THE UTILIZATION OF SOIL CHARACTERISTICS IN COMPUTING PRODUCTIVITY RATINGS OF OKLAHOMA SOILS

By

FERRIS PAUL ALLGOOD

Bachelor of Science
Oklahoma State University
Stillwater, Oklahoma
1954

Master of Science
Oklahoma State University
Stillwater, Oklahoma
1972

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of the Oklahoma State University
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Thesis Approved:

Fenton Gray
Thesis Adviser

Robert D Morrison

Lester W. Reed

Laval M. Verhalen

Billy B. Tucker

D D Durham
Dean of the Graduate College

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CHAPTER I

INTRODUCTION

Soil is the major natural resource of Oklahoma. It supports the gigantic agricultural system which is the major contributor to the state's development and continued prosperity. This agricultural industry is a dynamic system continually changing as new technology is introduced, major resources are utilized, and demands are asserted for increasing quantities of quality food and fiber. Urban expansion, recreation facilities, energy development, and transportation works are the major competitors for land; and the competition is certain to increase in the future with the expansion of the world population. The public's increasing demands for food and fiber increase the need for a more complete inventory of the soils used to produce those commodities.

In planning for future land use, productivity models are valid tools. Spatial planning, research, and land appraisal interests have a need for comparing soils. Soil surveys that have covered more than 90 percent of Oklahoma's land area make the proposed indices models especially timely. These soil surveys have been made by the United States Department of Agricultural in cooperation with Oklahoma Agricultural Experiment Stations. Approximately 91 percent of the available soil survey information has been developed since 1950. These surveys also contain advanced technological soils information. The value of these surveys has many dimensions that may be applied to infinite areas of resource planning.

Each soil has a set of unique characteristics by which it can be distinguished from all other soils. Those characteristics are the soil properties that determine the response of the soil to a particular crop in a particular environment. Systematically isolating those soil properties and making evaluations as related to crop yields provides a method to estimate the potential crop yield of a soil where the soil properties are known and the yield average has not yet been determined.

The index rating systems used in this study provide comparisons among soils in a part of the Central Rolling Red Plains Resource Area of Oklahoma. Indices were determined for wheat (Triticum vulgare), grain sorghum (Sorghum bicolor), and cotton (Grossypium hirsutum). The productivity rating systems used in the study area are proposed to establish a method of comparing soils for a particular crop and not the potential productivity of the soil. An index rating system of soils for corn (Zea mays) was previously compared by Committee VII, and this system was tested on soils in Northeastern Oklahoma (9). Evaluations of this system are in the Appendix of this thesis.

CHAPTER II

REVIEW OF LITERATURE

There are two basic index methods used in comparing soils, namely, the score card method which rates soil characteristics and sums the points contributed by those characteristics and the method of multiplying penalty points assigned to soil series characteristics expressed in percentages (18,40).

Storie (38,49) evaluated soils by assigning values to three sets of soil characteristics and multiplying the assigned percentage values to obtain an index rating. A soil with no limitations was given a value of 100 percent. In each system the soil profile was rated by evaluating soil properties that differentiate the soil series and associated phases. Indexes were established for field crop, grazing, and forest land evaluations (39,41, and 42).

Clarke (8) emphasized the importance of determining a uniform climate and management and maintaining them as constants with differences among soils as the main variables. Shumway et al. (28) hypothesized that soil productivity and climate are the key variables affecting crop production. "Production area" was used in making spatial analyses; and such an area was described as having a degree of homogeneity, especially in the soil, climate, and water. Values assigned to various soil characteristics were derived empirically and involved frequent trial and error. Estimates of production were compared to the producer's estimates of yield. A significant evaluation of estimates was made by comparing specific fields for crop yield versus soil characteristics.

Many of the soil surveys in the United States, especially publications before 1950, contain soil index ratings (1,2). A standard yield was commonly given a value of 100 percent (21), and this method remains the principal technique for assigning yield index ratings to soil mapping units in soil survey reports (46). The Committee VII - Soil Suitability Potential has implemented an advanced rating system which considers soil characteristics (9). The system was developed for corn on empirical bases with estimates of yield for the highest levels of management. The system was established to permit national or international comparisons for yield potentials among soils. Evaluations of that system are a part of this study. A system of soil indexing is a major advancement in utilizing soil survey information. Ableiter (1) pointed out the need for understanding the problems associated with soils which must be met in management practices. A soil classification that isolates those deficiencies is a major advancement in land evaluation.

Oschwald (23) related the crop production system to the influence of soil, climate, technology, and the ability of the producer. The prediction of input needs versus output requires a knowledge of the properties of the soil and its relationship to the plants grown (3,15).

Odell and Smith (22) indicated the importance of long-time average farm yields and random samples for a given crop. The amount of variation in yield, due to random fluctuation or uncontrolled factors, could vary within the range of a standard deviation above and below the mean and still provide a dependable average. Two-thirds of the samples would be expected to fall within such a range when the assumptions of normal distribution and random sampling are met. Gray (13) allowed a 20 percent variation from the yield values used in making this study. The indicated yields were those with limited additions of fertilizer, a practice that increases variations in yield depending on the season. Gross and Rust (15) described some of the variations in crop yields by studying simultaneously yield, soil management, and climate.

Estimates of production potentials based on analyses of soil survey data may be made with respect to soil properties. This includes characteristics of the soil series pedon, associated slope gradient, and synthesis of the soil survey data with other disciplines of science, such as crops, range, forestry, and wildlife management (19,27 and 28). Treating the component parts of a soil landscape in a spatial contiguity allows broad aerial planning. Mitchell (20) pointed out the value of index ratings of soils for use in tax evaluations. Soil indexes have also proven to be valuable in land appraisals (5,12 and 17). They may be used with models that evaluate locations and distances. The Geography Department at Oklahoma State University has implemented a number of computer programs to evaluate locations, distances, and attractions. Shumway et al. (28) used an allocation model in economic analyses among various areas in California. General soil maps, soil associations, and cartography are contemporary methods of spatial land analyses (16,24).

Simonson (29) defined the distinguishing features of soil associations and general areas. Fehrenbacher et al. (11) used productivity indexes in soil associations in Illinois. General soils maps showing soil index ratings have potentials for use in environmental quality considerations and in planning weather modifications (7,10,25, and 26).

CHAPTER III

"SOIL PROPERTIES MODEL"

The productivity rating is proposed by using the "Soil Properties Model" for soils occurring in the study area (Figure 1). It evaluates soil properties of soil pedons and associated crop yields. It uses these values to predict yields and index values for soils where yield values are not available. Analyses are made by using a regression program that utilizes the principle of least squares. The program provides a method to make increment evaluations of soil properties in respect to their influence on crop yields. The "Soil Properties Model" may determine which soil properties are most significant in determining yields of various crops and which value of each property is most significant in determining yields of a particular crop.

