	.28	2.04
	LSD(.05)=	NS	NS	NS	NS
SOY/COR					
	CHEM.	2185	4.30	.46	1.74
	CHEM/MECH	2302	4.19	.46	1.88
	MECH.	2243	4.37	.46	1.74
	MEAN=	2244	4.29	.46	1.79
	LSD(.05)=	NS	NS	NS	NS
SOY/SOR					
	CHEM.	2006	4.34	.43	1.70
	CHEM/MECH	1806	4.46	.45	1.74
	MECH.	1776	4.43	.45	1.66
	MEAN=	1863	4.41	.44	1.70
	LSD(.05)=	NS	NS	NS	NS
SOR/SOY					
	CHEM.	4985	2.56	.28	1.59
	CHEM/MECH	5124	2.69	.30	1.66
	MECH.	5133	3.25	.35	1.73
	MEAN=	5081	2.84	.31	1.66
	LSD(.05)=	NS	.15*	.02*	.10

* DENOTES SIGNIFICANCE AT 0.01

TABLE 14.

CONSERVATION TILLAGE
BROWN COUNTY-POWHATTAN EXPERIMENT FIELD
YIELD AND TISSUE ANALYSIS 1976

ROTATION CROPPING	TILLAGE	YIELD KG/HA	TISSUE DATE 1 %N	%P	%K	WHOLE PLANT %N	%P	%K
COR/SCY								
	CHEM.	3945	3.04	.30	1.79	1.62	.21	1.32
	CHEM/MECH	4127	3.04	.29	1.67	1.64	.21	1.42
	MECH.	3802	3.12	.30	1.75	1.87	.23	1.46
	MEAN=	3958	3.07	.30	1.74	1.71	.22	1.40
	LSD(.05)=	NS	NS	NS	NS	NS	NS	NS
SOY/COR								
	CHEM.	1422	4.70	.47	2.28	3.66	.29	1.46
	CHEM/MECH	1428	4.81	.46	2.17	3.60	.32	1.62
	MECH.	1529	4.27	.46	2.33	3.44	.32	2.12
	MEAN=	1460	4.59	.46	2.26	3.56	.31	1.73
	LSD(.05)=	NS	NS	NS	NS	NS	NS	.30*
SOY/SOR								
	CHEM.	1740	4.63	.45	2.25	3.58	.31	1.69
	CHEM/MECH	1724	4.62	.46	2.31	3.63	.30	1.64
	MECH.	1633	4.64	.44	2.41	3.58	.34	2.07
	MEAN=	1699	4.63	.45	2.32	3.60	.32	1.80
	LSD(.05)=	NS	NS	NS	NS	NS	NS	.17*
SOR/SOY								
	CHEM.	5896	3.18	.31	1.91	2.31	.26	1.88
	CHEM/MECH	5963	3.11	.33	2.13	2.26	.25	2.12
	MECH.	5484	3.07	.32	2.03	2.28	.25	2.01
	MEAN=	5781	3.12	.32	2.02	2.28	.26	2.00
	LSD(.05)=	NS	NS	NS	NS	NS	NS	.16

* DENOTES SIGNIFICANCE AT 0.01

TABLE 15.

CONSERVATION TILLAGE
BROWN COUNTY-POWHATTAN EXPERIMENT FIELD
TISSUE AND WHOLE PLANT ANALYSIS
1977

ROTATION CROPPING		TISSUE DATE 1			TISSUE DATE 2			WHOLE PLANT		
	TILLAGE	%N	%P	%K	%N	%P	%K	%N	%P	%K
COR/SOY										
	CHEM.	3.20	.30	1.28	2.69	.32	1.37	1.78	.24	1.42
	CHEM/MECH	3.32	.30	1.46	2.74	.31	1.38	1.82	.24	1.40
	MECH.	3.20	.30	1.56	2.80	.32	1.47	1.84	.24	1.50
	MEAN=	3.24	.30	1.44	2.74	.32	1.40	1.81	.24	1.44
	LSD(.05)=	NS	NS	.12*	NS	NS	NS	NS	NS	NS
SOY/COR										
	CHEM.	4.01	.44	2.58	4.99	.55	2.18	3.17	.29	2.06
	CHEM/MECH	4.04	.44	2.61	4.95	.58	2.15	3.34	.31	2.06
	MECH.	3.86	.42	2.60	4.96	.57	2.14	3.09	.28	1.98
	MEAN=	3.97	.43	2.60	4.97	.57	2.16	3.20	.29	2.03
	LSD(.05)=	NS	NS	NS	NS	NS	NS	NS	.01*	.07
SOY/SOR										
	CHEM.	3.93	.40	2.44	4.91	.54	2.21	3.31	.30	1.93
	CHEM/MECH	3.88	.39	2.56	4.77	.55	2.10	3.19	.26	1.93
	MECH.	4.04	.41	2.56	5.15	.57	2.13	3.21	.28	1.99
	MEAN=	3.95	.40	2.52	4.94	.55	2.14	3.24	.28	1.95
	LSD(.05)=	NS	NS	NS	NS	NS	NS	NS	NS	NS
SOR/SOY										
	CHEM.	3.04	.34	1.54	3.16	.39	1.80	1.89	.30	1.82
	CHEM/MECH	3.21	.36	1.77	3.14	.41	1.84	1.83	.30	2.02
	MECH.	3.14	.36	1.79	3.16	.41	1.79	1.80	.30	2.00
	MEAN=	3.13	.35	1.70	3.16	.40	1.81	1.84	.30	1.95
	LSD(.05)=	.13	NS	.08*	NS	NS	NS	NS	NS	NS

* DENOTES SIGNIFICANCE AT 0.01

TABLE 15, CONTINUED.

WHOLE PLANT ANALYSIS
1977

ROTATION CROPPING	TILLAGE	BULK WT GM	% D.M.	D.M. GM/ UNIT	GRAMS PER UNIT@@ N	P	K
COR/SOY							
	CHEM.	347	19.3	791	13.9	1.91	11.2
	CHEM/MECH	200	20.6	766	13.8	1.87	10.7
	MECH.	154	19.8	777	14.3	1.89	11.6
	MEAN=	234	19.9	778	14.0	1.89	11.2
	LSD(.05)=	NS	NS	NS	NS	NS	NS
SOY/COR							
	CHEM.	636	21.9	139	4.4	0.41	2.9
	CHEM/MECH	908	21.2	193	6.5	0.59	4.0
	MECH.	942	22.0	208	6.4	0.57	4.1
	MEAN=	828	21.7	180	5.8	0.52	3.6
	LSD(.05)=	104*	NS	29*	1.1*	.09*	.5*
SOY/SOR							
	CHEM.	590	22.7	134	4.4	0.40	2.6
	CHEM/MECH	624	22.5	140	4.5	0.37	2.7
	MECH.	647	22.4	145	4.6	0.41	2.9
	MEAN=	620	22.6	140	4.5	0.39	2.7
	LSD(.05)=	NS	NS	NS	NS	NS	NS
SOR/SOY							
	CHEM.	600	20.6	382	7.2	1.14	6.9
	CHEM/MECH	748	19.6	342	6.2	1.04	6.9
	MECH.	736	20.1	349	6.3	1.03	7.0
	MEAN=	694	20.1	357	6.6	1.07	6.9
	LSD(.05)=	NS	NS	NS	NS	NS	NS

* DENOTES SIGNIFICANCE AT 0.01
@@ GRAMS PER UNIT= THE AMOUNT OF NUTRIENTS,EXPRESSED IN GRAMS, FOR A SPECIFIED HARVEST AREA.

TABLE 16.

CONSERVATION TILLAGE
BROWN COUNTY-POWHATTAN EXPERIMENT FIELD
SOIL ANALYSIS

CROPPING SYSTEM	P PPM 1976	P PPM 1977	K PPM 1976	K PPM 1977	% O.M. 1976	% O.M. 1977	PH 1976	PH 1977
COR/COR	31	34	208	213	3.10	2.88	5.6	5.2
SOY/SOY	29	35	211	212	3.09	2.88	5.8	5.6
SOR/SOR	28	34	206	201	3.23	3.00	5.8	5.5
COR/SOY	30	32	221	195	3.14	2.84	5.9	5.5
SOY/COR	28	39	198	218	3.03	3.04	5.6	5.6
SOY/SOR	29	26	216	180	3.13	2.81	5.9	5.4
SOR/SOY	22	38	188	219	2.98	2.98	5.7	5.6
LSD(.05)	3*	3*	12*	11*	.12*	.12*	.1*	.1*
CROP TILLAGE								
COR/COR								
CHEM.	34	38	204	230	3.15	2.95	5.6	5.1
CHEM/MECH	30	31	203	206	3.08	2.88	5.6	5.2
MECH.	28	32	215	204	3.08	2.82	5.7	5.2
LSD(.05)	NS	2*	NS	NS	NS	NS	NS	NS
SOY/SOY								
CHEM.	29	36	214	211	3.10	2.80	5.8	5.6
CHEM/MECH	29	34	212	212	3.15	2.92	5.8	5.6
MECH.	29	35	206	214	3.02	2.90	5.8	5.6
LSD(.05)	NS	NS	NS	NS	NS	NS	NS	NS
SOR/SOR								
CHEM.	27	33	208	206	3.25	3.02	5.8	5.4
CHEM/MECH	28	37	207	200	3.15	3.05	5.8	5.5
MECH.	29	33	202	196	3.30	2.92	5.8	5.6
LSD(.05)	NS	NS	NS	NS	NS	NS	NS	NS

* DENOTES SIGNIFICANCE AT 0.01

and 1977. The differences can be attributed to high K content in soybean grain and relatively low K content in sorghum grain (Table 17). With minimum incorporation of residues, and surface (15.2 cm depth) soil sampling techniques being employed, the zone of greatest accumulation and removal is constantly being sampled.

Organic matter, although lower in 1977 than in 1976, exhibited the same trend within cropping systems for both years. The rate of decline should stabilize as the cropping systems become established.

Soil pH has dropped considerably during the study with continuous corn production producing the lowest values. Soil pH should be monitored closely or problems with nutrient availability will occur. Shear et al. (1969) observed the need for more frequent liming to maintain pH at more favorable levels to the plant.

Corn:

Continuous corn yields, though not outstanding, have steadily improved during the study (Tables 10 and 11). Yields from the corn/soybean rotation were consistently better than the continuous crop yields (Tables 13 and 14). No significant differences due to treatments were observed during the investigations. The higher yields have been from the chemical tillage treatment.

Tissue samples analyzed for percent N, P, and K revealed no significant differences in 1975. However, N values differed

TABLE 17.

KILOGRAMS OF PLANT NUTRIENTS
CONTAINED IN SELECTED CROPS
WITH SPECIFIED YIELDS *

PLANT		YIELD KG/HA	KG OF NUTRIENTS N	P	K
WHEAT	GRAIN	2688	56	12	13
	STRAW		22	1	32
SOYBEAN	GRAIN	6720	470	40	134
	STRAW		157	13	90
SORGHUM	GRAIN	8960	134	29	29
	STOVER		151	13	143
CORN	GRAIN	9408	151	26	37
	STOVER		112	18	136

* SCOTT AND ALDRICH 1970

significantly in 1976, and P significantly in 1977. Whole plant samples were collected and analyzed in 1976 and 1977, but no significant differences among tillage treatments were observed. In addition to whole plant analysis in 1977, dry matter per harvested area was calculated indicating significant differences between tillage treatments. Chemical tillage yielded more total dry matter than did the more intensive tillage treatments. The total amount of N, P, and K absorbed and expressed as grams per unit area harvested tended to be greater in the chemical treatment plots but was not statistically different from the chemical/mechanical and mechanical treatments.

Soybeans:

Yields were depressed at the Powhattan Field in 1976 due to droughty conditions throughout the flowering and pod set stages. No differences in chemical analyses were noted among tillage treatments except for the 1977 P levels in date 1 tissue. The chemical/mechanical tillage treatments generally produced the higher tissue N, P, and K levels as well as grams of N, P, and K per unit area harvested.

Grain sorghum:

Continuous grain sorghum yields improved considerably from 1975 to 1976. No yield differences among tillage treatments were noted. Sorghum in a rotation with soybeans yielded more in 1975 than continuous sorghum; however, the opposite occurred in 1976 (Tables 10 and 11, 13 and 14).

Tillage treatments had little effect on N, P, and K levels in sorghum tissue. Differences in P concentrations in 1975 and 1977 were significant between treatments (Tables 10 and 12). Sorghum whole plant samples indicated significant differences in N, P, and K concentrations between tillage treatments in 1977 (Table 12). Mechanical tillage treatments produced the lowest nutrient concentrations. However, mechanical treatments produced the highest percent dry matter among the tillage treatments.

Conclusions:

Corn, soybeans, grain sorghum and rotations involving these crops can be adapted to almost any tillage system. In a continuous cropping system, one must be constantly aware of soil, plant, and environmental factors that may prove detrimental to the crop at any given time. One extra tillage operation may cause enough soil moisture loss to subject the crop to a moisture stress at a critical stage of growth. Moisture stress alone could influence yields substantially.

When ample soil moisture is available, limited tillage may improve yields. However, if soil moisture is low, chemical or no-tillage culture would be advisable. Moisture stress was observed on the continuous soybeans and soybean/sorghum rotation plots at the Powhattan field in 1976 during the early stages of growth. The mechanical tillage treatment reflected moisture stress throughout the season as is shown in the yields (Tables 11 and 14), though not significantly different from the remaining tillage treatments.

Virtually any of the cropping systems investigated in this study at the Powhattan field could be recommended for use in the northeastern part of Kansas.

Franklin County: Ottawa Experiment Field.

The study was initiated in the fall of 1975 on a Woodson (tentative classification--Abruptic Argiaquolls) silt loam soil. Soil samples were collected in the spring of 1976 from each plot. Soil analyses are presented in Table 18. All parameters tested, i.e., P, K, O.M., and pH differed significantly among crop rotations, but not significantly within the continuous cropping systems with respect to tillage methods.

With only one year of soil data, no trends can be discerned. Soil pH has not been affected by tillage systems. Significant differences observed between rotations is probably due to site differences rather than rotation effects. Exchangeable K and percent organic matter closely paralleled each other. The relationship was also observed at the Powhattan site. Available P behaved rather erratically. Again, P, K, and organic matter differences were probably due to site variations rather than crop or cropping system effects.

TABLE 18.

CONSERVATION TILLAGE
FRANKLIN COUNTY-OTTAWA EXPERIMENT FIELD
SOIL ANALYSIS
1976

CROPPING SYSTEM	P PPM	K PPM	% O.M.	PH
WH/WH	15	150	2.66	6.0
SOY/SOY	19	137	2.68	5.9
SOR/SOR	26	135	2.65	5.8
WH/SOY	19	149	2.73	6.0
SOY/WH	10	150	2.77	6.0
SOY/SOR	27	139	2.58	5.9
SOR/SOY	32	168	3.01	5.8
LSD(.05)=	4*	20	.26	.1*

CROP TILLAGE	P PPM	K PPM	% O.M.	PH
WH/WH				
CHEM.	13	151	2.65	6.0
CHEM/MECH	14	145	2.72	6.0
MECH.	17	154	2.60	6.0
LSD(.05)=	NS	NS	NS	NS
SOY/SOY				
CHEM.	18	133	2.68	5.9
CHEM/MECH	23	144	2.65	5.9
MECH.	18	135	2.70	5.9
LSD(.05)=	NS	NS	NS	NS
SOR/SOR				
CHEM.	27	135	2.68	5.9
CHEM/MECH	26	135	2.60	5.8
MECH.	25	136	2.68	5.8
LSD(.05)=	NS	NS	NS	NS

* DENOTES SIGNIFICANCE AT 0.01

Wheat:

Depressed wheat yields in 1977 were due in part to late planting and winter kill. Little vegetative growth had occurred by the time plant dormancy occurred. Furthermore, the chemical treatment produced a poor stand due to difficulties in seeding into previous crop residue. The mechanical tillage treatment provided the better yields in 1976 while the chemical/mechanical combination provided the better yield in 1977 (Tables 19 and 21).