Methods and Procedures in the "Soil Properties Model"

The major objective of the study is to determine a crop yield index model that will utilize available data to facilitate the prediction of index values of all the soils in a particular area. The "Soil Properties Model" and "Soil Classification Model" are compared in Chapter V. Application of the index information is discussed in Chapter VI. The methods for grouping soils for information display were also evaluated as to the kinds of information that are presented in general

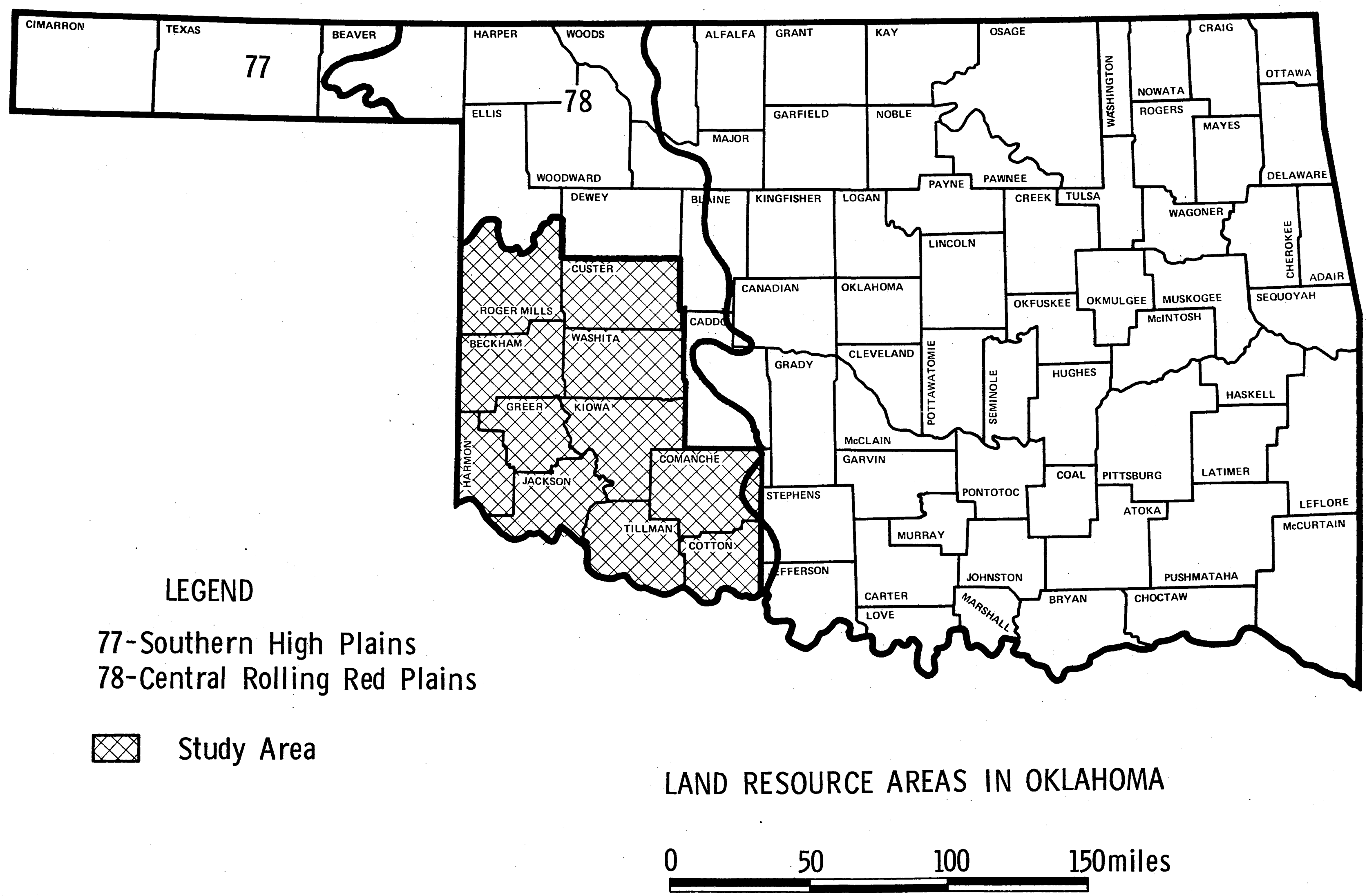

Figure 1. The location of the study area within the Central Rolling Red Plains Resourse Area

soils maps, soil associations, and in computer cartography (24).

Area for Study

The area chosen for the development and testing of the system lies in about the southern three-fourths of the Central Rolling Red Plains Land Resource Area No. 78 of the Central Great Plains winter wheat and range region in Oklahoma (4). The counties included were Roger Mills, Custer, Beckham, Washita, Greer, Kiowa, Comanche, Harmon, Jackson, Tillman, and Cotton (Figure 1). The northern boundary of the study area is the South Canadian River, and the southern boundary is the Red River. This area has a diversified cropping system that includes wheat, grain sorghum, and cotton; and those were the crops evaluated in the index models.

The Central Rolling Red Plains Resource Area in Oklahoma has an elevation that ranges from 1,500 to 3,000 feet, increasing gradually from the southeast to the northwest. The major land surface consists of broad, gently rolling upland areas between tributaries that lead to the rivers in the resource area. Valleys along the tributaries contain smooth, nearly level loamy bottomland soils. The steeper slopes are along the rims of the valley areas. The rivers are flanked by sandy soils that have nearly level to duned topography. The most prominent land feature in the area is the Wichita Mountains which outcrop in the northwestern part of Comanche County and tower up to 1,100 feet above the surrounding landscape (33).

Short, tall, and mid-height grasses comprise most of the natural vegetation of the region. The leading range plants of the area include blue grama (*Bouteloua gracillis*), little bluestem (*Schizachyrium* scoparium), buffalograss (Buchloe dactyloides), hairy grama (Bouteloua hirsuta), sideoats grama (Bouteloua curtipendula), Canada wildrye (Elymus canadensis), switchgrass (Panicum virgatum), Indiangrass (Sorghastrum nutans), and minor amounts of big bluestem (Andropogon gerardii). Small bushes, blackjack oak (Quercus marilandica) and red cedar (Juniperus virginiana) are associated with sandy upland while several species of broad-leaf trees occur along the tributaries and rivers that dissect the area. Mesquite (Prosopis glandulosa) is common on the clayey soils, especially in the southern part of the area.

The divisions between resource areas are an attempt to separate the state into fairly uniform climatic areas (4). The climate of Oklahoma does differ from semi-arid in the western to humid in the eastern part of the state (48). The average annual precipitation in the Central Rolling Red Plains Resource Area ranges from approximately 24 inches on the west to about 29 inches on the east side of the area (Figure 2). One year in 10 the precipitation is expected to be less than 20 inches and one year in 10 greater than 40 inches. The resource area has a temperate continental climate of the dry subhumid type (45). Erratic spring and summer rains cause the most erosion (50). The weather patterns which influence this area are sustained by the alternate movement of warm, moist air from the gulf of Mexico and of either contrasting cooler modified marine air from the West Coast or colder, drier air from the Arctic Circle. Rapid changes are common and result in distinct fluctuations of temperature, humidity, cloudiness, wind, and precipitation. Storms are more common in the spring than in any other season. Hail and high winds cause damage to crops every year in some parts of the area. Drought and hot winds are common in the

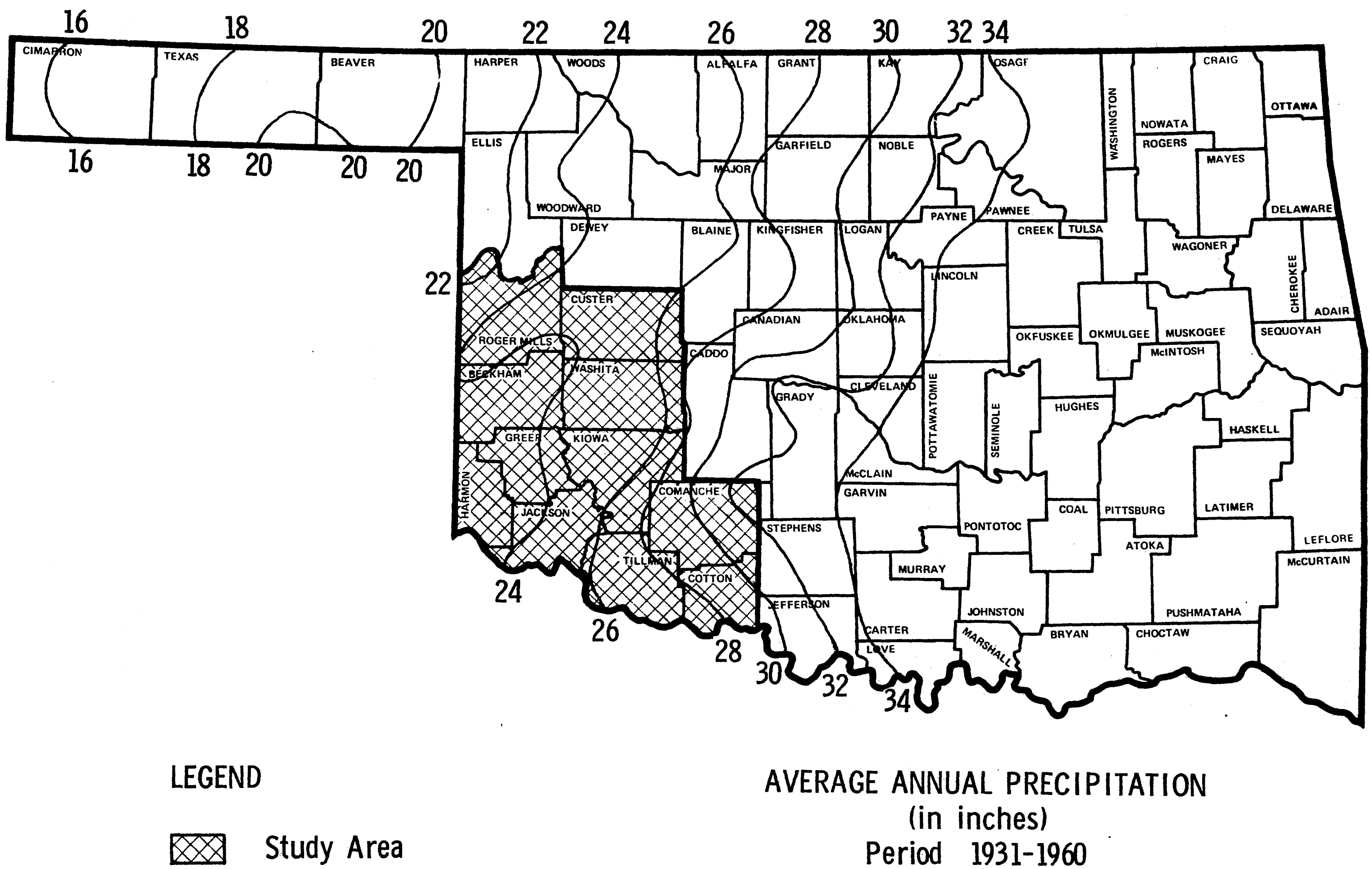

Figure 2. Average annual precipitation in inches in the Study Area (1931-1960)

summer months. The average monthly temperature ranges from 41°F in January to 84°F in August in the southeast part of the region to 37°F and 82°F, respectively, in the northwest part of the area. The annual temperature ranges from about 59°F in the north to 64°F in the south (Figure 1).

The soils in this region have developed from a wide variety of materials with the most common being the Permian Red Bed formation. The residual materials are mostly reddish colored shales and soft sandstone in the northern part with an increasing amount of mantle material occurring near the Wichita Mountains. Those mountains are located in the southern part of the Central Rolling Red Plains Resource Area; they are nearly barren hills and mountains of igneous rocks consisting mostly of granite. Alluvium and colluvium from weathered debris have contributed a source of mantle material for large areas of the surrounding landscape. Most of the small tributaries have narrow flood plains that consist of deep loamy soils. Sandy materials are most commonly associated with the rivers in the area. The South Canadian, Washita, and Red Rivers are the major streams.

A list of the soil series and phases used to produce wheat, grain sorghums and cotton in Southwestern Oklahoma was compiled by referring to recently published soil survey reports and soil survey legends pertaining to the area. Laboratory data used in the model were taken from soil surveys and other laboratory reports. Data compilations used to make the study are contained in Table VI. There were considerably more data compiled for analysis than used in the final analyses but because of either the insignificance or incompleteness in the matrices, the data were not used. Information regarding each sample was recorded as follows: Reference location, reference page number, soil series, sample number, card number, surface soil thickness in inches (A1 horizon), color hue, color value, color chroma, solum thickness in inches (depth of diagnostic horizon, except in mono-textured soils where depth of texture was used), pH, percent organic matter, percent nitrogen, cation exchange capacity, calcium, magnesium, potassium, sodium and hydrogen, iron, sand, silt, clay, type of clay, slope, erosion, flooding, wheat yield in bushels/acre, grain sorghum yield in bushels/acre, cotton yield in pounds of lint/acre, percent phosphorus, and study area. Yields were based on observations where little or no fertilizer was used in the production of the crop (13). Reference location refers to the literature from which the material was taken. A total of twenty-four references were cited in locating the data. The page number on which the main body of data occurred is also cited. The references are in a footnote of Table VI. Color values were reported according to the standard Munsell color charts (46). The typifying soil profile was consulted for colors. Organic matter, nitrogen, clay, silt and sand were reported in percentages. Cation exchange capacity, calcium, magnesium, potassium, and sodium and hydrogen were reported in milliequivalents per hundred grams of soil. Iron and phosphorus were reported in parts per million. Slope was reported as the average of a slope range (A, 0.5, average of 0-1 percent slope; B, 2.0, average of 1-3 percent slope; C, 4.0, average of 3-5 percent slope; D, 6.5, average of 5-8 percent slope). The properties for organic matter and nitrogen were reported for the A1 horizon. Clay, sand, silt, cation exchange capacity, exchangeable cations, and pH were values from the upper part of the _argillic_, _cambic_, or the material in the lower part of the epipedon if no diagnostic horizons occurred below this surface horizon. The typifying profile was consulted where laboratory data did not include the pH. Where the horizon was designated in various degrees of alkalinity, the pH was estimated near 8.0, depending on the associated adjective. Observations of strongly calcareous soil commonly range up to pH 8.3 in the study area (34). The kinds of clay were designated as P where montmorillonite comprises more than 50 percent of the clay present and M for all other soils with a mixed clay mineralogy. Erosion was coded as 0 where it ranged from none to slight; moderate was listed as 3 (46). Occasional flooding (claiming approximately 10 percent of the crops produced on that soil) was designated as 1, and frequent flooding (claiming up to 50 percent of the crops produced on the soil) was designated as 2. The soil was not considered suitable for cropland where more than 50 percent of the crops grown on that soil were destroyed by flooding. Crop yields were based on management that included a minimum amount of fertilizer. This allows a more uniform evaluation of the inherent properties of the soils. The yields permit a 20 percent yield variation where yields are based on the average of several years of crop production on the soil (13). Only observed data (laboratory and pedon determinations) were used in the regression analyses to produce an equation for estimating yield indexes on the soils having limited available data. The index percent was based on 15 bushels for wheat; 23 bushels for grain sorghum, and 250 pounds of lint for cotton. The "Soil Properties Model" equations were based on the principle of least squares in a multiple linear regression analysis (31). Analyses were made using the SAS system (6).

The General Linear Model

$Y = B_0 + B_1X_1 + B_2X_2 + \ldots + B_7X_7 + \varepsilon$ Where:

$Beta_0$ = the Y intercept

X_1 = slope

X_2 = percent clay

X_3 = percent sand

X_2^2 = quadratic effect of clay

ε = random error + lack of fit associated with Y

X_3^2 = quadratic effect of sand

X_4 = percent calcium

X_5 = surface soil thickness (A1 Horizon)

X_6 = solum depth

X_7 = pH

If any observation has a missing value for one of the variables, then that observation was not used in estimating the regression coefficient. As the number of independent variables to be considered increased, it was found that the number of complete sets of observations decreased. Due to the incompleteness of several of the observations a subjective decision had to be made in deciding what independent variables were finally used. A preliminary study was made by using a stepwise procedure to select the variables (31).

Estimates were made for necessary soil properties in order to complete the predictions of all the soils occurring in this study area. These estimates are accompanied by an asterisk (Table VI). A "type one" estimate was made by using average data of other samples of the series in the same column. A "type two" estimate was made by referring to a similar soil and transferring the data in the same column.

When the regression coefficients were estimated, it then became possible to estimate the response, (Y), using the given independent variables, (X).