Grain crude protein, although not significant within treatments, was considerably higher for this site than any other site in the conservation tillage study. The variety of wheat (Centurk) planted, and the level of soil fertility prior to the establishment of the study are the primary causes of the high protein levels. A review of the cropping history for the site shows grain sorghum (1974), spring oats (1975), fall planted wheat (1976) with 76 kg/ha actual N applied. Fertilization of the wheat was by split applications of a starter fertilizer (112 kg/ha of 8-14-13) at planting and an early spring topdress of urea. High N rates caused some lodging.

Soybeans:

Yields were poor in 1976 due to thin stands and weed competition (Table 19). Tissue samples collected at late bloom stage (growth stage 5) did not reveal any treatment differences in N, P, and K concentrations. Difficulty in

TABLE 19.

CONSERVATION TILLAGE
FRANKLIN COUNTY-OTTAWA EXPERIMENT FIELD
YIELD AND TISSUE ANALYSIS 1976

CONTINUOUS CROPPING	TILLAGE	YIELD KG/HA	% C.P.	TISSUE DATE 2 %N	%P	%K
WH/WH						
	CHEM.	1969	15.6			
	CHEM/MECH	2829	15.5			
	MECH.	2890	15.4			
	MEAN=	2563	15.5			
	LSD(.05)=	271*	NS			
SOY/SOY						
	CHEM.	625	38.0	4.95	.51	2.05
	CHEM/MECH	679	37.5	4.92	.51	2.09
	MECH.	544	38.4	4.88	.50	2.10
	MEAN=	618	38.0	4.92	.51	2.08
	LSD(.05)=	48	NS	NS	NS	NS
SOR/SOR						
	CHEM.	3544	7.6	2.71	.26	1.56
	CHEM/MECH	5632	7.7	2.83	.30	1.75
	MECH.	4679	7.4	2.62	.27	1.69
	MEAN=	4616	7.6	2.72	.28	1.67
	LSD(.05)=	696	NS	NS	NS	NS

* DENOTES SIGNIFICANCE AT 0.01

TABLE 20.

CONSERVATION TILLAGE
FRANKLIN COUNTY-OTTAWA EXPERIMENT FIELD
YIELD AND TISSUE ANALYSIS 1976

ROTATION CROPPING	TILLAGE	YIELD KG/HA	% C.P.	TISSUE DATE 2 %N	%P	%K
WH/SOY						
	CHEM.	3224	16.0			
	CHEM/MECH	3256	16.2			
	MECH.	3258	16.5			
	MEAN=	3246	16.2			
	LSD(.05)=	NS	NS			
SOY/WH						
	CHEM.	586	38.1	4.46	.38	1.78
	CHEM/MECH	722	37.3	4.73	.41	1.99
	MECH.	642	37.5	4.57	.38	1.92
	MEAN=	650	37.7	4.58	.39	1.89
	LSD(.05)=	NS	NS	NS	NS	NS
SOY/SOR						
	CHEM.	1098	37.8	4.69	.52	2.18
	CHEM/MECH	1124	37.2	4.38	.52	2.18
	MECH.	1045	37.3	4.59	.53	2.26
	MEAN=	1089	37.4	4.55	.52	2.21
	LSD(.05)=	NS	NS	NS	NS	NS
SOR/SOY						
	CHEM.	2654	9.0	3.05	.31	1.71
	CHEM/MECH	4407	8.6	3.23	.33	1.80
	MECH.	3585	8.1	2.94	.30	1.82
	MEAN=	3549	8.6	3.08	.31	1.78
	LSD(.05)=	1222	NS	NS	NS	NS

TABLE 21.

CONSERVATION TILLAGE
FRANKLIN COUNTY-OTTAWA EXPERIMENT FIELD
YIELD ANALYSIS 1977

CROPPING SYSTEM	TILLAGE	YIELD KG/HA	% C.P.
WH/WH			
	CHEM.	954	16.2
	CHEM/MECH	1915	16.1
	MECH.	1821	16.2
	MEAN=	1566	16.2
	LSD(.05)=	430*	NS
WH/SOY			
	CHEM.	1774	17.0
	CHEM/MECH	1777	17.3
	MECH.	1729	16.7
	MEAN=	1760	17.0
	LSD(.05)=	NS	NS

* DENOTES SIGNIFICANCE AT 0.01

obtaining a stand coupled with troublesome weather during planting resulted in the abandonment of the soybean plots in 1977.

Grain Sorghum:

Grain yields for 1976 were comparable to those of other studies in the immediate area; however, they were still less than the potential for the area. Yields varied significantly among tillage treatments in 1976 (Tables 19 and 20). The mechanical and chemical/mechanical tillage treatments produced higher yields than chemical tillage in the continuous as well as the rotation systems in 1976. No significant differences were observed in tissue N, P, and K concentrations in leaves sampled in growth stage 5 (boot stage). The highest grain yield and crude protein were produced from the chemical/mechanical tillage treatment in 1976. The treatment also produced the highest concentration of N, P, and K in the leaf tissue.

Conclusions:

Continuous cropping systems using a minimum tillage concept on these heavier silt loam soils must involve extreme caution. A missed application of a herbicide could mean a crop failure if weather conditions were abnormal.

It appears that crop rotations such as grain sorghum and soybeans or wheat and soybeans may be better adapted to this region of eastern Kansas than the continuous cropping systems.

Increased yields and higher crude protein of grain can be achieved with these rotations.

Riley County: Ashland Agronomy Farm.

The experimental site was established on a Reading silt loam (Typic Argiudolls) in the fall of 1973. The entire area was planted to wheat. Soil samples collected in the spring of 1974 and coded to the 1975 crop rotations are presented in Table 22.

The initial soil data of 1974 indicate a large amount of variation within the site in available P and exchangeable K values. Available P reflected the same trends with depth in 1977, only with much higher values. Available soil phosphorus values differed significantly both years among rotations, but non-significant differences existed within continuous crops with respect to tillage treatments. A review of the fertilization practices for the study reveals a blanket application of 258 kg/ha of a mixture of 123 kg 18-20-0 and 134 kg 33.5-0-0, with the final application rate being 58-20-0. Apparently an excess of P was applied each year beyond the requirements of the individual crops.

Soil exchangeable K followed nearly the same pattern for both years of the study and differences were highly significant among rotations. Only continuous sorghum for 1975 revealed tillage treatment differences in soil exchangeable K. Those plots which had wheat in the rotation appeared

TABLE 22.

CONSERVATION TILLAGE
RILEY COUNTY-ASHLAND AGRONOMY FARM
SOIL ANALYSIS

	P PPM 1975	P PPM 1977	K PPM 1975	K PPM 1977	% O.M. 1975	% O.M. 1977	PH 1975	PH 1977
WH/WH	63	86	406	396	1.92	1.98	5.9	5.4
SOY/SOY	36	54	246	268	1.78	1.76	5.8	5.6
SOR/SOR	38	51	276	283	1.82	1.77	5.9	5.6
WH/SOY	62	78	403	357	2.09	1.98	5.9	5.5
SOY/WH	58	81	378	364	2.09	2.11	5.8	5.7
SOY/SOR	46	63	280	312	1.95	1.87	5.8	5.6
SOR/SOY	42	65	293	318	1.78	1.88	5.8	5.5
LSD(.05)=	13*	12*	77*	54*	.16*	.15*	NS	.1*
CROP TILLAGE								
WH/WH								
CHEM.	67	82	431	390	2.02	1.98	5.9	5.4
CHEM/MECH	60	87	378	391	1.82	2.05	5.9	5.4
MECH.	61	88	409	407	1.92	1.92	5.8	5.4
LSD(.05)=	NS	NS	NS	NS	NS	NS	NS	NS
SOY/SOY								
CHEM.	37	56	242	273	1.80	1.75	5.8	5.6
CHEM/MECH	35	56	251	264	1.75	1.80	5.8	5.6
MECH.	35	51	243	266	1.78	1.72	5.9	5.7
LSD(.05)=	NS	NS	NS	NS	NS	NS	NS	NS
SOR/SOR								
CHEM.	39	53	284	279	1.82	1.72	5.8	5.4
CHEM/MECH	37	55	257	300	1.85	1.82	5.8	5.6
MECH.	40	47	288	269	1.80	1.75	5.9	5.6
LSD(.05)=	NS	NS	28	NS	NS	NS	NS	.1

* DENOTES SIGNIFICANCE AT 0.01

to produce a greater decline in exchangeable K as compared to other rotations without wheat. Potassium was not applied in the blanket fertilization, thus implying more K removal by wheat than any of the other crops in the study. According to Scott and Aldridge (1972), this is not the case. Data presented in Table 17 shows wheat grain and straw combined to contain less K than either soybeans, sorghum or corn.

Differences in soil organic matter, though highly significant among rotations, were not significant with respect to tillage treatment. Continuous sorghum in 1977 displayed significant differences in pH within tillage treatments. The chemical treatment had the lowest pH and as tillage was increased, pH also increased. The incorporation of the broadcast fertilizer with the surface 10 cm of soil reduced the concentration at the soil surface. Continuous wheat had the lowest pH of the rotations studied at this site. Values approached that range where nutritional problems associated with soil acidity begin to appear.

Available and total soil moisture calculated from neutron probe readings are presented in Table 23. In every case, the chemical tillage treatment plots contained more total moisture than did the mechanical tillage treatments. Allowance for stand reduction in selected sorghum plots due to insect damage should be made. Those plots are annotated in the table.

TABLE 23.

NEUTRON PROBE SOIL MOISTURE READINGS
RILEY COUNTY-ASHLAND AGRONOMY FARM
CONSERVATION TILLAGE STUDY @
1977

DATE OF SAMPLE (JULIAN)	TOTAL WATER IN 160CM	CROPPING SYSTEM	TOTAL WATER IN 160CM	TILLAGE TREATMENT	TOTAL WATER IN 160CM
189	47.5	@@SCR-SCR	46.4	CHEMICAL	45.7
196	46.6	SOY-SOY	36.8	MECHANICAL	38.8
203	43.4	@@SCR-SCY	43.2	MEAN	=42.3
211	40.8	SCY-SCR	37.0	LSD(.05)=	0.7*
220	40.5	SOY-WH	47.8		
225	39.5	MEAN	=42.2		
231	39.7	LSD(.05)=	1.1*		
239	39.9				
252	41.0				
259	43.8				
266	42.1				
273	41.9				
MEAN	=42.3				
LSD(.05)=	1.8*				

* DENOTES SIGNIFICANCE AT 0.01
@ DATA COURTESY OF DR. J. A. HOBBS
@@ DENOTES POOR STANDS, TOTAL WATER IS BIASED

Wheat:

Continous wheat yields for all tillage treatments steadily decreased from 2660 kg/ha in 1975 to 1347 kg/ha in 1977 (Tables 26, 28, 30). Beginning 1976, the chemical tillage wheat yields were significantly lower than the other two treatments. It is speculated that this trend would continue with time and that differences would become greater each year. The apparent reason for this decline is the inability of the seed drill to place the seed in the soil firmly and cover it adequately. Furthermore, without tillage to aid in controlling weeds and volunteer wheat, a non-selective herbicide should have been used prior to planting.

Grain crude protein normally fluctuates inversely with yields; however, in 1975 the higher yields from continuous wheat gave the higher protein values. Protein content in the grain is a function of the plants' ability to translocate nitrogen from stems and leaves to the maturing kernels at heading. If the stand population is high, more plants will be competing for the available soil nitrogen, thus producing a greater total yield but proportionally lower in nitrogen. Conversely, if the stand population is low, fewer plants are competing for soil nitrogen; yields will be reduced, but total nitrogen available for translocation to the heads will be increased. Apparently, tillage enhances the soil nitrogen cycle by promoting increased microbial activity through aerations, increasing infiltration rates, and incorporating crop residues and surface applied fertilizers.

TABLE 24.

CONSERVATICN TILLAGE
RILEY COUNTY-ASHLAND AGRONOMY FARM
YIELD ANALYSIS 1974

CONTINUOUS CROPPING	TREATMENT	YIELD KG/HA
SCYBEAN/SOYBEAN		
	CHEM.	2392
	CHEM/MECH	2224
	MECH.	2607
	MEAN=	2406
	LSD(.05)=	175*
SORGHUM/SORGHUM		
	CHEM.	3280
	CHEM/MECH	4466
	MECH.	6308
	MEAN=	4685
	LSD(.05)=	1286*

* DENOTES SIGNIFICANCE AT 0.01

TABLE 25.

CONSERVATION TILLAGE
RILEY COUNTY-ASHLAND AGRONOMY FARM
YIELD ANALYSIS 1974

ROTATION CROPPING	TREATMENT	YIELD KG/HA
SOYBEAN/SORGHUM		
	CHEM.	2292
	CHEM/MECH	2231
	MECH.	2648
	MEAN=	2390
	LSD(.05)=	NS
SCYBEAN/WHEAT		
	CHEM.	2312
	CHEM/MECH	2580
	MECH.	2950
	MEAN=	2390
	LSD(.05)=	NS
SORGHUM/SOYBEAN		
	CHEM.	3556
	CHEM/MECH	4152
	MECH.	6372
	MEAN=	4693
	LSD(.05)=	NS

TABLE 26.

CONSERVATION TILLAGE
RILEY COUNTY-ASHLAND AGRONOMY FARM
YIELD AND TISSUE ANALYSIS 1975

CONTINUOUS CROPPING	TILLAGE	YIELD KG/HA	% C.P.	TISSUE DATE 1 %N	%P	%K
WH/WH						
	CHEM.	2566	14.1			
	CHEM/MECH	2580	15.3			
	MECH.	2834	14.2			
	MEAN=	2660	14.5			
	LSD(.05)=	NS	.7*			
SOY/SOY						
	CHEM.	3019	38.5	4.13	.47	1.87
	CHEM/MECH	3118	40.6	4.14	.46	2.06
	MECH.	2800	39.7	4.20	.49	2.12
	MEAN=	2979	39.6	4.16	.47	2.02
	LSD(.05)=	NS	NS	NS	NS	.18
SOR/SOR						
	CHEM.	5154	9.2	2.36	.29	1.92
	CHEM/MECH	5472	9.1	2.58	.29	1.85
	MECH.	4773	9.9	2.51	.32	2.01
	MEAN=	5133	9.4	2.48	.30	1.92
	LSD(.05)=	NS	NS	NS	NS	NS

* DENOTES SIGNIFICANCE AT 0.01

TABLE 27.