Results and Discussion of the "Soil Properties Model"

Soil interpretations include analyses of selected properties of the soil pedon and the separation of a soil landscape into its component parts. Each soil contains a set of unique properties that separate it from all other soils. The interaction of these properties also determines the response of that soil to a kind of plant. The "Soil Properties Model" used in this study is based on the response of soil properties to production. The basis for this study is that crop yields are directly related to specific soil properties where the influences of climate and cultural practices are considered to be similar over the area. It is also assumed that certain soil properties are more significant in determining crop yields than are others. To provide relatively homogeneous conditions regarding climate, the study was conducted within the Central Rolling Red Plains Resource Area in the southwestern part of Oklahoma for wheat, grain sorghum, and cotton.

Yield observations in the "Soil Properties Model" were the result of several yield observations on each soil (13). The data emphasize the inherent properties of the soil as related to crop yields and were the most consistent data available for the soils studied. Data pertaining to the results of this study are in the Appendix. The analyses were made with calcium included in the prediction model (Tables IX, XIII and XVII) and calcium excluded from the prediction equation (Tables VII, XI, and XV). The prediction model including calcium gave the prediction equation having the best fit with the data.

Evaluations and readjustments of relative values credited to soil properties through multiple linear regression are significant steps in establishing consistencies between soils and yield values. The adjustment can be made only where sufficient observed data are available and these are the only data used in deriving the prediction equation for the parameter. The calculated prediction equations are as follows:

<u>Wheat index prediction formula</u>

Wheat index = $-31.38 - 7.80X_1 + 5.25X_2 - 0.33X_3 - 0.09X_2^2 + 0.01X_3^2 + 0.21X_4 + 1.55X_5 - 0.26X_6 + 7.23X_7$

Mean wheat index = 83.23

<u>Grain sorghum index prediction formula</u>

Grain sorghum index = $113.70 - 7.30X_1 + 4.72X_2 + 0.91X_3 - 0.10X_2^2 - 0.01X_3^2 + 0.56X_4 + 0.81X_5 - 0.001X_6 - 12.99X_7$

Mean grain sorghum index = 84.65

<u>Cotton lint index prediction formula</u>

Index of lint = $-16.01 - 7.65X + 5.13X_2 + 0.72X_3 - 0.08X_2^2 - 0.001X_3^2 + 1.04X_4 + 1.40X_5 - 0.31X_6 - 1.23X_7$

Mean lint index = 72.2

The above symbols are defined as follows:

$Beta_0$ = the Y intercept	X_3^2 = quadratic effect of sand
X_1 = slope	X_4 = percent calcium
X_2 = percent clay	X_5 = surface soil thickness, A1 horizon
X_3 = percent sand	
X_3^2 = quadratic effect of clay	X_6 = solum depth
	X_7 = pH

ε = random error + lack of fit associated with Y

Independent variables (soil properties) were evaluated separately in regard to the dependent variable (crop yields) while all other variables were considered fixed. The procedure was repeated among variables until, according to statistical data, the most suitable prediction formula was determined. In the first analysis, the yield for each crop was predicted on all known observations. Those values were then used to predict yields related to soil properties in those cases where yield observations were missing. Yield indexes for the soils with calcium in the model are in Tables IX, XIII and XVII.

Data for thirty-five soils with yield observations were used to predict the values for wheat. Thirty-four observations for grain sorghum were used, and thirty-two were used for cotton.

Where yield data were missing, there was also limited information regarding soil pedons. Therefore, where yields were predicted for those soils, some of the associated soil properties were also estimated. (Estimates are discussed in Methods and Procedures). Estimated properties are denoted by asterisks (Table VI). Most of the limiting data involving chemical properties as references containing laboratory data were inconsistent in the type of properties analyzed. This presented the major problem in completing the matrix. Most observable data regarding soil properties such as slopes, soil colors, solum, depths, surface soil thickness were available.

According to the statistical analysis (see statistical analysis in Tables X, XIV, and XVIII) the slope of the soil is the most significant factor in predicting yield for the three major crops of the region. Clay was next most influential in determining crop yield (Tables X, XIV and XVIII). In wheat, the slope of the soil was the most highly significant factor in determining yield, followed by clay, surface soil thickness (A1 horizon), solum depth, surface thickness, pH, sand, and calcium. The slope of the soil was the most important factor for determining sorghum yield, followed by clay, pH, sand, surface soil thickness (A1 horizon), calcium, and solum thickness. Cotton exhibited significant differences in response to soil slope followed by clay, solum thickness, surface soil thickness (A1 horizon), calcium, sand, and pH.

Moisture is the major limiting factor for crop production in this particular study area, and it would therefore seem logical that slope and clay would be the most significant soil properties in yield determinations (10,17). Considering all the soil variables, the value of a soil property to crop yield is based on data accumulated from soils most commonly used for that crop and may have limitations in projecting to other soils in the area. For example, there were limitations in observations of yield on the soils containing very high percentages of clay and sand. As a result, values predicted for those soils are extremes beyond the sampling limits and therefore are less reliable. It would seem logical to expect that the parameters used in establishing the prediction equation should contain observations for the extreme limits of the independent variables that occur in the samples to be predicted. Soils having extreme limitations are generally not used extensively for some crops and, as a result, representative observations were limited. Such data were limited for this study and, as a result, predictions of extremes in clays and sands were possibly the most ambiguous. This error was minimized to some degree by the addition of Clay 2 and Sand 2 (quadratic values) in the prediction equation. According to statistical values (see statistical variances in Appendix), the addition was successful and highly significant in the evaluations. However, it was unsuccessful in predicting index values for soils having extremely high percentages of clay. Vernon, (samples 397, 398, 399), Lela (sample 355), and Mangum (sample 155) contained negative values traceable to the lack of yield observations associated with clay ranging between 50 and 68 percent (Tables IX, XIII and XVII).

When all data were present for the independent variable columns, predictions correlated extremely well with the yield expected by comparing them to a similar soil containing a known yield observation. Variations of soil properties within series samples are well exhibited in the program. A Vernon soil (Table IX) in sample 352 for wheat values had a predicted index of 107. This prediction is considerably higher than the associated Vernon soil yield observation in sample 74 (Table IX). The Vernon soil in sample 74 has a predicted value of 55. The difference is traceable to a lower clay content of 25.0 percent associated with high index 107. The high clay content (48.8 percent) is in sample 74 which contains the lower index of 55. This apparent difference in the Vernon series is traceable to an erroneous classification of observation 352, where the percent clay is too low to be classified as a Vernon soil under the National Classification System (37). Vernon, observation 352, is eliminated from the Vernon series because of limited clay in the control section (37). Weymouth, sample 303, contains a surface horizon eleven inches thick with colors that qualify it for a Mollisol and, therefore, is removed from the Weymouth series. Woodward and Springer soils have high yields because of thick surface horizons. However, these surface horizons exaggerate the fertility of these soils as they are low in organic matter. Springer soils have loamy fine sand surface horizons. Predictions for the Roscoe profile may be higher than normal for the series as related to other soils in the set. The Miller soil contains 37 percent clay in the subsoil and is, therefore, on the lower end of the scale for the normal clay content of the Miller series. Insufficient data were available to properly evaluate shallow soils for wheat.

The Acme 403, 404, and 405 have an extremely high yield for a typical Acme soil which can be traced to an extreme solum depth (34). Acme soil is classified at the family level as loamy, mixed, thermic, shallow which has a depth of no more than 19 inches, i.e., 50 cm (37). This would indicate the soil sample referred to as Acme does not belong in the Acme series. It must be remembered that soil science is dynamic, and there will always be minor classification changes. Those soils mapped under certain criteria must continue to be treated according to their potential. Where the Acme soil is less than 19 inches in depth, it is considered unsuited to cultivation. With a solum depth of 24 inches, Acme can be suited to crop production (34). Observed data related to shallow soils were not sufficient to correlate its effect on crop yields. This type of program could have merit in presenting such correlations within an area where sufficient data is available.

Lela, in observation row 355, contains 68 percent clay. The high percentage of clay removes the sample from the Lela series according to the National Classification System (37). The low yield calculated for this soil indicates the need for additional yield observations on soils having high percentages of clay. The data containing asterisks have been estimated; field samples would change those values at least to some extent. Predicted yields are most reliable when total data are present.

Where surface soil textures are extremely sandy or clayey, these properties may be highly significant if the proper data are available for testing. The yields for particular soils were taken from mapping units where other inclusions of soils were present. In contrast, the prediction equation is using these values to evaluate the specific properties of a soil profile or pedon as related to yield. Ideally, yield would be collected for a number of years on each kind of soil pedon.

Grain sorghum accountable data in making yield evaluations was .91 while wheat and cotton had .83 and .76 R square values respectively. The better fit of data was with grain sorghum and, as a result, predictions are more dependable (Table XIII).

Predictions for grain sorghum and cotton contain discrepancies similar to those for wheat. The problem is mainly traceable to limited data, especially for the extremes of clay, sand, and shallow depths of soil. Lucien, a shallow soil, was assigned a high index rating similar to that of wheat. Lela clay and Hollister present a problem in analysis because of clay percentages. Cotton predictions were less reliable because of a lack of data in the soil property extremes (Tables XV and XVII).

The lack of variation for some soil properties apparently accounted for their insignificance in the prediction equation. Organic matter, nitrogen, and potassium were similar in most available samples. Contributions of those three characters are highly important to crop production, but because values were similar in all soils within the study area, they do not make significant contributions to the equation. Data were insufficient for a complete testing of phosphorus and iron.

Also, colors of the epipedon were not tested sufficiently to fully determine their value in the study. Calcium was slightly more important than magnesium. The removal of calcium for the set of independent variables increased the number of observations that could be used in deriving the prediction equation but resulted in producing a lower R square value (Tables VII, XI and XV). This indicates the significance of complete data to derive the most efficient prediction equation.

Insufficient laboratory data was the major limiting factor in the success of the "Soil Properties Model". It is apparent that the program would be a reliable method of making predictions for yield where data for soil properties are available to include all variables of the parameter. Dependable yield data for soils are vital to the completion of the parameter. Uniformity of observed yield data may be more difficult to secure in the future because of wide variations in use of soil amendments. Laboratory analyses and slopes of soils in Southwestern Oklahoma provide a dependable, objective method for comparing soils to establish productivity indexes. The formulation of reliable predictions will require representative data of the soils and crop yields in the study area.

With limited data, only interval ratings of soils are reliable (Tables XXII-XXIV). Soils that were expected to occur in the intervals for wheat, grain sorghums, and cotton were as anticipated with few exceptions. Suggested use and value of this data in spatial planning and appraisal are discussed in Chapter VI. Representative index values for each soil series are listed alphabetically according to slope in Table I.

TABLE I

INDEX VALUES ACCORDING TO SLOPE
"SOIL PROPERTIES MODEL"*

	Grouping of 0 to 1 percent slopes		
Soil Series	Wheat Index %	Grain sorghum Index %	Cotton Index %
Abilene	84	63	60
Altus	101	97	88
Brazos	99	72	85
Canadian	62	85	51
Carey	99	95	82
Carwile	98	99	94
Chickasha	102	126	108
Dalhart	101	93	88
Devol	81	91	74
Elsmere	98	62	76
Enterprise	103	114	107
Farnum	99	132	95
Foard	77	70	68
Grandfield	108	97	93
Hardeman	81	82	71
Hinkle	85	72	72
Holdredge	102	122	93
Hollister	67	28	46
Lawton	84	90	76
Lincoln	59	50	31
Mansic	99	89	78
Miles	94	93	78
Miller	126	88	109
Port	105	91	70
Pratt	96	80	81
Reinach	94	106	80
Roscoe	108	60	96
Springer	126	91	105
Spur	97	91	69
Stamford	90	39	73
St. Paul	101	122	88
Tillman	96	76	76
Tipton	104	108	87
Waurika	91	65	75
Wann	117	106	99
Yahola	86	85	55
Zavala	102	71	87

TABLE I "CONTINUED"

Soil Series	Wheat Index %	Grouping of 1 to 3 percent slope Grain sorghum Index %	Cotton Index %
Abilene	72	52	49
Altus	89	86	76
Berthoud	80	72	69
Brownfield	72	102	69
Carey	88	84	70
Cobb	91	91	81
Dalhart	89	82	88
Devol	69	80	62
Dill	79	69	64
Enterprise	89	108	101
Eufaula	62	52	46
Foard	64	58	55
Hardeman	69	71	60
Hollister	55	17	35
Konawa	84	101	81
La Casa	91	43	61
Lawton	72	79	64
Lucien	99	99	94
Mansic	87	78	67
Miles	88	81	75
Otero	81	44	67
Pratt	83	68	68
Quinlan	76	66	46
Springer	114	80	93
St. Paul	94	108	84
Tillman	74	55	53
Tipton	92	97	75
Vernon	55	37	53
Weymouth	103	73	76
Windthorst	80	92	86
Woodward	103	67	63
Zaneis	83	81	79

TABLE I "CONTINUED"

Soil Series	Wheat Index %	Grain sorghum Index %	Cotton Index %
		Grouping of 3 to 5 percent slope	
Brownfield	56	87	53
Carey	77	72	59
Cobb	75	75	65
Dalhart	71	66	59
Dill	62	53	47
Enterprise	73	93	86
Hardeman	46	56	36
La Casa	76	106	46
Lawton	57	65	59
Mansic	72	63	52
Miles	80	78	74
Nobscot	58	48	43
Otero	66	29	52
Pratt	74	48	43
Quinlan	62	53	55
Springer	99	65	78
St. Paul	71	95	59
Weymouth	87	58	61
Woodward	68	35	29
Zaneis	67	66	64
		Grouping of 5 to 8 percent slope	
Carey	57	54	40
Enterprise	54	75	67
Miles	65	68	52
Pratt	49	37	36
Windthorst	60	73	67

*Representative data for each slope range was taken from Tables IX, XIII and XVII appendix. Soils having simple characteristics outside the range of the series were omitted. These soils are discussed in the text.

CHAPTER IV

"SOIL CLASSIFICATION MODEL"

The "Soil Classification Model" is based on the crop yield evaluation of major soil properties above and below yields of a "normal soil" in the area (Figure 1). A "normal soil" is defined as one that has no major sufficiencies or deficiencies. The soil properties are diagnostic in categories of the National Classification System (Tables III and VI). Limits established for soil characteristics in the various categories are broad, as described in the National Soil Classification System (37). Soil forming processes are relatively homogeneous in the study area which accounts for similarities of properties as described in the orders of the National Classification System. Since the variations are not excessive, each category that designates major qualities of the soils may be evaluated as related to yields. Values resulting from observed data may then be used to predict crop yields and index values on soils where yield information is not available. Limits of the various categories of the classification system were established by evaluating research data (37).

The objective of analyses using the "Soil Classification Model" is to establish index values for all the soils in the study area and compare the Model to the "Soil Properties Model". Using the same observations the two models were compared. The results of this evaluation are discussed in Chapter V.

Methods and Procedures in the "Soil Classification Model"

The National Soil Classification System provides an organized system to evaluate the major characteristics of a soil pedon. These characteristics are described at the various levels of classification (37). The categories include order, suborder, great soil group, subgroup, series, and family. Inherent characteristics of a soil determine the response of that soil to the needs of crops. These differentiating characteristics are isolated in the various levels of the classification system. At the series level the series, texture, and phases are evaluated. By systematically establishing a corresponding value for the characteristics, it is possible to produce an index rating for all soils having like characteristics. Deficiency values are determined by comparing soil characteristics to the crop yield values produced on bench mark soils in Oklahoma (13). These yields include wheat, grain sorghum, and cotton. The yields of soil taxonomic units containing a wide range of soil characteristics were compared and tested to isolate values for differentiating criterion in the various categories of the classification system.