CONSERVATION TILLAGE
RILEY COUNTY-ASHLAND AGRONOMY FARM
YIELD AND TISSUE ANALYSIS 1975

ROTATION CROPPING	TILLAGE	YIELD KG/HA	% C.P.	TISSUE DATE 1 %N	%P	%K
WH/SOY						
	CHEM.	3063	13.5			
	CHEM/MECH	3142	13.3			
	MECH.	2994	13.7			
	MEAN=	3066	13.5			
	LSD(.05)=	NS	NS			
SOY/WH						
	CHEM.	3821	38.1	4.01	.50	2.16
	CHEM/MECH	3919	37.1	4.18	.52	2.22
	MECH.	4004	38.5	4.08	.49	2.20
	MEAN=	3914	37.9	4.11	.50	2.19
	LSD(.05)=	NS	NS	NS	NS	NS
SOY/SOR						
	CHEM.	3588	39.9	4.21	.51	1.81
	CHEM/MECH	3653	40.6	4.17	.53	2.04
	MECH.	3666	40.4	4.08	.52	2.09
	MEAN=	3636	40.3	4.15	.52	1.98
	LSD(.05)=	NS	NS	NS	NS	NS
SOR/SOY						
	CHEM.	5308	10.0	2.60	.28	2.14
	CHEM/MECH	4719	10.2	2.94	.29	1.91
	MECH.	4900	9.7	2.99	.31	1.84
	MEAN=	4976	9.9	2.84	.30	1.96
	LSD(.05)=	NS	NS	NS	NS	NS

TABLE 28.

CONSERVATION TILLAGE
RILEY COUNTY-ASHLAND AGRONOMY FARM
YIELD AND TISSUE ANALYSIS 1976

CONTINUOUS CROPPING	TILLAGE	YIELD KG/HA	% C.P.	TISSUE DATE 1 %N	%P	%K
WH/WH						
	CHEM.	1707	13.5			
	CHEM/MECH	2508	13.7			
	MECH.	2656	13.4			
	MEAN=	2290	13.5			
	LSD(.05)=	383*	NS			
SOY/SOY						
	CHEM.	991	40.1	3.74	.38	2.24
	CHEM/MECH	1102	40.1	3.76	.34	2.22
	MECH.	767	39.7	3.61	.35	2.26
	MEAN=	954	40.0	3.70	.36	2.24
	LSD(.05)=	173*	NS	NS	NS	NS
SOR/SOR						
	CHEM.	7026	9.4	4.77	.46	2.90
	CHEM/MECH	7761	10.3	4.66	.45	3.05
	MECH.	7421	10.7	4.76	.44	3.06
	MEAN=	7403	10.1	4.73	.45	3.00
	LSD(.05)=	NS	NS	NS	NS	NS

* DENOTES SIGNIFICANCE AT 0.01

TABLE 29.

CONSERVATION TILLAGE
RILEY COUNTY-ASHLAND AGRONOMY FARM
YIELD AND TISSUE ANALYSIS 1976

ROTATION CROPPING	TILLAGE	YIELD KG/HA	% C.P.	TISSUE DATE 1 %N	%P	%K
WH/SOY						
	CHEM.	2440	11.5			
	CHEM/MECH	2656	11.6			
	MECH.	2568	11.4			
	MEAN=	2554	11.5			
	LSD(.05)=	NS	NS			
SOY/WH						
	CHEM.	1491	40.9	3.80	.38	2.18
	CHEM/MECH	1598	40.6	3.82	.38	2.27
	MECH.	1561	40.9	3.80	.37	2.24
	MEAN=	1550	40.8	3.81	.38	2.22
	LSD(.05)=	NS	NS	NS	NS	NS
SOY/SOR						
	CHEM.	1642	40.2	4.04	.41	2.18
	CHEM/MECH	1531	40.7	4.01	.41	2.17
	MECH.	1368	39.8	3.84	.41	2.24
	MEAN=	1514	40.2	3.96	.41	2.20
	LSD(.05)=	NS	NS	.16	NS	NS
SOR/SOY						
	CHEM.	5055	10.0	4.97	.50	3.04
	CHEM/MECH	4171	12.5	4.80	.49	3.04
	MECH.	4172	12.6	4.77	.48	3.12
	MEAN=	4466	11.7	4.85	.49	3.06
	LSD(.05)=	NS	NS	.12	NS	NS

TABLE 30.

CONSERVATION TILLAGE
RILEY COUNTY-ASHLAND AGRONOMY FARM
YIELD AND TISSUE ANALYSIS 1977

CONTINUOUS CROPPING	TILLAGE	YIELD KG/HA	% C.P.	TISSUE DATE 1 %N	%P	%K
WH/WH						
	CHEM.	666	16.8	4.33	.42	3.79
	CHEM/MECH	1945	16.0	4.00	.37	3.51
	MECH.	1431	16.7	4.01	.34	3.30
	MEAN=	1347	16.5	4.11	.38	3.54
	LSD(.05)=	644*	.5*	NS	NS	NS
SOY/SOY						
	CHEM.	2991		4.84	.41	2.29
	CHEM/MECH	2986		4.75	.43	2.34
	MECH.	2964		5.03	.43	2.34
	MEAN=	2980		4.87	.42	2.32
	LSD(.05)=	NS		NS	NS	NS
SOR/SOR						
	CHEM.	4952		3.79	.36	3.08
	CHEM/MECH	6292		3.54	.39	3.40
	MECH.	6414		3.66	.37	3.10
	MEAN=	5886		3.66	.37	3.19
	LSD(.05)=	656		NS	NS	NS

* DENOTES SIGNIFICANCE AT 0.01

Early spring tissue samples (growth stage 2) were collected in 1977 to determine tillage effects on N, P, and K concentrations of the leaf tissue. Statistically, no significant differences were found. A trend, though small, was observed in the tissue percent N. Treatments producing the lower yields had higher percent N in their tissue and a higher crude protein percentage in the grain. However, the wheat/soybean rotation (Table 31) did not follow the tissue N: crude protein: yield relationship.

Soybeans:

Continuous soybean yields have been average under the conditions of this study. Significant yield differences were noted in 1974 and 1975 between treatments (Tables 24 and 28). Soybeans grown on the chemical and chemical/mechanical treatments tended to produce higher yields than the mechanical treatments for two of the three years reported. No significant differences were noted in grain crude protein or tissue N and P concentrations. Potassium concentrations in leaf tissue varied significantly among tillage treatments in 1975 (Table 26) with the mechanical tillage treatment producing the higher concentrations. Since soil K is only slightly more mobile than soil P, the availability of soil K is apparently enhanced with increased tillage.

Grain sorghum:

Continuous grain sorghum yields at the Riley County site steadily improved from a mean of 4685 kg/ha in 1974 to a mean

TABLE 31.

CONSERVATION TILLAGE
RILEY COUNTY-ASHLAND AGRONOMY FARM
YIELD AND TISSUE ANALYSIS 1977

ROTATION CROPPING	TILLAGE	YIELD KG/HA	% C.P.	TISSUE DATE 1 %N	%P	%K
WH/SOY						
	CHEM.	1258	17.7	3.85	.40	3.49
	CHEM/MECH	1185	18.1	3.54	.40	3.24
	MECH.	1231	18.1	4.00	.41	3.41
	MEAN=	1225	17.9	3.80	.40	3.38
	LSD(.05)=	NS	NS	NS	NS	NS
SOY/WH						
	CHEM.	3598		4.82	.49	2.48
	CHEM/MECH	3899		4.72	.46	2.42
	MECH.	3734		4.88	.49	2.52
	MEAN=	3744		4.81	.48	2.47
	LSD(.05)=	NS		NS	NS	NS
SOY/SOR						
	CHEM.	3606		4.89	.48	2.38
	CHEM/MECH	3844		4.80	.50	2.35
	MECH.	3500		4.56	.47	2.29
	MEAN=	3650		4.75	.48	2.34
	LSD(.05)=	NS		NS	NS	NS
SOR/SOY						
	CHEM.	2856		2.86	.27	2.26
	CHEM/MECH	5944		3.70	.34	3.26
	MECH.	6047		2.88	.24	2.30
	MEAN=	4949		3.15	.29	2.61
	LSD(.05)=	NS		NS	NS	NS

of 7403 kg/ha in 1976 (Tables 24 to 28). All yield differences except those in 1974 were statistically non-significant with respect to tillage treatments. The general trend for increased yields has favored increased tillage rather than the chemical tillage treatment. No significant differences have been noted in percent N, P, and K in leaf tissue with respect to tillage treatments. Potassium levels in leaf tissue have trended upward since 1975 even though potassium has not been applied through the fertilization program. Soil levels of exchangeable K are more than adequate for the cropping systems at the present time.

Grain sorghum yields from a sorghum/soybean rotation were comparable to the continuous cropping system. Tissue N and grain crude protein were higher for the sorghum/soybean rotation than for continuous sorghum in 1975 and 1976. Since soybeans synthesize the major portion of their N requirements from the environment, only small amounts of the applied fertilizer were utilized thus providing a carry-over of nutrients.

Conclusions:

Recommendations for continuous wheat production at this location should include some form of seedbed preparation. Obtaining the initial stand is the key to profitable wheat production. With technological advancements in seeding equipment and a selective herbicide that is compatible with wheat production, continuous no-tillage wheat would be feasible.

With proper setting of the Buffalo No-Till planter, few problems have been encountered in obtaining the desired plant population of soybeans in the chemical tillage treatments. Data indicate that yields may be improved by incorporating wheat or grain sorghum into a rotation with soybeans. A rotation may help alleviate the disease charcoal rot (Sclerotium bataticola) in soybeans. The population of soil borne fungus tends to increase with continuous soybeans. Population counts by the Plant Pathology Department at Kansas State University have confirmed a population increase in the continuous soybeans. To date, there is no preventive measure against the disease other than selective rotations with crops that are not so susceptible.

With good management, grain sorghum can be utilized in a no-tillage culture as a continuous crop or in a rotation system. From observations at the various locations, grain sorghum apparently adapts better to a reduced tillage system than either soybeans or wheat and may be comparable to corn in adaptability.

Reno County: Hutchinson Experiment Field.

The experimental site was established on a Clark - Ost complex (Typic Calciustolls--Typic Argiustolls) soil in the spring of 1975 with the planting of grain sorghum.

Initial soil samples were collected in the spring of 1976. Soil test levels of available P indicated a buildup in the surface 15 cm in 1977 from that of 1976 (Table 32). Since wheat was included in all the rotations investigated except one, and since wheat is a small user of phosphorus, this type of buildup would be expected (Table 17). With only partial recovery of applied P by wheat and sorghum, and substantial amounts of P returned to the soil surface via decomposition of sorghum stover, a buildup of soil P levels would be feasible.

The early spring soil samples were taken directly in wheat plots that had received a starter application of fertilizer the previous fall (Table 5). Soil phosphorus was highly significant among rotations and between years (Table 32). No differences due to tillage treatments were noted; however, the two years' data closely paralleled each other.

Exchangeable K varied significantly among rotations, but differences were non-significant between tillage treatments. Soil K levels tended to increase slightly with time for all rotations except for the fallow/wheat/sorghum and wheat/sorghum/wheat rotations. When the rotations are properly aligned with the year of initiation, one notes that wheat was either currently established or had been the previous crop when the soil samples were collected.

Organic matter decreased significantly between years among all rotations. However, the trend was nearly identical for all rotations.

Soil pH differences were non-significant among rotations, treatments, and years. The only noticeable trend was that of

TABLE 32.

CONSERVATION TILLAGE
RENO COUNTY-HUTCHINSON EXPERIMENT FIELD
SOIL ANALYSIS

CROPPING SYSTEM	P PPM 1976	P PPM 1977	K PPM 1976	K PPM 1977	% O.M. 1976	% O.M. 1977	PH 1976	PH 1977
WH/WH/WH	20	24	223	235	1.75	1.55	6.0	6.0
SOR/SOR/SOR	16	17	246	252	1.78	1.53	6.1	6.0
WH/SOR/FAL	16	18	225	227	1.95	1.60	6.1	6.1
WH/SOR/WH	22	24	273	231	1.97	1.68	6.0	6.2
SOR/WH/SOR	17	20	221	282	1.94	1.80	6.2	5.9
SOR/FAL/WH	17	18	207	225	1.80	1.67	6.1	6.3
FAL/WH/SOR	16	20	228	215	1.92	1.49	6.2	6.0
LSD(.05)=	2*	2*	19*	19*	.15	.13*	NS	NS
CROP TILLAGE								
WH/WH/WH								
CHEM.	20	25	213	232	1.72	1.50	5.8	5.7
CHEM/MECH	18	22	225	237	1.80	1.55	6.0	6.0
MECH.	21	24	230	235	1.75	1.60	6.2	6.2
LSD(.05)=	NS	NS	NS	NS	NS	NS	NS	NS
SOR/SOR/SOR								
CHEM.	16	17	244	245	1.75	1.52	6.1	6.0
CHEM/MECH	16	17	247	256	1.82	1.48	6.1	6.0
MECH.	15	16	247	256	1.78	1.60	6.2	6.0
LSD(.05)=	NS	NS	NS	NS	NS	NS	NS	NS

* DENOTES SIGNIFICANCE AT 0.01

continuous wheat where pH increased with increased tillage. The same trend was also observed at the Riley County site.

Wheat:

From 1976 to 1977, wheat yields increased approximately fourfold in the chemical tillage treatments. The other tillage treatments increased yields approximately one-third for the same period of time (Tables 34 and 35). Significant yield differences due to treatments existed in 1976 but not in 1977. The highest yields both years were produced on the chemical/mechanical treatment plots. Some difficulty was encountered in planting into the previous years' crop residue on the chemical tillage treatments. The difficulty, described earlier, resulted in a poorer stand and greatly reduced yields which produced higher crude protein values in the grain. Crude protein varied significantly with tillage treatments in both years of the study.

Grain sorghum:

Continuous sorghum yields in 1975 were considerably lower than sorghum yields in a rotation. Considering rotations, the sorghum/fallow/wheat system yielded better than the sorghum/wheat/sorghum system in 1975. In 1976, the chemical tillage treatment produced the lowest yields even though all yields were depressed due to insufficient moisture (Table 34).

Tissue analysis for the continuous cropping system indicated non-significant differences in 1975. No tissue

TABLE 33.

CONSERVATION TILLAGE
RENO COUNTY-HUTCHINSON EXPERIMENT FIELD
YIELD AND TISSUE ANALYSIS 1975

CROPPING SYSTEM	TILLAGE	YIELD KG/HA	% C.P.	TISSUE DATE 2 %N	%P	%K
SOR/SOR/SOR						
	CHEM.	2753	11.0	2.85	.26	1.99
	CHEM/MECH	2967	11.4	2.83	.26	1.90
	MECH.	2985	11.4	2.73	.25	1.96
	MEAN=	2904	11.3	2.80	.26	1.95
	LSD(.05)=	NS	NS	NS	NS	NS
SOR/WH/SOR						
	CHEM.	4864	12.9	3.28	.26	2.02
	CHEM/MECH	4127	12.6	3.25	.26	2.02
	MECH.	4689	13.3	3.03	.26	2.03
	MEAN=	4560	12.9	3.19	.26	2.02
	LSD(.05)=	NS	NS	NS	NS	NS
SOR/FAL/WH						
	CHEM.	4689	13.1	2.98	.25	1.92
	CHEM/MECH	4689	13.8	3.10	.25	1.78
	MECH.	4553	13.4	3.31	.27	1.88
	MEAN=	4644	13.4	3.13	.25	1.86
	LSD(.05)=	NS	NS	NS	NS	NS

TABLE 34.