In the index program, the first step in its development is to determine a production area where environmental conditions are homogeneous. This includes climate, soils, crops, vegetation, relief, and types of farming. With some modifications the resource areas outlined in Oklahoma are acceptable areas (4). One necessary modification is that the boundaries must agree with known locations such as counties, rivers, or mountains. The northern part of the Central Rolling Red Plains Resource Area in Oklahoma does not contain some of the crops grown in the southern part of the state. For example, cotton is not normally grown in the northern part of Oklahoma. The modifications in the case of the Central Rolling Red Plains as used herein was a separation at the South Canadian River and the agreement of other boundary lines with county boundaries (Figure 1). Each resource area contains fundamental environmental characteristics that separate it from neighboring areas (36). These are considered maximum geographic areas where climate, vegetation, and soil patterns are relatively homogeneous. The similarity of the environmental characteristics that exist in the area largely removes the problem of evaluating yields according to climate or precipitation. A soil rated as 100 percent is 100 percent only for that resource area. The comparison of the productivity of soils between any two resource areas is not possible in this model.

The program will have minimum error where yield data are available to allow analyses of all the various soil characteristics. The bulletin, "Productivity of Key Soils in Oklahoma" (13) provides sufficient data to complete the model in the study area. In this study only the maximum number of observations used in testing the "Soil Properties Model" were used in computing the prediction equation for this model. This included 61 observations for wheat, 60 for grain sorghum, and 55 for cotton (Tables VII, XI and XV).

To establish the index model, it is necessary to have sufficient knowledge of the soil series occurring in the homogeneous productivity area, the various phases, and the classification of the soils according to the National Classification System of the United States Department of Agriculture (37,47). There is sufficient soil survey information to characterize all the land area that occurs within the study area. In particular, Gray and Galloway (14) have described the soils in general in the various parts of Oklahoma.

Classification of the soil within the National Classification System is a major component of the program (Table II). The Taxonomic Classification has been made for all parts of the United States, Puerto Rico, and the Virgin Islands (32,37).

Nomenclature of Soil Taxonomy

Soils of Southwestern Oklahoma are classified according to the current classification of the Soil Survey Staff, USDA (37). Soil classification in this system emphasizes diagnostic horizons of the soil pedon. The soil pedons are classified by placing them in six categories as follows: order, suborder, great group, subgroup, family, and series (Soil Survey Staff, USDA, 1960, 1967, 1970, and others). Orders are the highest category in the system (44). In 1970, there were 10 orders recognized in classifying soils of the world. The differentials used among orders were developed with emphasis on characteristics that indicated the intensity of processes which develop soil horizons. Soils within a particular order contain similar characteristics indicating similar influences of soil-forming processes. Suborders are subdivisions of orders based on characteristics that emphasize similarity of origin. The suborder name contains two syllables. The color associated with wetness is used to define suborders in each order in which it is found. Soil variations caused by different types of climate, vegetation, and chemical or mineralogical processes are also used in determining the suborder divisions.

TABLE II

SOIL SERIES OCCURRING IN THE CENTRAL ROLLING RED PLAINS RESOURCE AREA

Series	Subgroup	Family
Abilene	Pachic Argiustolls	Fine, mixed, thermic
Acme	Torriorthentic Haplustolls	Loamy, mixed, thermic, shallow
Altus	Pachic Argiustolls	Fine-loamy, mixed, thermic
Berthoud	Aridic Ustochrepts	Fine-loamy, mixed, thermic
Brazos	Typic Udifluvents	Sandy, mixed, thermic
Brownfield	Arenic Aridic Paleustalfs	Loamy, mixed, thermic
Canadian	Udic Haplustolls	Coarse-loamy, mixed, thermic
Carey	Typic Argiustolls	Fine-loamy, mixed, thermic
Carwile	Typic Argiustolls	Fine, mixed, thermic
Chickasha	Udic Argiustolls	Fine-loamy, mixed, thermic
Cobb	Udic Haplustalfs	Fine-loamy, mixed, thermic
Dalhart	Aridic Haplustalfs	Fine-loamy, mixed, mesic
Devol	Udic Haplustalfs	Coarse-loamy, mixed, thermic
Dill	Udic Ustochrepts	Coarse-loamy, mixed, thermic
Elsmere	Aquic Haplustolls	Sandy, mixed, thermic
Enterprise	Typic Ustochrepts	Coarse-silty, mixed, thermic
Eufaula	Psammentic Paleustalfs	Sandy, sileous, thermic
Farnum	Pachic Argiustolls	Fine-loamy, mixed mesic
Foard	Typic Natrustolls	Fine, mont., thermic
Grandfield	Udic Haplustalfs	Fine-loamy, mixed, thermic
Hardeman	Typic Ustochrepts	Coarse-loamy, mixed, thermic
Hinkle	Mollic Natrustalfs	Fine, mont., thermic

TABLE II "CONTINUED"

Series	Subgroup	Family
Holdredge	Typic Argiustolls	Fine-silty, mixed, thermic
Hollister	Pachic Paleustolls	Fine, mixed, thermic
Indiahoma	Paleustollic Chromusterts	Fine, mont., thermic
Kenesaw	Typic Haplustolls	Coarse-silty, mixed, mesic
Konawa	Udic Haplustalfs	Fine-loamy, mixed, thermic
La Casa	Typic Argiustolls	Fine, mixed, thermic
Lawton	Udic Argiustolls	Fine, mixed, thermic
Lela	Typic Chromusterts	Fine, mixed, thermic
Lincoln	Typic Ustifluvents	Sandy, mixed, thermic
Lucien	Udic Haplustolls	Loamy, mixed, thermic, shallow
Mangum	Vertic Ustifluvents	Fine, mixed (calc) thermic
Mansic	Aridic Calciustolls	Fine-loamy, mixed, thermic
Manter	Aridic Argiustolls	Coarse-loamy, mixed thermic
Meno	Aquic Arenic Haplustalfs	Loamy, mixed, thermic
Miles	Udic Paleustalfs	Fine-loamy, mixed, thermic
Miller	Vertic Haplustalfs	Fine, mixed, thermic
Nobscot	Arenic Haplustalfs	Loamy, mixed, thermic
Norwood	Typic Udifluvents	Fine-silty, mixed (calc), thermic
Otero	Ustic Torriorthents	Coarse-loamy, mixed (calc), mesic
Port	Cumulic Halustolls	Fine-silty, mixed, thermic
Pratt	Psammentic Haplustalfs	Sandy, mixed, thermic
Quanah	Typic Calciustolls	Fine, silty, mixed, thermic

TABLE II "CONTINUED"

Series	Subgroup	Family
Quinlan	Typic Ustochrepts	Loamy, mixed, thermic, shallow
Reinach	Pachic Haplustolls	Coarse-silty, mixed, thermic
Roscoe	Typic Pellusterts	Fine, mont., thermic
Ruella	Typic Ustochrepts	Fine-loamy, mixed, thermic
Springer	Udic Paleustalfs	Fine-loamy, mixed, thermic
Spur	Fluventic Haplustolls	Fine-loamy, mixed, thermic
Stanford	Typic Chromusterts	Fine, mont., thermic
St. Paul	Pachic Argiustolls	Fine, silty, mixed, thermic
Tillman	Typic Paleustolls	Fine, mixed, thermic
Tipton	Pachic Argiustolls	Fine-loamy, mixed, thermic
Vanoss	Udic Argiustolls	Fine-silty, mixed, thermic
Vernon	Typic Ustochrepts	Fine, mixed, thermic
Wann	Fluvaquentic Haplustolls	Coarse-loamy, mixed, thermic
Waurika	Typic Argialbolls	Fine, mont., thermic
Weymouth	Typic Ustochrepts	Fine-loamy, mixed, thermic
Windthorst	Typic Paleustalfs	Fine, mixed, thermic
Woodward	Typic Ustochrepts	Coarse-silty, mixed, thermic
Yahola	Typic Ustifluvents	Coarse-loamy, mixed (calc), thermic
Zaneis	Udic Argiustolls	Fine-loamy, mixed, thermic
Zavala	Typic Ustifluvents	Coarse-loamy, mixed, non-acid, hyperthermic

Great groups are subdivisions of suborders. Each great group is defined within its suborder, primarily on the presence or absence of diagnostic horizons and the arrangement of the horizons present. Where horizon arrangements do not vary within a suborder, other diagnostic properties are used such as base saturation, irreversible soil hardening, properties of clays, tonguing of eluvial horizons into illuvial horizons, or soil temperature.