CONSERVATION TILLAGE
RENO COUNTY-HUTCHINSON EXPERIMENT FIELD
YIELD ANALYSIS 1976

CONTINUOUS CROPPING	TILLAGE	YIELD KG/HA	% C.P.
WH/WH/WH			
	CHEM.	410	13.0
	CHEM/MECH	1814	10.8
	MECH.	1519	11.0
	MEAN=	1250	11.6
	LSD(.05)=	188*	1.3
SOR/SOR/SOR			
	CHEM.	1185	10.3
	CHEM/MECH	1944	9.7
	MECH.	1957	10.4
	MEAN=	1993	10.1
	LSD(.05)=	414*	NS

ROTATION CROPPING	TILLAGE	YIELD KG/HA	% C.P.
WH/SOR/WH			
	CHEM.	2695	12.5
	CHEM/MECH	2798	12.6
	MECH.	2794	12.9
	MEAN=	2762	12.7
	LSD(.05)=	NS	NS
WH/SOR/FAL			
	CHEM.	2279	12.6
	CHEM/MECH	2728	13.3
	MECH.	2659	13.0
	MEAN=	2556	12.9
	LSD(.05)=	312	NS
SOR/WH/SOR			
	CHEM.	1094	11.2
	CHEM/MECH	1642	11.1
	MECH.	1305	10.6
	MEAN=	1347	11.0
	LSD(.05)=	NS	.3*
SOR/FAL/WH			
	CHEM.	1747	10.3
	CHEM/MECH	2269	9.7
	MECH.	1832	9.7
	MEAN=	1949	9.9
	LSD(.05)=	416	NS

* DENOTES SIGNIFICANCE AT 0.01

TABLE 35.

CONSERVATION TILLAGE
RENO COUNTY-HUTCHINSON EXPERIMENT FIELD
YIELD AND TISSUE ANALYSIS 1977

CROPPING SYSTEM	TILLAGE	YIELD KG/HA	% C.P.	CROPPING SYSTEM	TISSUE DATE 1	%N	%P	%K
WH/WH/WH				SOR/SOR/SOR				
	CHEM.	1929	11.2		CHEM.	3.51	.28	2.78
	CHEM/MECH	2292	9.7		CHEM/MECH	3.78	.28	2.64
	MECH.	2238	9.8		MECH.	3.82	.30	2.70
	MEAN=	2150	10.2		MEAN=	3.70	.29	2.71
	LSD(.05)=	NS	.6*		LSD(.05)=	.21	NS	NS
WH/SOR/WH				SOR/WH/SOR				
	CHEM.	2661	12.4		CHEM.	3.31	.30	2.88
	CHEM/MECH	2762	12.2		CHEM/MECH	3.71	.29	2.80
	MECH.	2612	11.8		MECH.	3.76	.32	2.65
	MEAN=	2679	12.1		MEAN=	3.59	.30	2.77
	LSD(.05)=	NS	NS		LSD(.05)=	.26	NS	NS
WH/SOR/FAL				SOR/FAL/WH				
	CHEM.	2128	10.6		CHEM.	3.53	.28	2.77
	CHEM/MECH	2019	10.5		CHEM/MECH	3.97	.30	2.72
	MECH.	2053	9.9		MECH.	3.92	.31	2.75
	MEAN=	2066	10.4		MEAN=	3.81	.30	2.75
	LSD(.05)=	NS	NS		LSD(.05)=	.27	NS	NS

CROPPING SYSTEM	TILLAGE	1977 YIELD KG/HA	CROPPING SYSTEM		YIELD KG/HA
SOR/SOR/SOR			SOR/WH/SOR		
	CHEM.	2452		CHEM.	3339
	CHEM/MECH	3808		CHEM/MECH	3912
	MECH.	4186		MECH.	3834
	MEAN=	3482		MEAN=	3695
	LSD(.05)=	645*		LSD(.05)=	NS
SOR/FAL/WH					
	CHEM.	3390			
	CHEM/MECH	3320			
	MECH.	4030			
	MEAN=	3780			
	LSD(.05)=	NS			

* DENOTES SIGNIFICANCE AT 0.01

samples were collected in 1976. The crop was subjected to extreme moisture stress in 1976 at the scheduled time of sampling. Only N varied significantly in 1977 with the chemical tillage treatment producing the lower tissue N levels.

Differences in grain crude protein was non-significant with respect to tillage treatments for 1975 and 1976 except for the sorghum/wheat/sorghum rotation in 1976. The chemical tillage treatment produced the lowest yield and highest grain crude protein.

Conclusions:

The Clark - Ost complex soils require careful management in choosing the proper tillage practices. With conventional tillage, the tilled region tends to become droughty. In a no-tillage system, the surface tends to become sealed, although adequate infiltration rates can be maintained. However, when the soil dries to below field capacity, problems can arise at planting time with poor seed-to-soil contact and seed coverage.

For soils of this area, a rotation of wheat and sorghum is recommended as opposed to continuous cropping. The inclusion of a fallow period in a wheat or wheat/sorghum rotation would be a choice of the operator. The data presented in Tables 33 to 35 does not indicate that a fallow period is essential in the rotations. However, a no-tillage sorghum system may benefit from a fallow period in that additional soil moisture might be available. Smika and Wicks (1967) found that soil water storage was greater during the fallow period of a wheat/fallow/wheat or wheat/sorghum/fallow rotation when herbicides were used to control weeds rather than conventional tillage practices.

A high level of management, such as timeliness of field operations, and a thorough knowledge of the soil type will be the key to success of minimum tillage systems.

Republic County: Belleville Experiment Field.

The study was established on a Crete silt loam (Pachic Argiustolls) soil in 1974 with the planting of the continuous and rotation wheat plots.

Two consecutive years of soil analysis revealed no significant changes in soil organic matter content with respect to tillage treatments or crop rotation (Table 36). Though pH was lower the second year of sampling and significantly lower across crop rotations, only continuous wheat revealed differences within treatments. Available soil phosphorus was significant only within rotations in 1977. The two year trend for P was higher for continuous soybeans and the soybean/sorghum rotations than for the other rotations. Exchangeable potassium varied significantly within rotations in 1976. Potassium values for 1977 were considerably higher than in 1976, with the mechanical treatments within the continuous wheat, soybean, and sorghum plots being higher than the other tillage treatments. Apparently, the mechanical tillage increased the

TABLE 36.

CONSERVATION TILLAGE
REPUBLIC COUNTY-BELLEVILLE EXPERIMENT FIELD
SOIL ANALYSIS

CROPPING SYSTEM	P PPM 1976	P PPM 1977	K PPM 1976	K PPM 1977	% O.M. 1976	% O.M. 1977	PH 1976	PH 1977
WH/WH	28	29	320	353	2.01	2.12	5.7	5.6
SOY/SOY	34	36	370	376	2.11	2.14	5.7	5.4
SOR/SOR	31	30	358	373	1.92	2.09	5.5	5.1
WH/SOY	31	32	319	366	2.08	2.22	5.7	5.6
SOY/WH	33	31	368	375	2.14	2.13	5.7	5.5
SOY/SOR	31	33	368	368	2.13	2.21	5.6	5.3
SOR/SOY	31	37	337	371	2.09	2.16	5.5	5.2
LSD(.05)=	NS	5*	26*	NS	NS	NS	.1*	.1*
CROP TILLAGE								
WH/WH								
CHEM.	29	30	324	341	2.00	2.10	5.8	5.7
CHEM/MECH	28	31	318	356	1.90	2.08	5.7	5.5
MECH.	28	26	318	361	2.12	2.20	5.7	5.5
LSD(.05)=	NS	NS	NS	NS	NS	NS	.1	.2*
SOY/SOY								
CHEM.	33	37	360	358	2.10	2.12	5.7	5.4
CHEM/MECH	36	35	382	378	2.10	2.18	5.7	5.4
MECH.	32	36	368	393	2.12	2.12	5.8	5.5
LSD(.05)=	NS	NS	NS	NS	NS	NS	NS	NS
SOR/SOR								
CHEM.	34	29	394	380	1.98	2.08	5.5	5.1
CHEM/MECH	30	28	337	344	1.80	2.08	5.6	5.1
MECH.	29	33	343	395	2.00	2.12	5.5	5.2
LSD(.05)=	NS	NS	NS	NS	NS	NS	NS	NS

* DENOTES SIGNIFICANCE AT 0.01

rate of release of soil K and the decomposition rate of the residues.

Wheat:

Wheat yields were disappointing for the three years reported (Tables 37 to 42). Initially, yields responded to the chemical tillage environment but the trend was reversed by 1977 where the mechanical treatment gave the better yield. Poor stands were the rule all three years in the chemical plots due to the inability of the seed drill to properly cover the seed during planting. Also cheat (*Bromus secalinus*) became an increasing problem in all plots especially the chemical tillage treatment. To date, no herbicide has been released for use on wheat that is effective on cheat and compatible with wheat.

Soybeans:

Yields were depressed in 1976 because of the lack of adequate moisture at flowering, and particularly at pod set. Continuous soybeans tended to favor the reduced tillage system as reflected in the yields for 1975 and 1976 (Tables 37 and 39). Yields varied significantly in 1975 with the chemical treatment out-yielding the tillage plots. Poor stands were the rule for the three years reported. Lack of timeliness of tillage operations and planting were the major contributors to this problem.

TABLE 37.

CONSERVATION TILLAGE
REPUBLIC COUNTY-BELLEVILLE EXPERIMENT FIELD
YIELD AND TISSUE ANALYSIS 1975

CONTINUOUS CROPPING	TILLAGE	YIELD KG/HA	% C.P.	TISSUE DATE 1 %N	%P	%K
WH/WH						
	CHEM.	1801				
	CHEM/MECH	880				
	MECH.	820				
	MEAN=	1169				
	LSD(.05)=	578				
SOY/SOY						
	CHEM.	2123	37.9	4.65	.49	2.26
	CHEM/MECH	1391	38.2	4.85	.53	2.24
	MECH.	789	38.4	4.68	.49	2.16
	MEAN=	1431	38.2	4.73	.50	2.22
	LSD(.05)=	894	NS	NS	NS	NS
SOR/SOR						
	CHEM.	1499	11.2	2.89	.33	2.44
	CHEM/MECH	2158	11.6	3.43	.35	2.62
	MECH.	1969	11.2	3.21	.32	2.54
	MEAN=	1875	11.3	3.17	.34	2.53
	LSD(.05)=	NS	NS	NS	NS	NS

TABLE 38.

CONSERVATION TILLAGE
REPUBLIC COUNTY-BELLEVILLE EXPERIMENT FIELD
YIELD AND TISSUE ANALYSIS 1975

ROTATION CROPPING	TILLAGE	YIELD KG/HA	% C.P.	TISSUE DATE 1 %N	%P	%K
WH/SOY						
	CHEM.	809				
	CHEM/MECH	674				
	MECH.	634				
	MEAN=	706				
	LSD(.05)=	97				
SOY/WH						
	CHEM.	2048	36.7	4.44	.48	2.08
	CHEM/MECH	1824	37.4	4.59	.51	2.39
	MECH.	2070	36.3	4.56	.52	2.44
	MEAN=	1981	36.8	4.53	.51	2.31
	LSD(.05)=	NS	NS	NS	NS	.27
SOY/SOR						
	CHEM.	1579	39.2	4.62	.47	2.19
	CHEM/MECH	1760	37.3	4.66	.50	2.35
	MECH.	1919	37.2	4.75	.50	2.28
	MEAN=	1752	37.9	4.68	.49	2.27
	LSD(.05)=	NS	.9*	NS	.02	NS
SOR/SOY						
	CHEM.	720	12.6	3.04	.31	2.84
	CHEM/MECH	1230	12.7	3.33	.31	2.76
	MECH.	885	12.4	3.50	.32	2.66
	MEAN=	945	12.6	3.29	.31	2.75
	LSD(.05)=	NS	NS	NS	NS	NS

* DENOTES SIGNIFICANCE AT 0.01

TABLE 39.

CONSERVATION TILLAGE
REPUBLIC COUNTY-BELLEVILLE EXPERIMENT FIELD
YIELD AND TISSUE ANALYSIS 1976

CONTINUOUS CROPPING	TILLAGE	YIELD KG/HA	% C.P.	TISSUE DATE 1 %N	%P	%K
WH/WH						
	CHEM.	578				
	CHEM/MECH	1579				
	MECH.	1566				
	MEAN=	1243				
	LSD(.05)=	759				
SOY/SOY						
	CHEM.	820	39.1	4.42	.39	2.53
	CHEM/MECH	564	38.9	4.35	.38	2.50
	MECH.	800	37.9	4.35	.38	2.51
	MEAN=	726	38.6	4.37	.38	2.51
	LSD(.05)=	NS	NS	NS	NS	NS
SOR/SOR						
	CHEM.	3663	11.4	3.29	.34	1.51
	CHEM/MECH	3098	13.8	3.21	.32	1.63
	MECH.	2923	12.2	3.12	.33	1.74
	MEAN=	3224	12.5	3.21	.33	1.62
	LSD(.05)=	NS	1.4	.10	.01	NS

TABLE 40.

CONSERVATION TILLAGE
REPUBLIC COUNTY-BELLEVILLE EXPERIMENT FIELD
YIELD AND TISSUE ANALYSIS 1976

ROTATION CROPPING	TILLAGE	YIELD KG/HA	% C.P.	TISSUE DATE 1 %N	%P	%K
WH/SOY						
	CHEM.	585				
	CHEM/MECH	577				
	MECH.	786				
	MEAN=	649				
	LSD(.05)=	NS				
SOY/WH						
	CHEM.	1036	38.4	4.26	.30	2.28
	CHEM/MECH	876	39.6	4.26	.30	2.44
	MECH.	879	39.8	4.26	.31	2.36
	MEAN=	930	39.3	4.26	.30	2.36
	LSD(.05)=	NS	NS	NS	NS	NS
SOY/SOR						
	CHEM.	445	38.2	4.21	.30	2.33
	CHEM/MECH	328	39.3	4.34	.33	2.42
	MECH.	566	38.8	4.43	.33	2.39
	MEAN=	446	38.8	4.33	.32	2.38
	LSD(.05)=	NS	NS	NS	NS	NS
SOR/SOY						
	CHEM.	2621	13.1	3.04	.30	1.76
	CHEM/MECH	3114	13.2	2.98	.31	1.77
	MECH.	3299	13.1	3.08	.32	1.84
	MEAN=	3011	13.1	3.04	.31	1.79
	LSD(.05)=	NS	NS	NS	NS	NS

TABLE 41.

CONSERVATION TILLAGE
REPUBLIC COUNTY-BELLEVILLE EXPERIMENT FIELD
YIELD AND TISSUE ANALYSIS 1977

CONTINUOUS CROPPING	TILLAGE	YIELD KG/HA	% C.P.	TISSUE DATE 1 %N	%P	%K
WH/WH						
	CHEM.	7				
	CHEM/MECH	242				
	MECH.	585				
	MEAN=	276				
	LSD(.05)=	242*				
SOY/SOY						
	CHEM.			4.91	.39	2.78
	CHEM/MECH			4.88	.41	2.90
	MECH.			4.92	.44	2.93
	MEAN=			4.91	.41	2.88
	LSD(.05)=			NS	NS	NS
SOR/SOR						
	CHEM.			3.70	.36	3.21
	CHEM/MECH			3.69	.34	3.36
	MECH.			3.75	.37	3.33
	MEAN=			3.71	.36	3.30
	LSD(.05)=			NS	NS	NS

* DENOTES SIGNIFICANCE AT 0.01

TABLE 42.

CONSERVATION TILLAGE
REPUBLIC COUNTY-BELLEVILLE EXPERIMENT FIELD
YIELD AND TISSUE ANALYSIS 1977

ROTATION CROPPING	TILLAGE	YIELD KG/HA	% C.P.	TISSUE DATE 1 %N	%P	%K
WH/SOY						
	CHEM.	459	14.7			
	CHEM/MECH	1091	16.6			
	MECH.	773	16.6			
	MEAN=	774	16.0			
	LSD(.05)=	NS	.8*			
SOY/WH						
	CHEM.			4.86	.42	2.93
	CHEM/MECH			3.77	.31	2.26
	MECH.			4.93	.43	2.92
	MEAN=			4.52	.39	2.70
	LSD(.05)=			NS	NS	NS
SOY/SOR						
	CHEM.			4.73	.40	2.87
	CHEM/MECH			4.72	.38	2.84
	MECH.			4.60	.40	2.96
	MEAN=			4.68	.39	2.89
	LSD(.05)=			NS	NS	NS
SOR/SOY						
	CHEM.			3.66	.34	3.35
	CHEM/MECH			3.68	.32	3.33
	MECH.			3.96	.37	3.27
	MEAN=			3.76	.34	3.32
	LSD(.05)=			.12*	.03*	NS

* DENOTES SIGNIFICANCE AT 0.01

Tissue analyses revealed no significant differences among N, P, and K levels between tillage treatments. Nitrogen and phosphorus levels paralleled each other over years while K levels steadily increased.

Grain crude protein was not significantly different between tillage treatments or across the two years reported.

Grain sorghum:

With two years of data, yields and crude protein of the grain appear to be on the increase with the chemical and chemical/mechanical treatments being the highest. However, the upward trend in yield resulting from tillage treatments is not consistent within rotations nor statistically significant. All continuous sorghum plots, regardless of tillage, had competition from weeds for soil moisture in 1975 and 1976. Weed competition coupled with low populations account for a portion of the yield depression.

Leaf tissue N and P varied significantly with the mechanical tillage in the continuous sorghum by producing the lowest values. As tillage was decreased from mechanical to chemical, yields increased and tissue N levels increased. Since total soil moisture was low in 1976, the extra tillage operations prior to planting and cultivation during the growing season created an additional loss of moisture beyond that of the chemical tillage treatment. Although differences in tissue P in 1977 was not significant within tillage treatments, it became highly significant when adjusted for soil P as covariate.

Grain crude protein levels were significant only in 1976. The chemical tillage treatment in the continuous sorghum cropping system produced the highest yield and lowest crude protein. The yield-crude protein phenomena in grain sorghum is similar to that of wheat but is not so consistent as in wheat.

Conclusions:

Minimum tillage and no-tillage practices in the Crete silt loam soils common to the area of this study should be scrutinized. These soils have slow permeability, and internal drainage can be a problem in performing needed operations at the appropriate time.

A rotation of soybeans and sorghum with minimum tillage techniques is recommended, as opposed to continuous cropping and either chemical or mechanical tillage methods. Of the three crops studied--wheat, soybeans, and grain sorghum--grain sorghum adapted better to the cropping systems and tillage methods than did the other crops.

Continuous wheat culture may be practical only with proper management and tillage operations to hold weeds in check. If weeds and especially cheat are a problem, a wheat/sorghum rotation might be feasible.

NO-TILLAGE GRAIN SORGHUM STUDIES

Two, no-tillage, dryland grain sorghum studies were initiated in 1974 and 1975. These studies were designed to investigate the effects of a no-till culture, and methods of fertilizer application on nutrient concentration in leaf tissue and grain yield. The studies are similar in design except for the potassium variable at the Labette County site. Tables 8 and 9 depict the fertilizer variables and application methods.

Franklin County: Ottawa Experiment Field.

The study was initiated in 1975 on a Woodson (tentative classification--Abruptic Argiaquolls) silt loam soil. Soil samples from selected fertilizer application methods were collected from incremented depths to 61 cm in 1976 and 1977 (Table 43).

Soil pH dropped approximately 0.5 from 1976 to 1977 in all the fertilizer treated plots while the control dropped only 0.2. Implications are that the fertilized plots have a larger drop in pH between years with respect to depth than the non-fertilized plots. Variations in pH were significant with respect to depth for both sampling years in the control plots. It is speculated that continuous sorghum, as a crop, may be the contributing factor to the lower pH values over time. The zero P applications for 1976 and the band P applications for 1977 also varied significantly with depth.

TABLE 43.

FRANKLIN COUNTY-OTTAWA EXPERIMENT FIELD
CTTAWA NO-TILLAGE GRAIN SORGHUM
SOIL ANALYSIS

FERTILIZER TREATMENT	DEPTH CM	---PH--- 1976	1977	AVAIL. P --PPM--- 1976	1977	NH4 --PPM--- 1976	1977	NO3 --PPM--- 1976	1977
CONTROL	5.1	5.4	5.2	10.2	9.2	8.0	11.1	20.2	35.4
	10.2	5.8	5.5	3.0	3.0	7.3	10.0	5.0	18.2
	15.2	5.8	5.5	2.0	2.8	10.4	8.7	5.8	14.6
	30.5	5.8	5.6	2.0	3.0	7.8	7.4	2.8	12.2
	61.0	6.0	5.7	1.5	1.0	5.7	14.0	0.3	4.8
	MEAN=	5.7	5.5	3.8	3.8	7.8	10.2	6.8	17.0
	LSD(.05)=	.2	.2	NS	2.4*	NS	NS	NS	15.2
ZERO P	5.1	5.4	4.9	16.8	8.8	15.3	18.3	23.1	57.8
	10.2	5.7	5.3	2.5	2.6	9.1	9.9	6.6	21.7
	15.2	5.8	5.4	2.0	2.4	5.6	11.5	8.0	26.0
	30.5	5.9	5.4	2.4	1.2	6.2	11.4	6.6	16.1
	61.0	6.0	5.5	1.4	0.6	6.9	8.7	4.0	5.0
	MEAN=	5.8	5.3	5.0	3.2	8.6	12.0	9.7	25.3
	LSD(.05)=	.2*	NS	NS	1.1*	5.4	NS	5.6*	14.2*
B'CST PP-N	5.1	5.8	5.4	17.0	25.8	10.3	12.0	15.6	20.0
	10.2	6.1	5.4	3.0	4.8	8.4	11.6	5.8	15.1
	15.2	6.1	5.6	2.8	2.8	7.6	10.0	5.2	19.4
	30.5	6.0	5.6	2.0	2.3	11.8	6.6	5.2	13.7
	61.0	6.2	5.6	1.0	0.5	9.2	9.2	0.4	7.1
	MEAN=	6.0	5.5	5.2	7.2	9.5	9.9	6.4	15.1
	LSD(.05)=	NS	NS	NS	7.0*	NS	NS	6.2	6.2
BAND	5.1	5.7	5.2	8.4	15.3	7.1	19.6	15.6	61.8
	10.2	6.0	5.1	2.8	5.8	10.4	15.8	4.9	45.6
	15.2	6.0	5.2	2.5	3.1	8.7	14.9	5.4	32.4
	30.5	5.9	5.5	1.8	2.8	6.8	8.9	3.6	20.6
	61.0	6.0	5.6	1.3	0.4	7.8	7.4	5.4	5.4
	MEAN=	5.9	5.3	3.3	5.4	8.2	13.3	7.0	33.2
	LSD(.05)=	NS	.3	NS	6.7*	NS	NS	8.0	20.8*

* DENOTES SIGNIFICANCE AT 0.01

FRANKLIN COUNTY-OTTAWA EXPERIMENT FIELD
OTTAWA NO-TILLAGE GRAIN SORGHUM
SOIL ANALYSIS

FERTILIZER TREATMENT	DEPTH CM	---PH---	AVAIL. P ---PPM---	NH4 --PPM---	NO3 --PPM---
KNIFED PP					
(1976-1977)	5.1	6.0	9.8	14.4	14.7
	10.2	5.9	3.5	10.2	8.0
	15.2	6.0	2.3	12.2	11.6
	30.5	5.9	2.3	10.6	10.4
	61.0	5.8	0.8	5.4	4.6
	MEAN=	5.9	3.7	10.6	9.8
	LSD(.05)=	NS	NS	5.2	NS
(ACROSS YEARS)					
	1976	6.2	5.8	10.2	8.2
	1977	5.6	9.0	10.9	11.5
	MEAN=	5.9	7.4	10.6	9.8
	LSD(.05)=	.4	NS	NS	NS

Available soil P values varied significantly with depth of sampling for all treatments including the control in 1977. Some accumulation of P began to occur from the broadcast, preplant methods of P application as well as the band treatments. There is little evidence of P accumulation below 10 cm in depth with all treatments exhibiting similar trends.

Ammonium and nitrate concentrations responded similarly in all treatments in 1976. The levels in 1977 were erratic and fluctuated greatly from 0 to 10 cm in depth in all treatments, as well as the control. All treatments varied significantly in 1977 with respect to depth. However, when analyzed across years this effect was not significant with changes in depth of sample.

Grain yields increased from 1975 to 1976 but crude protein of the grain decreased. Yields varied significantly between treatments in 1975 but not in 1976 (Tables 44 and 45). Phosphorus application methods produced highly significant yield differences in 1975. Knife preplant methods of applying P produced the highest yields for the study in 1975. Preplant applications of P produced significantly better yields than band applied P in 1976 (Table 45). However, the banded P application method in 1976 produced significantly higher grain crude protein than knifed P application methods. Band P application methods in 1976 also produced significantly higher crude protein than the plots receiving no P.

Tissue N, P, and K varied significantly in 1975 with respect to treatments. Treatment effects on P concentrations

TABLE 44.

FRANKLIN COUNTY-OTTAWA EXPERIMENT FIELD
OTTAWA NO-TILLAGE GRAIN SORGHUM
YIELD AND TISSUE ANALYSIS 1975

FERTILIZER TREATMENT N	P	YIELD KG/HA	% CRUDE PROTEIN	TISSUE DATE 1 %N	%P	%K
CONTROL		1186	12.89	2.85	.21	1.38
KNIFE PP	---	1380	12.67	3.44	.22	1.18
B'CST PP	---	1480	12.38	2.83	.20	1.26
B'CST POST	---	1368	12.85	3.12	.18	1.39
KNIFE PP	KNIFE PP	2246	12.20	3.44	.36	1.02
B'CST PP	B'CST PP	1204	12.45	2.98	.31	1.28
KNIFE PP	KNIFE PP	1995	12.05	3.30	.28	1.13
B'CST PP	B'CST PP	1154	12.78	3.08	.24	1.47
KNIFE PP	BAND	1844	12.20	3.35	.25	1.32
B'CST PP	BAND	1424	12.56	3.09	.26	1.53
KNIFE POST	BAND	1468	12.67	3.36	.26	1.52
B'CST POST	BAND	1487	12.63	3.40	.26	1.41
	MEAN=	1520	12.53	3.19	.25	1.32
	LSD(.05)=	602	NS	.29	.03*	.31

N APPLICATION METHODS					
KNIFE PP	1844	12.20	3.35	.25	1.32
B'CST PP	1424	12.56	3.08	.26	1.53
KNIFE POST	1468	12.67	3.36	.26	1.52
B'CST POST	1487	12.63	3.40	.26	1.42
MEAN=	1556	12.52	3.30	.26	1.45
LSD(.05)=	NS	NS	NS	NS	NS

P APPLICATION METHODS					
KNIFE PP	2120	12.13	3.37	.32	1.08
B'CST PP	1179	12.62	3.03	.27	1.38
MEAN=	1650	12.37	3.20	.30	1.23
LSD(.05)=	483*	NS	.22*	.02*	.19*

* DENOTES SIGNIFICANCE AT 0.01

FRANKLIN COUNTY-OTTAWA EXPERIMENT FIELD
OTTAWA NO-TILLAGE GRAIN SORGHUM
YIELD AND TISSUE ANALYSIS 1976

FERTILIZER TREATMENT N	P	YIELD KG/HA	% CRUDE PROTEIN	TISSUE DATE1 %N	%P	%K	WHOLE PLANT %N	%P	%K
CONTROL		2578	8.70	3.00	.23	1.39	1.83	.19	1.30
KNIFE PP	---	2553	9.26	2.94	.23	1.42	1.98	.17	1.15
B'CST PP	---	2139	8.45	2.99	.23	1.31	1.90	.17	1.40
B'CST POST	---	2873	9.16	3.01	.22	1.39	2.10	.20	1.25
KNIFE PP	KNIFE PP	2421	8.13	2.99	.29	1.22	1.88	.22	1.18
B'CST PP	B'CST PP	2459	8.86	2.91	.26	1.30	1.96	.20	1.26
KNIFE PP	KNIFE PP	3005	8.76	2.93	.27	1.21	1.82	.22	1.34
B'CST PP	B'CST PP	2672	8.58	3.06	.26	1.29	2.01	.21	1.17
KNIFE PP	BAND	2936	9.48	3.02	.24	1.26	1.93	.18	1.09
B'CST PP	BAND	2358	8.46	3.08	.26	1.22	2.03	.20	1.19
KNIFE POST	BAND	2358	10.41	3.09	.24	1.33	2.12	.18	1.21
B'CST POST	BAND	1932	9.04	3.12	.25	1.23	1.96	.18	1.19
	MEAN=	2524	8.94	3.01	.25	1.30	1.96	.19	1.23
	LSD(.05)=	NS	.84	NS	.03*	.13	NS	.03*	NS

ORTHOGONAL COMPARISONS

FERTILIZER TREATMENT	YIELD KG/HA
KNIFE N	2936
B'CST N	1932
LSD(.05)=	953
PREPLANT N	3005
POST-PLANT N	1932
LSD(.05)=	953*
KNIFE P-PP	3005
BAND P	1932
LSD(.05)=	953

FERTILIZER TREATMENT	% CRUDE PROTEIN
KNIFE P-PP	8.76
BAND P	9.48
LSD(.05)=	.41*
ZERO P	8.45
APPLIED P	10.41
LSD(.05)=	.41

* DENOTES SIGNIFICANCE AT 0.01

were highly significant in 1976 and 1977, with knifed preplant (N and P) producing the highest values. Methods of P application effects on tissue N, P, and K concentrations were highly significant in 1975 but only P and K varied significantly in 1976. The knife preplant application method produced the highest P concentrations while the broadcast, preplant treatments produced the highest K concentrations.

Whole plant analyses in 1976 indicated a significant difference in P concentration between treatments but failed to show effects of methods of fertilizer application. The trend, though small, depicts the preplant application method as yielding the highest whole plant P concentrations while the plots receiving only N produced the lowest P concentrations.

Nitrogen application methods in 1976 did not show any statistical differences with analysis of variance procedures, but when compared orthogonally, knife vs. broadcast, and preplant vs. post-plant were significant with respect to yield (Table 45). In 1975, the broadcast post and banded P, knife preplant N, and knife preplant N and P, all gave higher tissue N concentrations than the remaining treatments.

Late planting, inclement weather, and poor herbicide performance forced the abandonment of the study in 1977.

Conclusions:

Problems encountered in attempting to establish the study in 1977 are prime examples of what can occur in a no-tillage system. Excessive rainfall prior to emergence caused problems with seedling emergence as well as producing some erosion in portions of the field. Persistent weather patterns nullified the herbicide applications on three occasions resulting in numerous broadleaf and perennial weeds. The excess rainfall may partially explain the erratic ammonium and nitrate concentrations in the soil profile indicated in the soil analysis data (Table 43).

Labette County: Parsons Experiment Field.

The design and objective of this study is identical to the Ottawa site except for a potassium variable.