Subgroups are subdivisions of great groups. Subgroups indicate the variation of particular soils from the central concept of that great group. Varying properties are usually intergraded to other great groups, suborders, or orders. Descriptive adjectives are used to specify particular situations exemplified, i.e., truncated by rocks or extra thick surface layers of soils.

Families are subdivisions of subgroups. Soil textures, mineralogy reaction, and temperature are the main properties used in this part of the classification with permeability, soil depth, slope, coatings, and soil consistency used in some special divisions. Each family name requires one or more names. One family name consists of adjectives modifying the subgroup name. Particle size modifiers used in the family classes are taken from depth limits within the pedon and are referred to as the control section. Where there are no contrasting textures between the top of the argillic horizon and a depth of 1 m, the particle size modifiers are determined from the whole argillic horizon if it is less than 50 cm thick or from the upper 50 cm if the argillic horizon is more than 50 cm thick. In soils without argillic horizons, particle size modifiers or substitutes are applied from a depth of 25 cm to 1 m or to rock, if present, at a shallow depth. In soils having a depth to rock less than 36 cm, particle size modifiers or substitutes are applied from the surface to the rock strata. The classification of each soil is made by constructing a complete family name. The soil is classified within each category. The characteristics that categorize the soil in the classification system are described in the table representing the level of classification (Table III). In this production index system, the soil series are evaluated by determining values for the series phases.

Where a deficiency or sufficiency of a soil exists, it will be isolated within one of the six levels of classification. At that level the deficiency is described. The table categories (A through G) and row code (A1, A7, ..., G14) designations listed by the series in the index table serve as references for locating the soil characteristic described in Table III. The inherent characteristics of the soils recognized in this study were used to maintain a uniform system of soil comparison.

Data in the "Soil Classification Model"

Crop yields on representative soils of a resource area are necessary to establish the "Soil Classification Model". Yield data for several kinds of crop representing different soil characteristics at the various levels of classification which occur in the resource area are in the bulletin, "Productivity of Key Soils in Oklahoma" (13). After values of soil characteristics are evaluated and deficiency penalties established, other soils with similar characteristics may be evaluated. Where insufficient data are available to determine a value for a characteristic, an estimate may be made from a soil with a similar characteristic.

The purpose of a table showing deficiencies and sufficiency points is to establish values for evaluating all soils in the study area (Table III). The values estimated were derived by using values computed for similar characteristics from observed data. The Y or source intercept is the value for the normal soil (Table III). All quality points are added or subtracted from this value.

Tables of Deficiencies, Sufficiencies, and Penalty Points

It is convenient to establish tables to record percentage points for each category of classification. The following categories are included: A. Order, B. Suborder, C. Great soil group, D. Subgroup, E. Family modifiers, F. Series texture phases, and G. Series slope and flooding phases.

Each of the soil characteristics in a category of the index table is described in the designated table along with its resulting value (Table III).

Preparing the Data for Analysis

Soil textures, slopes and associated crop yield for each soil are entered in the left margins of the matrix. Columns are designated for each of the classification soil characteristics affecting crop yields above or below a "normal soil" of the area. Number one is entered in the cell in the column where the characteristic is present in the soil. A zero is entered in the column where characteristics do not apply. Soil slope is entered in one column with the mid-range value representing the particular slope phase (Table VI). The value of the applicable properties are then isolated and evaluated as yield above or below the yields of the "normal soil". The observed values in each row and column are evaluated in a procedure that applies the principle of transformation of the matrices. The slope of the soil is calculated in a procedure that applies the principle of least squares. The calculated values therefrom are then used to establish the predictions. Predictions are made on classified soils with values computed from similar observed data.

Computations for the "Soil Classification Model"

$$Y = B_0 + AZ + \sum_{i=1}^{19} X_i C_i + \varepsilon$$

C_i = the effect attributed to the presence of Alfisol or the other characteristics (A1, B5, ... F12)

The following are C_i variables:

Effect due to soil characteristics as follows:

A1 = Alfisols

B5 = ochr

C5 = calc

C13 = natr

D2 = arenic

D9 = pachic

D11 = aridic

D13 = vertic

D17 = psamment

E8 = Fine, mixed, thermic

E12 = Fine, montmorillonitic, thermic

E16 = Loamy, mixed, thermic shallow

E17 = Sandy, mixed, thermic

F5 = Fine sand surface texture

F6 = Loamy fine sand surface texture

F8 = Fine sandy loam surface texture

F8.5 = Very fine sandy loam surface texture

F11 = Clay loam surface texture

F12 = Silty clay loam surface texture

*For definitions of soil characteristic variables see Table III, "Soil Characteristics in Classification Categories".

X_i = 1 if the characteristic is present.

X_i = 0 if the characteristic is not present in the particular soil etc.

B_0 = the predicted value of the "Normal soil".

ε = random error + lack of fit associated with Y

The coefficients of A and C_i effects are obtained by applying the principle of least squares (31) in a multiple regression equation by using an SAS system (6).

The General Linear Model

$$Y = B_0 + B_1X_1 + \varepsilon$$

X_1 = soil slope

A (0 to 1 percent slope), if percent slope is 0 to 1 percent, Z = 0.5

B (1 to 3 percent slope), if percent slope is 1 to 3 percent, Z = 2.0

C (3 to 5 percent slope), if percent slope is 3 to 5 percent,

$Z = 4.0$

D (5 to 8 percent slope), if percent slope is 5 to 8 percent,

$Z = 6.5$

Slopes are given for each soil in the tables, "Data Compilation for Soil Series" (Table VI).

ε = random error + lack of fit associated with Y.

Only observed data is used in the prediction equation (13). Where predictions of an estimated yield are requested, the yield column is left blank with all other information listed in the appropriate cell of the matrix.

For preparation of the "Soil Classification Model" consult the Appendix of this thesis (Table VI).

Results and Discussion of the "Soil Classification Model"

The taxonomy of soil considers properties of soil in separate categories (Tables III, VI). Each of the modifiers which makes up the family name represents the properties of the soil at that level of classification. The objective is to evaluate these properties of the soil to establish its index value. If the soil property is negative, it is designated as a "deficient" quality; if the value is positive, it is a "sufficient" quality. Index values for the soils containing data in the study area are in Tables VII, XI, and XV of the Appendix. These soils plus other soils with estimates from Table III are in Table IV.

TABLE III

SOIL PROPERTIES IN CLASSIFICATION CATEGORIES - DESCRIPTIONS OF PROPERTIES AND VALUES OF DEFICIENCIES AND SUFFICIENCIES IN EACH CATEGORY

Classification Category		Formative element	Simplified definitions of soil characteristics	Positive or Negative points[1] Wheat	Grain Sorghum	Cotton
A Values - Order						
A1	Alfisols	alf	Mineral soils; relatively low in organic matter; relatively high base saturation; an illuvial horizon of silicate clays; moisture available to mature a crop.	-24.0	-23.0	-49.0
A7	Vertisols	ert	Clayey soils; deep wide cracks at some time during most years.	-3.5*	-9.2*	-7.0*
B Values - Suborder						
B5		ochr	A surface horizon that is light in color, low in organic matter (less than .5 percent)	-21.4	-25.0	-33.0
C Values - Great Groups						
C5		calc	A soil that is calcareous throughout and that has a horizon with an appreciable accumulation of lime.	-12.2*	-18.0*	-27.6*
C13		natr	Presence of significant amounts of exchangeable sodium or of magnesium and sodium.		-26.0	

TABLE III "CONTINUED"