The study was established on a Parsons silt loam (Mollic Albaqualfs) soil in the spring of 1974. Soil samples were collected to 46 cm in depth, when a fine particled, high density clay layer (claypan) was encountered. Due to the slow permeability of this clay layer, sampling through and below the layer would not only be painstaking but also futile. Few plant roots extend into this layer and nutrient concentrations, of any magnitude, are above the clay layer. Soil samples were analyzed for available P, ammonium, and nitrate. The results are presented in Table 46. No significant soil test value differences were produced by fertilizer treatments. However, available P did vary significantly within treatments with respect to depth. Available P tended to accumulate in the surface 5 cm and remained relatively unchanged from 15 to 46 cm.

TABLE 46.

LABETTE COUNTY-PARSONS EXPERIMENT FIELD
PARSONS NO-TILLAGE GRAIN SORGHUM
SOIL ANALYSIS 1974

FERTILIZER TREATMENT	DEPTH CM	AVAIL. P PPM	NH4 PPM	NO3 PPM
CONTROL	5.1	5.5	11.2	9.5
	10.2	3.2	15.6	8.3
	15.2	3.2	11.5	9.7
	45.7	1.2	14.6	6.6
	MEAN =	3.3	13.2	8.5
	LSD(.05)=	NS	NS	NS
ZERO P	5.1	6.6	17.5	13.4
	10.2	2.5	8.7	7.2
	15.2	3.6	13.9	6.2
	45.7	1.7	7.1	4.7
	MEAN =	3.6	11.8	7.9
	LSD(.05)=	NS	NS	NS
B'CST PP-NP	5.1	12.4	16.4	8.4
	10.2	3.4	13.1	8.6
	15.2	2.4	13.4	9.9
	45.7	0.8	9.2	7.6
	MEAN =	4.7	13.0	8.6
	LSD(.05) =	NS	NS	NS
AVERAGE				
	5.1	8.2	15.0	10.4
	10.2	3.0	12.5	8.0
	15.2	3.1	12.9	8.6
	45.7	1.3	10.3	6.3
	MEAN =	3.9	12.7	8.3
	LSD(.05) =	2.7*	NS	2.8

* DENOTES SIGNIFICANCE AT 0.01

Ammonium and nitrate concentrations were relatively consistent and depth distribution did not vary significantly between fertilizer treatments. Nitrate levels varied significantly with depth when analyzed within fertilizer treatments.

Grain sorghum yields in 1976 were almost double those of 1974. Treatments produced significant differences in yields both years. However, N and P application methods produced no significant differences in yield in 1974 or 1976. Treatment effects on crude protein were highly significant in 1976 with the knife post nitrogen application treatment being the lowest and knife preplant being the highest (Tables 47 and 48).

Tissue samples in 1975 revealed significant changes in (date 1) P and K concentrations as well as significant (date 2) N, P, and K concentration changes. Nitrogen application methods had no significant effects in 1975 but P application methods produced (date 1) K and (date 2) N concentration changes. Tissue P concentrations were lower in those plots that received only nitrogen. Tissue K concentrations (date 1) responded positively to all phosphorus applications, while (date 2) K concentrations responded to only knifed, preplant P and K application methods and to the broadcast post N, band P and K method.

Conclusions:

The one-time application of P and K rather than prorating over years produced no detrimental effects on the crop or soil. Yields in 1974 from this method of application were the highest in the study.

TABLE 47.

PARSONS NO-TILLAGE GRAIN SORGHUM
LABETTE COUNTY-PARSONS EXPERIMENT FIELD
YIELD ANALYSIS 1974 AND 1976

FERTILIZER TREATMENTS			---- 1974----		----1976-----	
N	P	K	YIELD KG/HA	% CRUDE PROTEIN	YIELD KG/HA	%CRUDE PROTEIN
---	CONTROL	---	979	10.9	2572	10.6
KNIFE PP	---	---	1286	11.8	3061	11.7
B'CST PP	---	---	1041	11.6	2572	11.2
B'CST POST	---	---	1104	11.9	2735	11.2
KNIFE PP	KNIFE PP	KNIFE PP	2829	11.5	4711	11.0
B'CST PP	B'CST PP	B'CST PP	3431	11.1	4027	11.0
KNIFE PP	KNIFE PP	---	1342	10.6	3350	11.9
B'CST PP	B'CST PP	---	1386	11.0	2202	11.1
KNIFE PP	BAND	---	1255	11.6	4209	11.3
KNIFE PP	KNIFE PP	KNIFE PP	2390	10.9	5357	12.0
B'CST PP	B'CST PP	B'CST PP	2045	11.2	3551	11.3
KNIFE PP	BAND	BAND	2384	9.9	4862	11.3
B'CST PP	BAND	BAND	2578	11.4	4460	11.9
KNIFE POST	BAND	BAND	2541	10.7	4892	9.9
B'CST POST	BAND	BAND	2729	11.1	4479	10.4
		MEAN=	1955	11.1	3803	11.2
		LSD(.05)=	527	NS	891*	.9*

TABLE 48.

PARSONS NO-TILLAGE GRAIN SORGHUM
LABETTE COUNTY-PARSONS EXPERIMENT FIELD
TISSUE ANALYSIS 1975

FERTILIZER TREATMENTS			TISSUE DATE 1			TISSUE DATE 2		
N	P	K	%N	%P	%K	%N	%P	%K
---	CONTROL	---	3.87	.34	0.71	3.03	.27	0.84
KNIFE PP	---	---	3.98	.28	0.77	3.34	.27	0.84
B'CST PP	---	---	3.77	.29	0.69	3.15	.26	0.79
B'CST POST	---	---	3.99	.32	0.72	3.11	.26	0.72
KNIFE PP	KNIFE PP	KNIFE PP	4.10	.32	1.16	3.23	.32	1.10
B'CST PP	B'CST PP	B'CST PP	4.08	.36	1.55	2.90	.29	1.17
KNIFE PP	KNIFE PP	---	4.08	.34	0.62	3.24	.29	0.67
B'CST PP	B'CST PP	---	4.02	.35	0.80	3.09	.29	0.89
KNIFE PP	BAND	---	4.00	.35	0.70	3.29	.29	0.76
KNIFE PP	KNIFE PP	KNIFE PP	4.14	.35	0.89	3.16	.30	0.97
B'CST PP	B'CST PP	B'CST PP	4.05	.34	1.03	3.14	.30	1.01
KNIFE PP	BAND	BAND	3.85	.32	1.16	3.05	.29	0.90
B'CST PP	BAND	BAND	3.95	.34	1.29	2.92	.28	0.99
KNIFE POST	BAND	BAND	3.75	.37	1.53	2.92	.28	0.98
B'CST POST	BAND	BAND	4.15	.37	1.43	2.93	.28	1.06
		MEAN=	3.99	.34	1.00	3.10	.28	0.91
		LSD(.05)=	NS	.05	.32*	.29	.02	.25

* DENOTES SIGNIFICANCE AT 0.01

A poor stand and inclement weather forced the abandonment of the study in 1977. With only fragmentary data, it is obvious that problems may occur with a no-tillage study on these heavier soils in eastern Kansas. A high degree of management is required to successfully operate a no-tillage system in this area of the state.

NO-TILLAGE IRRIGATED CORN STUDY

A no-tillage irrigated corn study was initiated in 1974 to investigate the effects of a no-till culture, and methods of fertilizer application on nutrient concentration in leaf tissue and grain yield. The fertilizer application methods are identical to the dryland grain sorghum study described previously. Table 7 describes the fertilizer treatment.

Stafford County: Sandyland Irrigation Experiment Field.

The study was established on a Pratt-Carwile complex (Psammentic Haptustalfs--Typic Argiaquolls) fine sandy loam soil. Soil samples from selected fertilizer application methods were collected in 1976 and 1977 to 61 cm in depth. Detailed soil analyses data are presented in Tables 50 and 51. A dense layer was encountered at depths varying from 30 to 61 cm. On these sandy soils, this clayey layer prevents the loss of valuable soil water from percolating through the soil profile beyond the normal root zone. The clayey layer also presents a problem in that the soil is able to store only limited amounts of available water, thus necessitating frequent but small irrigations.

Soil analyses for 1976 and 1977 revealed no significant differences within treatments, with respect to depth, for any of the parameters tested (Table 49). When the soil was analyzed across treatments with respect to depth, pH in 1976 and 1977, and ammonium in 1976 were significant (Table 49 cont.).

TABLE 49.

STAFFORD COUNTY-SANDYLAND EXPERIMENT FIELD
ST.JOHN NO-TILLAGE CORN SOIL ANALYSIS

FERTILIZER TREATMENT	DEPTH CM	PH		AVAIL. P PPM		NH4 PPM		NO3 PPM	
		1976	1977	1976	1977	1976	1977	1976	1977
CONTROL	5.1	7.3	7.3	6.5	8.6	4.4	4.5	5.6	1.9
	10.2	7.2	7.0	3.8	6.8	1.9	2.7	2.8	1.7
	15.2	7.1	6.9	4.8	8.8	3.0	4.5	2.4	2.2
	30.5	6.8	6.7	5.6	8.4	2.2	2.4	2.5	0.9
	61.0	6.6	6.5	3.5	5.6	2.2	1.4	3.5	1.0
	MEAN=	7.0	6.9	4.8	7.6	2.7	3.1	3.4	1.5
	LSD(.05)=	NS	NS	NS	NS	NS	NS	NS	NS
B'CST PP-N	5.1	7.2	7.3	7.4	10.5	3.4	2.9	3.8	2.2
	10.2	7.1	6.8	9.5	8.0	2.5	2.0	2.7	0.5
	15.2	7.0	6.7	4.8	9.8	2.1	2.8	1.5	0.4
	30.5	6.8	6.5	4.4	6.2	1.5	2.3	3.0	1.5
	61.0	6.6	6.6	4.5	3.8	1.6	1.5	1.8	1.1
	MEAN=	6.9	6.8	6.1	7.6	2.2	6.4	2.6	1.1
	LSD(.05)=	NS	NS	NS	NS	NS	NS	NS	NS
B'CST PP-NP	5.1	7.0	7.3	5.5	10.0	3.0	3.9	3.8	2.3
	10.2	6.9	7.0	4.8	12.0	2.7	2.7	3.7	2.7
	15.2	6.9	6.8	7.4	7.4	2.2	1.1	2.7	1.5
	30.5	6.9	6.8	4.5	6.8	1.3	0.8	1.3	0.5
	61.0	6.7	6.6	3.4	4.0	2.4	2.0	1.7	1.4
	MEAN=	6.9	6.9	5.1	8.0	2.3	2.1	2.6	1.7
	LSD(.05)=	NS	NS	NS	NS	NS	NS	NS	NS

TABLE 49, CONTINUED.

ST.JOHN NO-TILLAGE CORN SOIL ANALYSIS
STAFFORD COUNTY-SANDYLAND EXPERIMENT FIELD
ANALYSIS ACROSS TREATMENTS WITHIN DEPTHS

DEPTH CM	PH		AVAIL. P PPM		NH4 PPM		NO3 PPM	
	1976	1977	1976	1977	1976	1977	1976	1977
5.1	7.2	7.3	6.4	9.7	3.6	3.7	4.4	2.1
10.2	7.1	6.9	6.0	9.0	2.4	2.5	3.0	1.6
15.2	7.0	6.8	5.6	8.6	2.5	2.8	2.2	1.4
30.5	6.8	6.6	4.8	7.1	1.6	1.8	2.3	1.0
61.0	6.6	6.6	3.8	4.5	2.0	1.6	2.4	1.1
MEAN=	6.9	6.8	5.4	7.8	2.4	2.5	2.9	1.4
LSD(.05)=	.2*	.3*	NS	NS	1.1	NS	NS	NS

ANALYSIS OF DEPTH ACROSS YEARS
(1976-1977)

DEPTH CM	PH	AVAIL. P PPM	NH4 PPM	NO3 PPM
5.1	7.2	8.1	3.7	3.3
10.2	7.0	7.5	2.4	2.3
15.2	6.9	7.2	2.6	1.8
30.5	6.8	6.0	1.8	1.6
61.0	6.6	4.2	1.8	1.8
MEAN=	6.9	6.6	2.5	2.2
LSD(.05)=	.2*	4.6*	.9*	1.1

* DENOTES SIGNIFICANCE AT 0.01

Soil pH remained rather constant in all samplings, which was not the expected trend. Reports by other researchers (Blevins et al. 1977 and Shear et al. 1969) indicate the need to lime in order to maintain proper soil pH in no-till systems. In dryland no-till cultures, soil pH tends to decrease with time due to continuous surface applications of fertilizers. Irrigated no-till systems flush the soil surface of accumulated fertilizer salts which tend to lower pH. The irrigation water used at this site has a high pH, therefore, the fertilizer salt effects on pH are somewhat neutralized.

Broadcast applications of phosphorus have not only produced concentrations in the surface 5 cm but have also increased P concentrations to depths as great as 30 cm. Stanberry et al. (1955) reported that in sandy soils and some peats where insoluble phosphate compounds are scarce, downward movement of phosphates may take place following application of phosphate fertilizers. Frequent irrigations may enhance this phenomena. The values for 1977 may be biased in that a large amount of precipitation occurred following fertilizer application, creating extensive ponding on the plots.

Ammonium and nitrate levels were quite uniform within treatments as well as across years. The major ammonium and nitrate concentrations occurred at the 0 to 15 cm depth.

Yields have steadily decreased since the initiation of this study in 1974. Increased populations of *Diatraea grandiosella* (southwestern corn borer) are primarily responsible for the decline in yields. Infestations are great enough to warrant hand harvesting while the moisture content of the grain is relatively high but after physiological maturity has occurred.

Fertilizer treatment effects produced significant yields every year except 1976. However, P application method effects on yield were significant in 1976, with the knife preplant method producing the highest yield (Tables 50 to 54). The knifed preplant P application method produced significant tissue N (date 2 and whole plant) concentrations in 1976, and tissue P and K (date 2) concentrations in 1977.

The one-time application of P produced yields comparable to those of the prorated band treatments but not significantly better. Tissue P concentrations of the one-time application of P were generally comparable to band application tissue P concentrations, and usually higher than those plots receiving only nitrogen.

The control plots exhibited severe nitrogen deficiency throughout the cropping season each year. Yields were extremely poor from 1975 through 1977. Bandel (1975) noted that with suboptimal N rates, nitrogen deficiency symptoms were more severe throughout the season on untilled corn than on tilled corn.

Nitrogen application methods have affected yields statistically for three years of the study. Preplant N application yields have been significantly better than N applied, post-plant, yields from 1975 through 1977. Knifed N applications have produced statistically higher yields than broadcast N methods from 1975 to 1977 (Tables 50 to 53).

TABLE 50.

STAFFORD COUNTY-SANDYLAND EXPERIMENT FIELD
ST.JOHN NO-TILLAGE IRRIGATED CORN 1974
YIELD AND TISSUE ANALYSIS

FERTILIZER TREATMENT N	P	YIELD KG/HA	TISSUE %N DATE1	TISSUE %N DATE2
CONTROL		6761	3.69	2.03
KNIFE PP	---	10625	4.19	2.61
B'CST PP	---	10092	3.96	2.54
B'CST POST	---	9841	3.93	2.79
KNIFE PP	KNIFE PP	10399	4.35	2.83
B'CST PP	B'CST PP	10487	4.04	2.57
KNIFE PP	KNIFE PP	8894	4.29	2.88
B'CST PP	B'CST PP	9734	3.97	2.65
KNIFE PP	BAND	9922	4.55	2.63
B'CST PP	BAND	10342	4.21	2.81
KNIFE POST	BAND	10123	3.73	2.66
B'CST POST	BAND	9381	3.97	2.42
	MEAN=	9716	4.07	2.62
	LSD(.05)=	1330*	.38*	.29*

TABLE 51.

STAFFORD COUNTY-SANDYLAND EXPERIMENT FIELD
ST.JOHN NO-TILLAGE IRRIGATED CORN 1975
YIELD AND TISSUE ANALYSIS

FERTILIZER TREATMENT N	P	YIELD KG/HA	TISSUE DATE 1 %N	%P	%K	TISSUE DATE 2 %N	%P	%K
CONTROL		2183	1.88	.254	2.38	1.20	.159	1.72
KNIFE PP	---	8034	2.65	.204	2.43	2.50	.204	1.52
B'CST PP	---	7664	2.62	.224	2.55	1.96	.176	1.39
B'CST POST	---	6354	3.64	.285	2.48	2.66	.218	1.83
KNIFE PP	KNIFE PP	8273	3.05	.242	2.12	2.54	.222	1.32
B'CST PP	B'CST PP	8549	3.02	.267	1.98	2.54	.227	1.36
KNIFE PP	KNIFE PP	6611	2.50	.212	2.38	2.42	.200	1.43
B'CST PP	B'CST PP	5827	2.74	.236	2.37	2.20	.177	1.27
KNIFE PP	BAND	8982	3.08	.329	2.30	2.54	.222	1.57
B'CST PP	BAND	8091	2.94	.296	2.26	2.55	.229	1.60
KNIFE POST	BAND	8210	2.28	.324	2.51	2.42	.230	1.57
B'CST POST	BAND	7771	3.20	.309	2.51	2.72	.269	1.49
	MEAN=	7213	2.80	.265	2.34	2.36	.211	1.51
	LSD(.05)=	2296*	.59*	.069*	NS	.52*	.040*	NS

ORTHOGONAL COMPARISONS

FERTILIZER TREATMENT	YIELD KG/HA	FERTILIZER TREATMENT	YIELD KG/HA
KNIFE N-PP	8982	KNIFE P-PP	6611
B'CST N-PP	5827	BAND P	8982
LSD(.05)=	2295	LSD(.05)=	2295*

* DENOTES SIGNIFICANCE AT 0.01

TABLE 52.

STAFFORD COUNTY-SANDYLAND EXPERIMENT FIELD
ST.JOHN NO-TILLAGE IRRIGATED CORN 1976
YIELD AND TISSUE ANALYSIS

FERTILIZER TREATMENT N	P	YIELD KG/HA	% CRUDE PROTEIN	TISSUE DATE 1 %N	%P	%K	TISSUE DATE 2 %N	%P	%K	WHOLE PLANT %N	%P	%K
CONTROL		508	4.88	2.24	.305	2.32	0.81	.156	1.81	0.60	.151	1.66
KNIFE PP	---	1888	9.07	2.75	.216	2.23	1.90	.150	1.43	1.14	.122	1.25
B'CST PP	---	747	8.01	2.45	.253	2.42	1.08	.135	1.63	0.78	.113	1.43
B'CST POST	---	1424	8.74	3.92	.339	2.97	2.11	.179	1.62	1.29	.134	1.37
KNIFE PP	KNIFE PP	2365	8.99	2.98	.229	2.03	1.93	.163	1.37	1.27	.167	1.12
B'CST PP	B'CST PP	590	7.88	2.62	.300	2.26	1.01	.151	1.80	0.79	.129	1.39
KNIFE PP	KNIFE PP	1600	8.62	2.41	.339	2.24	1.85	.181	1.37	1.18	.169	1.18
B'CST PP	B'CST PP	734	8.45	2.62	.294	2.11	1.12	.204	1.65	0.69	.169	1.50
KNIFE PP	BAND	1694	9.44	3.09	.245	2.27	2.09	.183	1.46	1.33	.166	1.28
B'CST PP	BAND	740	7.90	2.37	.326	2.48	1.08	.159	1.68	0.72	.147	1.50
KNIFE POST	BAND	1958	8.99	2.52	.350	2.21	2.17	.198	1.45	1.40	.170	1.30
B'CST POST	BAND	2020	9.88	3.87	.350	3.10	2.18	.210	1.71	1.03	.143	1.50
	MEAN=	1355	8.40	2.82	.295	2.38	1.61	.172	1.58	1.02	.148	1.37
	LSD(.05)=	NS	NS	.61*	.070*	.23*	.60*	.040*	.26*	.35*	NS	.18*
N APPLICATION METHODS												
B'CST PP		740	7.90	2.37	.326	2.48	1.08	.159	1.68	0.72	.147	1.50
KNIFE PP		1694	9.44	3.09	.245	2.27	2.09	.183	1.46	1.33	.166	1.28
KNIFE POST		1958	8.99	2.52	.350	2.21	2.17	.198	1.45	1.40	.170	1.30
B'CST POST		2020	9.88	3.87	.350	3.10	2.18	.210	1.71	1.03	.143	1.50
	MEAN=	1606	9.05	2.96	.318	2.51	1.88	.188	1.57	1.12	.156	1.40
	LSD(.05)=	NS	NS	.69*	.070	.28*	.84	NS	NS	NS	NS	NS

ORTHOGONAL COMPARISONS

FERTILIZER TREATMENT	YIELD KG/HA	FERTILIZER TREATMENT	YIELD KG/HA
KNIFE N	2365	PREPLANT P	590
B'CST N	590	BAND P	2020
LSD(.05)=	1282*	LSD(.05)=	1282
PREPLANT N	590		
POST-PLANT N	2020		
LSD(.05)=	1282*		

* DENOTES SIGNIFICANCE AT 0.01

TABLE 53.

STAFFORD COUNTY-SANDYLAND EXPERIMENT FIELD
ST.JOHN NO-TILLAGE IRRIGATED CORN 1977
YIELD AND TISSUE ANALYSIS

FERTILIZER TREATMENT N	P	YIELD KG/HA	% CRUDE PROTEIN	TISSUE DATE 1 %N	%P	%K	TISSUE DATE 2 %N	%P	%K	WHOLE PLANT %N	%P	%K
CONTROL		245	7.66	1.95	.313	2.18	1.10	.149	1.87	1.10	.191	2.49
KNIFE PP	---	1932	8.21	2.68	.191	1.92	1.96	.150	1.88	1.55	.143	2.22
B'CST PP	---	2014	8.22	2.71	.189	2.01	1.85	.151	1.81	1.26	.107	1.99
B'CST POST	---	2459	8.75	3.09	.207	2.23	2.14	.194	2.10	1.36	.135	2.27
KNIFE PP	KNIFE PP	2804	8.81	2.79	.226	1.93	2.22	.188	1.98	1.48	.155	2.40
B'CST PP	B'CST PP	2177	8.21	2.71	.206	1.91	1.92	.172	1.78	1.28	.154	2.18
KNIFE PP	KNIFE PP	1895	8.43	2.62	.268	1.89	1.86	.195	1.95	1.32	.190	2.30
B'CST PP	B'CST PP	860	8.07	2.34	.278	1.90	1.29	.153	1.78	1.02	.179	2.09
KNIFE PP	BAND	2250	8.17	2.74	.267	2.01	1.99	.193	1.76	1.62	.185	2.37
B'CST PP	BAND	2434	8.40	2.72	.270	2.03	2.14	.207	1.70	1.48	.213	2.26
KNIFE POST	BAND	2566	8.34	2.50	.290	1.96	2.20	.214	1.86	1.45	.186	2.29
B'CST POST	BAND	2473	8.25	2.46	.301	2.56	2.22	.214	1.85	1.72	.189	2.23
	MEAN=	2026	8.29	2.69	.251	2.04	1.91	.182	1.86	1.39	.169	2.26
	LSD(.05)=	1135*	NS	.41*	.050*	.32*	.46*	.039*	.15*	NS	.044*	NS

ORTHOGONAL COMPARISONS

FERTILIZER TREATMENT	YIELD KG/HA	FERTILIZER TREATMENT	YIELD KG/HA
KNIFE N	2804	PREPLANT P	860
B'CST N	860	BAND P	2566
LSD(.058=	1138*	LSD(.05)=	1138*

PREPLANT N	2566
POST-PLANT N	860
LSC(.05)=	1138*

* DENOTES SIGNIFICANCE AT 0.01

TABLE 54.

STAFFORD COUNTY-SANDYLAND EXPERIMENT FIELD
ST.JOHN NO-TILLAGE IRRIGATED CORN 1977
WHOLE PLANT ANALYSIS

FERTILIZER TREATMENT N	FERTILIZER TREATMENT P	WHOLE PLANT %N	WHOLE PLANT %P	WHOLE PLANT %K	BULK WT. GM	D.M. %	D.M. GM	GRAMS PER HARVEST UNIT N	GRAMS PER HARVEST UNIT P	GRAMS PER HARVEST UNIT K
CONTROL		1.10	.191	2.49	1301	15.9	206.6	2.1	.39	5.2
KNIFE PP	---	1.55	.143	2.22	2331	17.3	400.8	6.4	.60	9.0
B'CST PP	---	1.26	.107	1.99	2785	18.5	512.2	6.4	.55	10.2
B'CST POST	---	1.35	.135	2.27	2588	15.5	395.4	5.4	.55	9.1
KNIFE PP	KNIFE PP	1.48	.155	2.40	3027	15.7	474.2	7.0	.73	11.3
B'CST PP	B'CST PP	1.28	.154	2.18	2497	17.1	419.8	5.4	.66	9.1
KNIFE PP	KNIFE PP	1.32	.190	2.30	2088	16.4	338.9	4.5	.63	7.8
B'CST PP	B'CST PP	1.02	.179	2.09	2270	17.9	408.1	4.2	.73	8.4
KNIFE PP	BAND	1.62	.185	2.37	3042	16.2	492.6	8.0	.91	11.7
B'CST PP	BAND	1.48	.213	2.26	3632	17.0	604.3	9.0	1.30	13.8
KNIFE POST	BAND	1.45	.186	2.29	2921	15.9	464.7	6.8	.85	10.4
B'CST POST	BAND	1.72	.189	2.23	2739	16.3	440.7	7.6	.84	9.8
	MEAN=	1.39	.169	2.26	2602	16.6	429.8	6.1	.73	9.7
	LSD(.05)=	NS	.044*	NS	970	NS	140.5*	2.6*	.34*	3.5*

* DENOTES SIGNIFICANCE AT 0.01

Phosphorus applied preplant produced statistically higher yields, from 1975 to 1977, than banded P application methods.

Tissue analyses revealed (date 1) N and (date 2) N concentrations as varying significantly among treatments from 1974 to 1977. Nitrogen application methods produced a significant tissue N concentration difference in all years except 1975. Phosphorus concentrations in plant tissue were significantly affected by treatments from 1975 through 1977.

Potassium concentrations in plant tissue were variable throughout the study; however, they differed significantly in 1976 and 1977 among treatments. Although K was not a variable in this study, an effect was observed from N application methods in 1977.

Whole plants were collected and analyzed in 1976 and 1977. Whole plant N and K concentrations varied significantly in 1976 due to treatments, but only P was significantly affected in 1977. Whole plant nutrient concentrations paralleled tissue (date 2) nutrient concentrations for both years. The data indicates that properly sampled leaf tissue can accurately represent the actual nutrient concentration levels within the entire plant. Table 54 depicts N, P, and K concentrations expressed as grams per unit area harvested.

Conclusions:

The results of this study, while quite variable, indicate that irrigated corn on a sandy soil will require proper fertilizer and pesticide management to obtain profitable yields.

Knifed applications either preplant or broadcast post plant gave better yield response to nitrogen than broadcast preplant N applications. Banded P application at planting produced higher levels of P in (date 1) tissue than other methods of P application used in this study.

Continuous no-tillage corn production in this region of Kansas will have to overcome the southwestern corn borer problem before advancements in tillage systems can be effectively applied. To help alleviate the corn borer problem, rotations with non-host crops, extensive use of insecticides, and the departure from a no-till system to minimum tillage will be necessary.

Maintaining good soil pH has been a problem in no-tillage corn due to broadcast fertilizers. Salt concentrations in the surface 10 to 15 cm tend to lower pH considerably unless the salts are diluted with soil via tillage, or flushed into the soil profile with water.

Sandy soils with low cation exchange capacity (CEC), may develop low pH values rather quickly with high rates of fertilization. Furthermore, if the system is irrigated, poor water quality will have an additive effect to the fertilizer salts and will lower the pH faster than fertilizer alone. If the irrigation water is of good quality, a neutralizing effect of the salts will occur thus countering the effect of the fertilizer salts on pH.

SUMMARY

Alternative methods to full-scale tillage systems are dependent on many interrelated factors. As the amount of tillage decreases, control of vegetation becomes more dependent on herbicides. Various combinations of herbicides have proven superior to single chemicals for this purpose (Ross et al. 1970).

Each farm operator must evaluate certain conditions before embarking upon a reduced to no-tillage operation. Listed below is a brief checklist of items that should be considered prior to selection of any tillage system.

1. Level of farm management.
2. Equipment investments.
3. Sequence of crops to be grown.
4. Soil type and general fertility level.
5. Available soil moisture or adequate irrigation water.
6. Ability to withstand a crop loss financially.

Once these items have been considered, one may begin to choose the tillage system that best suits his present farming operation with a minimal additional cost. The primary criteria of any tillage operation is the magnitude of benefit or return generated per cost of input. According to Griffith (1970), percent seed germination, soil temperature, and weed control have been the dominant factors affecting yield of the tillage systems.

A certain amount of experimentation on the part of the operator will be essential in maintaining proper fertilization and herbicide levels for the chosen tillage system and crop. Stanford et al. (1973) stated that little is known concerning the relative N requirements of untilled corn grown in cover-crop residues. Depending on the soil type, geographic location and average annual rainfall, the methods of fertilizer application may dictate the type of tillage system required. If rainfall is near 76 cm per year, method and time of N application is important due to the leaching factor of nitrogen. Phosphorus is less critical than potassium with regard to leaching; however, the Stafford County irrigated corn study and the Franklin County dryland sorghum study reported here did show some movement of P into the soil profile from surface applications of phosphorus.

Utilization of broadcast fertilizers were good at all sites but knifed applications of N and band applications of P performed much better than broadcast applications. No adverse effects could be ascertained with the one-time application of P during the first year of the study in comparison with the same amount prorated over four years.

Herbicide performance is one of the keys to success of the no-tillage systems. Timeliness of applications along with the proper tank sizes to handle a broad spectrum of weed problems will be a critical step in this phase of a no-tillage operation. Grain sorghum, soybeans, and corn all have excellent herbicide products on the market to handle most all problems that may be encountered. Wheat still requires a good herbicide beyond present day technology to control cheat, the major weed problem in wheat today.

Another problem encountered in minimum tillage wheat production is that of equipment capable of seeding into heavy residues and provide adequate soil coverage of the seed. Difficulties with seeding were encountered in these investigations with the chemical tillage treatments at all sites that included wheat in the rotations. Limited seedbed preparations, i.e., a single undercutting with a "V-blade" or a single discing, would prove satisfactory in obtaining the needed seed coverage.

Various tillage systems had only minute effects upon nutrient concentrations in tissue samples of corn, grain sorghum, soybeans and wheat. Tissue P and K concentrations fluctuated the most with respect to tillage. Trends in corn have indicated that as tillage increased, the concentrations of P and K either remained unchanged or decreased though not significantly. Tissue P and K concentrations in soybeans were inconsistent with respect to tillage. There appears to be a tillage by rotation by site interaction affecting concentrations of P and K in leaf tissue samples. Potassium concentrations in continuous sorghum tissue tended to increase with tillage while phosphorus tended to decrease. However, P levels in grain sorghum tissue from a rotation with soybeans tended to increase with tillage.

Tillage effects upon all crops have varied with the site, the crop, and the year. Grain sorghum can be produced from either a no-till system or full conventional tillage methods. If total soil moisture is low, the number of tillage operations should be scrutinized with care due to the loss of moisture with each operation. Soybeans tend to favor a reduced tillage system although the data were inconsistent from site to site. Large quantities of water are necessary for maximum soybean production; therefore, extra tillage operations may reduce available soil water below optimum levels for the plant.

Corn appears to be as well adapted to no-tillage techniques as any of the crops studied. The crop can be planted with relative ease due to the no-till planters that are available today. Also, a full line of herbicides for pest control, plus advanced irrigation and fertilization techniques have been developed for corn. In these studies, dryland corn exhibited few problems in acquiring required nutrients from surface (broadcast) applications of N, P, and K.

Close monitoring of various soil parameters, i.e., pH, available P, exchangeable K, extractable ammonium and nitrate are of primary importance in achieving optimum production. Blevins et al. (1977) reported that the no-tillage system with moderate N rates and lime most nearly preserved soil characteristics as compared to uncropped, untreated plots. His conclusions were that land can be intensively cropped and still remain in good condition.

Monitoring of the crop during the growing season is as important as monitoring soil parameters. Constant observations for moisture stress, insect and herbicide requirements, adequacy of fertilization should be made. There are many technical advisory service groups in existence today that provide these services for a nominal fee.

A technique to be developed beyond existing levels is that of satellite monitoring using various methods of remote sensing. Many technical advisory service groups are currently using infrared color photography to monitor moisture stress, insect and herbicide damage to crops. Aerial color infrared techniques were used during 1976 and 1977 on the Riley County conservation tillage study to monitor moisture stress, stand variation, and effectiveness of herbicides. These data are inconclusive at the present time and are not included in this report.

Possible projected use of infrared aerial photography could include the monitoring of nutrient levels in the crop at selected stages of growth and development. Certain aspects of plant vigor are reflected in the relative level of photosynthesis when various nutrients are lacking or limited. This level of active photosynthesis can be easily detected and recorded. The relationships of photosynthetic rate, plant vigor, nutrient uptake are all positively correlated, and may or may not be positively correlated with nutrient concentration within the plant. The nutrient concentration relationship will depend on the current environmental stresses acting upon the plant, as well as stage of development. Therefore, monitoring the plants' relative rate of photosynthesis could lead one to infer the relative concentration of a selected nutrient at that instance in time. From this, a prediction of yield (grain or forage) and protein content may be made.

BIBLIOGRAPHY

Adriano, D.C., L. S. Murphy, 1970. Agron. J. 62(5): 561-567. Effects of Ammonium Polyphosphate on Yield and Chemical Composition of Irrigated Corn.

Amer, F., M. M., Elgabaly, A. M. Balba, 1964. Alexandria J. Agr. Res. 12(1): 41-52 (Eng.)(Univ. of Alexandria, Egypt). N, P, and K Content of Corn in Relation to Fertilizer Application.

Bandel, V. A., S. Dzienia, G. Stanford, and J. O. Legg. 1975. Agron. J. 67: 782-786. N Behavior under No-Till vs. Conventional Corn Culture.

Bates, T. E., 1971. Agron. J. 63: 372-375. Response of Corn to Small Amounts of Fertilizer Placed with the Seed: III Relation to P and K Placement and Tillage.

Belcher, C. R. and J. L. Ragland, 1972. Agron. J. 64: 754-756. P Absorption by Sod-Planted Corn from Surface Applied P.

Bennett, O. L., 1973. Agron. J. 65: 488-491. Crop Responses to No-Tillage Management Practices on Hilly Terrain.

Blevins, R. L., D. Cook, S. H. Phillips, R. E. Phillips, 1971. Agron. J. 63: 593-596. Influence of No-Tillage on Soil Moisture.

Blevins, R. L., G. W. Thomas, and P. L. Cornelius, 1977. Agron. J. 69: 383-386. Influence of No-Tillage and Nitrogen Fertilization on Certain Soil Properties.

Bray, R. H. and L. T. Kurtz, 1945. Soil Sci. 59: 39-45. Determination of Total, Organic and Available Forms of Phosphorus in Soil.

Bremner, J. M., 1965(a). Inorganic Forms of Nitrogen. pp 1191-1206. In: Agronomy No. 9, Methods of Soil Analysis--Part 2. C. A. Black, Editor in Chief, American Society of Agronomy Inc., Madison, Wisconsin.

Bremner, J. M., 1965(b). Total Nitrogen. pp 1149-1178. In: Agronomy No. 9, Methods of Soil Analysis--Part 2. C. A. Black, Editor in Chief, American Society of Agronomy, Inc., Madison, Wisconsin.

Chapman, H. D., P. F. Pratt, 1961. Methods of Analysis for Soils, Plants, and Waters. Div. Agri. Sci., Univ. of California.

Ellis, B. G., C. J. Knauss and F. W. Smith, 1956. Agron. J. 48: 455-459. Nutrient Content of Corn As to Fertilizer Application.

Estes, G. O., 1972. Agron. J. 64: 733-735. Elemental Composition of Maize Grown Under No-Tillage and Conventional Tillage.

Fenster, C. R., 1973. Proceedings Soil Conservation Service: Conservation Tillage--A Handbook for Farmers. pp 53.

Findlay, W. I., J. M. Fulton, 1964. Can. J. Soil Sci. 44(2): 217-222. The Nutrient Composition of Hybrid Corn as Influenced by 1) Fertilizer, 2) The Phosphorus Percentage.

Fink, R. J., 1974. Agron. J. 66: 70-71. Corn Yield as Affected by Fertilization and Tillage.

Fuehring, H. D., 1966. Proc. Soil Sci. Soc. Amer. 30(4): 489-494. Nutrition of Corn on a Calcareous Soil. III Interaction of Zinc and Boron with Plant Population and the Relation Between Grain Yield and Leaf Composition.

Garg, K. P., L. F. Welch, 1967. Agron. J. 59: 152-154. Growth and Phosphorus Uptake by Corn as Influenced by Phosphorus Placement.

Griffith, D. R., J. V. Mannering, 1970. Agron. Abstracts 1970, pp 149. Corn Response to Eight Tillage--Planting Systems on Five Indiana Soils.

Hanway, J. J., 1971. How a Corn Plant Develops. Special Report No. 48. Iowa State University, Cooperative Extensive Services, Ames, Iowa.

Hemmerle, W. J., 1967. Statistical Computations on a Digital Computer. Ginn-Blaisdell Publishing Company.

Jones, J. N., 1968. Agron. J. 60: 17-20. No-Tillage System for Corn.

Jones, J. N., J. E. Moody and J. H. Lilland, 1969. Agron. J. 61: 719-721. Effects of Tillage, No-Tillage and Mulch on Soil Water and Plant Growth.

Jones, J. B., Jr. and W. A. Steyn, 1971. Sampling, Handling and Analyzing Plant Tissue Samples. In: Soil Testing and Plant Analysis. L. M. Walsh and J. D. Beaton, Eds. Amer. Soc. of Agron., Inc., Madison, Wisconsin.

Larson, W. E., 1972. Crops and Soils 25: 5-6. (Dec.). Tillage During the Past 25 Years.

Liniford, A. B., 1973. Proceedings Soil Conservation Service: Conservation Tillage--A Handbook for Farmers. pp 3.

Lutz, J. A. and Lillard, J. H., 1973. Agron. J. 65: 733-736. Effect of Fertility Treatments on the Growth, Chemical Composition and Yield of No-Tillage Corn on Orchardgrass Sod.

Melsted, S. W., H. L. Motto and T. R. Peck, 1969. Agron. J. 61: 17-20. Critical Plant Nutrient Composition Values Useful in Interpreting Plant Analysis Data.

Miller, R. J., J. T. Pesek, J. J. Hanway, 1961. Agron. J. 53: 393-396. Relationships Between Soybean Yield and Concentrations of Phosphorus and Potassium in Plant Parts.

Moody, J. E., G. M. Shear and J. N. Jones, 1961. S.S.S.A. Proc. 25: 516-517. Growing Corn Without Tillage.

Moschler, W. W., G. M. Shear, D. C. Martens, 1972. Agron. J. 64: 229-231. Comparative Yield and Fertilizer Efficiency of No-Tillage and Conventionally Tilled Corn.

Moschler, W. W. and D. C. Martens, 1975. S.S.S.A. 39: 886-891. Nitrogen, Phosphorus and Potassium Requirements in No-Tillage and Conventionally Tilled Corn.

Musick, G. J. and H. B. Petty, 1973. Proceedings Soil Conservation Service: Conservation Tillage--A Handbook for Farmers. pp 51.

Oschwald, W. R., 1973. Proceedings Soil Conservation Service: Conservation Tillage--A Handbook for Farmers. pp 21.

Robertson, W. K., P. M. Smith, A. J. Ohlrogge and D. M. Kinch, 1954. Soil Science 77: 219-226. P Utilization by Corn as Affected by Placement and N and K Fertilization.

Robertson, W. K., H. W. Lundy, G. M. Prine, W. L. Curry, 1976. Agron. J. 68(2): 271-274. Planting Corn in Sod and Small Grain Residues with Minimum Tillage.

Ross, M. A., J. L. Williams, Jr., 1970. Agron. Abstracts, 1970. pp 153-154. Comparisons of Vegetative Control Practices for Corn Tillage Systems.

Sanford, J. O., D. L. Myhre, and N. C. Merwine, 1973. Agron. J. 65: 978-982. Double Cropping Systems Involving No-Tillage and Conventional Tillage.

Scott, W. O., S. R. Aldrich, 1970. Modern Soybean Production. pp 177. S and A Publications, Champaign, Illinois.

Shear, G. M., H. L. Crane and A. T. Myers, 1946. Proc. Amer. Soc. Hort. Sci. 47: 239-248. Nutrient--Element Balance: A Fundamental Concept in Plant Nutrition.

Shear, G. M. and W. W. Moschler, 1969. Agron. J. 61: 524-526. Continuous Corn by the No-Tillage and Conventional Tillage Methods: A Six-Year Comparison.

Singh, T. A., G. W. Thomas, W. W. Moschler and D. C. Martens, 1966. Agron. J. 58: 147-148. Phosphorus Uptake by Corn Under No-Tillage and Conventional Practices.

Smika, D. E., G. A. Wicks, 1967. Agron. Abstracts 1967. pp 129. Soil Water Storage During Fallow in the Central Great Plains as Influenced by Tillage and Herbicide Treatments.

Snedecor, G. W. and W. G. Cochran, 1967. Statistical Methods. (Sixth Edition), The Iowa State University Press, Ames, Iowa, U.S.A.

Stanberry, C. O., C. D. Converse, H. R. Haise and O. J. Kelley. 1955. S.S.S.A. Proc., 19(3): 303-310. Effect of Moisture and Phosphate Variables on Alfalfa Hay Production on the Yuma Mesa.

Stanford, G., O. L. Bennett and J. F. Power, 1973. 'Conservation Tillage Practices and Nutrient Availability.' pp 54-62. In: Conservation Tillage. Soil Conservation Society of America, Ankeny, Iowa.

Stangel, P. J., 1964. Diss. Abstract, University of Wisconsin, Madison. Relationships Between Fertilization and Various Predictors of Yields of Field Corn.

Technicon Industrial Systems/Tarrytown, New York, 10591. Industrial Method No. 334-74 W/B+, March, 1977.

Triplett, G. B. and D. M. Van Doren, 1969. Agron. J. 61: 637-639. Nitrogen, Phosphorus and Potassium Fertilization of Non-Tilled Maize.

Tyner, E. H., 1947. S.S.S.A. Proc. 11: 317-323. Relationships of Corn Yield to Leaf N, P, and K Content.

Vanderlip, R. L., 1972. 'How a Sorghum Plant Develops.' C-447. Cooperative Extension Service, Kansas State University, Manhattan, Kansas 66502.

Van Doren, D. M., G. B. Triplett and J. E. Henry, 1976. S.S.S.A. 40(1): 100-105. Influence of Long Term Tillage, Crop Rotation and Soil Type Combinations on Corn Yield.

Viets, F. G., C. E. Nelson and C. L. Crawford, 1954. S.S.S.A. Proc. 18: 297-301. Relationships Among Corn Yields, Leaf Composition and Fertility.

Wiese, A. F. and D. W. Staniforth, 1973. Proceedings Soil Conservation Service: Conservation Tillage--A Handbook for Farmers. pp 43.

CONVENTIONAL AND NO-TILLAGE SYSTEM EFFECTS ON PLANT COMPOSITION AND YIELD

By

GLENN ALLEN RAINES

B.S., Kansas State University, 1967

An Abstract of a Master's Thesis

submitted in partial fulfillment of the

requirements of the degree

MASTER OF SCIENCE

Department of Agronomy

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1977

ABSTRACT

CONVENTIONAL AND NO-TILLAGE SYSTEM
EFFECTS ON PLANT COMPOSITION AND YIELD

Five conservation tillage studies and three no-tillage studies were initiated in 1974 and 1975 at seven locations throughout the State of Kansas.

The conservation tillage studies were designed to investigate three tillage systems (chemical, chemical/mechanical, mechanical) and their effects upon plant nutrient (N, P, and K) composition and grain yield. Crops used in these studies were corn (Zea mays, L.)., grain sorghum (Sorghum bicolor, (L.) Moench), soybeans (Glycine max, L. Merr.), and wheat (Triticum aestivum, L.). Analytical determinations were performed on soil, leaf tissue, whole plant and grain samples.

Continuous wheat yields in the conservation tillage studies have been variable and extremely poor. Wheat yields responded favorably to increased tillage. Seeding difficulties were encountered at all sites with the chemical tillage treatment (no-tillage). Grain sorghum and soybean yields were inconsistent with respect to tillage treatments. The chemical and chemical/mechanical tillage treatments generally produced the higher yields. Corn yields have responded favorably to reduced tillage as opposed to mechanical tillage.

Tissue samples were inconsistent in concentration levels of N, P, and K with respect to tillage treatments.

Tissue P and K concentration levels fluctuated more with respect to tillage treatments than did N.

A comparative study between whole plant analysis and leaf tissue analysis produced similar N, P, and K concentration trends with respect to tillage treatments. The whole plant concentration levels were generally lower than the tissue concentration levels; however, a good representation of nutrient uptake was achieved with tissue sampling.

Three no-tillage fertilization practice studies were conducted, one using irrigated corn, and two using dryland grain sorghum. These studies were designed to investigate the effect of five methods of application of two nitrogen materials and one phosphorus material on grain yield and plant composition.

Irrigated no-till corn yields steadily decreased throughout the study. Difficulties in obtaining a stand and ineffective weed control on certain weed species were the main problems encountered. Knifed applications of N and band applications of P at planting produced higher yields and higher tissue N and P concentrations than did broadcast applications of N and P. Extensive infestation of southwestern corn borer (*Diatraea grandiosella*) hampered continuous corn production in this area of Kansas.

Dryland grain sorghum produced adequately with the no-tillage concept. Yields have been comparable to conventionally tilled sorghum in the surrounding areas of the studies. Knifed preplant and broadcast post applications of nitrogen produced higher tissue N concentrations than broadcast preplant or knife post applications of nitrogen. Banded P at planting gave higher P concentration levels than the other methods. Yield trends appear to favor knife preplant applications of nitrogen and phosphorus.