Classification Category	Formative element	Simplified definitions of soil characteristics	Positive or Negative points Wheat	Grain Sorghum	Cotton
C20	torr	Inadequate moisture to mature a crop without irrigation	45.92*	-55.0	-48.1*
D Values - Subgroups					
D2	arenic	Sandy eluvial horizons (sand or loamy sand), mostly between 50 cm and 1 m thick.	-13.4	-22.0	+8.3
D8	cumulic	Accumulated-usually on bottom land,	+2.0*	+11.0*	+8.2*
D9	pachic	A thick dark surface horizon	+2.0	+11.0	+8.2
D11	aridic	Relatively low in organic matter; inadequate moisture to mature a crop without irrigation in most years;	____	____	____
D12	torrior-thentic	Droughty, limited in available moisture without irrigation.	12.2*	55.0*	-29.0*
D13	vertic	Clayey soils; some deep wide cracks at some time in most years	-2.9	-9.2	-9.0 (upland soil)
D17	psamment	Sandy texture, sand, or loamy sand to a depth of 1 m or more or to rock or with fine sandy loam in some stratas or lamellae in the subsoil.	+12.1	+24.0	+15.0

TABLE III "CONTINUED"

Classification Category	Formative element	Simplified Definitions of soil characteristics	Positive or Negative points Wheat	Grain Sorghum	Cotton
D18	arenic aridic	Sandy soils in a semi-arid climate	—	—	—
D19	aquic	A soil that is very wet or that has been artificially drained.	-18.0*	+18.0*	+8.2*
D20	aquic arenic	Thick sandy surface soil that is wet periodically.	+12.1*	+18.0*	49.0*
E Values - Family Modifiers					
E8	Fine, mixed, thermic	Clayey 35-59% fine fractions; mixed mineralogy, warm climate;	-12.2	-18.0	-27.4
E9	Fine, mixed, calcareous, thermic	Clay, mixed mineralogy, warm climate;	-12.2*	-18.0*	-27.4*
E12	Fine, montmorillonitic, thermic	Fine clays, more than half montmorillonite, warm climate.	-12.2	-18.0*	-27.4*
E16	Loamy, mixed, thermic,	Loamy shallow soil, warm climate	-12.2*	-18.0*	-27.4*
E17	Sandy, mixed, thermic	Sandy texture, mixed mineralogy, warm climate	-14.0	-2.0	-15.4
F Values - Series texture phase					
F1		Clay	-0.0* (upland soil)	-18.0*	—

TABLE III "CONTINUED"

Classification Category	Formative element	Simplified definitions of soil characteristics	Positive or Negative points		
			Wheat	Grain Sorghum	Cotton
F5		Fine sand	-18.0*	-18.0*	-15.0*
F6		Loamy fine sand	-12.1*	-8.0*	-8.2*
F8		Fine sandy loam	+17.0	+2.1	+41.0
F9		Very fine sandy loam	+27.4	+23.3	+68.4
F11		Clay loam	+2.2	-18.0	______
F12		Silty clay loam	+2.2	-18.0 (upland soils)	______
G Values - Series Slope Phase					
		0 to 1 percent slope	-3.5	-4.2	-3.7
G2		1 to 3 percent slopes	-14.13	-16.9	-14.8
G3		3 to 5 percent slopes	-28.26	-33.8	-29.6
G4		5 to 8 percent slopes	-45.92	-55.0	-48.1
		Flooding Phase			
G14		Occasional flooding	10%	10%	10%

*Estimates made subjectively by comparison with similar variables determined in the model.

[1]Point values assigned to deficiencies and sufficiencies were added to or subtracted from the calculated intercept to determine the yield for the crop of interest as follows: Crop and Y or source intercept, Wheat 105.3, Grain sorghum 118.0, Cotton 92.5, respectively.

TABLE IV

INDEX RATING OF SOIL TAXONOMIC UNITS FOR WHEAT, GRAIN SORGHUM, AND COTTON IN THE CENTRAL ROLLING RED PLAINS RESOURCE AREA OF OKLAHOMA

Series	Texture	Slope	A	B	C	D	E	F	G	Wheat Pred. Index*	Grain Sorghum Pred. Index*	Cotton Pred. Index*
			Soil Characteristics reference codes									
Abilene	cl	A				D9	E8	F11		94	89	70*
	cl	B				D9	E8	F11	G2	83	76	58*
Acme	sil	B				D12	E16		G2	67*	28*	21*
	sil	C				D12	E16		G2	53*		
	sil	D				D12	E16		G4	38*		
Altus	fsl	A				D9		F8		120	127	138
	fsl	B				D9		F8	G2	110	114	127
Berthoud	l	B		B5		D11*			G2	70*	76*	44
	l	C		B5		D11*			G3	56*	56*	30*
Brazos		A	A1				E17	F8		81*	90*	65*
Brownfield	s	B	A1			D18		F5	G2	49*	55*	14*
	s	C	A1			D18		F5	G3	35*	29*	
Canadian	fsl	A						F8		118	115*	97
Carey	sil	A								102	114	89
	sil	B							G2	91	101	78
	sil	C							G3	77	84	63
	sil	D							G4	59	63	44

TABLE IV "CONTINUED"

Series	Texture	Slope	Soil Characteristics reference codes							Wheat Pred. Index*	Grain Sorghum Pred. Index*	Cotton Pred. Index*
			A	B	C	D	E	F	G			
Carwile	1	A					E8			92	79	89
Occasionally Flooded	1	A					E8		G14	83	71	80
Chickasha	1	A								102	114	89
Cobb	fsl	B	A1					F8	G2	84	80	70
	fsl	C	A1					F8	G3	70	63	55
	fsl	D	A1					F8	G4	52	42	
Dalhart	fsl	A	A1			D11		F8		100	96	80
	fsl	B	A1			D11		F8	G2	84	80	70
	fsl	C	A1			D11			G3	70	63	55
Devol	lfs	A	A1					F6		66	83	40
	lfs	B	A1					F6	G2	55	70	30
Dill	fsl	B		B5				F8	G2	86	78	85
	fsl	C		B5				F8	G3	72	62	71
	fsl	D		B5				F8	G4	54*	40	
Elsmere	lfs	A				D19		F6		102*	114	89
Enterprise	vfsl	A		B5				F9		108	112	124
	vfsl	B		B5				F9	G2	97	100	113
	vfsl	C		B5				F9	G3	83	83	98
	vfsl	D		B5				F9	G4	65	62	79

TABLE IV "CONTINUED"

Series	Texture	Slope	Soil characteristics reference codes A	B	C	D	E	F	G	Wheat Pred. Index*	Grain Sorghum Pred. Index*	Cotton Pred. Index*
Farnum	1	A				D9				104	124	97
	1	B				D9			G2	79*	111*	86
Foard	sil	A			C13		E12			90*	70	62*
	sil	B			C13		E12		G2	79*	57	51*
Grandfield	fsl	A	A1					F8		92	93	81
	fsl	B	A1					F8	G2	81	80*	70
Hardeman	fsl	A		B5				F8		97	91	96
	fsl	B		B5				F8	G2	86	78	85
	fsl	C		B5				F8	G3	72	62	70
Hinkle	sil	A			C13		E12			90	70	62*
	sil	B	A1		C13		E12		G2	79*	57	51*
Holdredge	sil	A								102	114	89
	sil	B							G2	91	111	78
Hollister	sil	A				D9	E8			91	107	70
	sil	B					E8		G2	81	94	58
Indiahoma	sicl	A	A7				E12	F12		88*	73*	55*
	sicl	B	A7				E12	F12	G2	77*	57*	44*
	sicl	C	A7				E12	F12	G3	63*	49*	
Kenesaw	sil	A								102	114	88

TABLE IV "CONTINUED"

Series	Texture	Slope	Soil characteristics reference codes A	B	C	D	E	F	G	Wheat Pred. Index*	Grain Sorghum Pred. Index*	Cotton, Pred. Index*
Konawa	fsl	B	A1					F8	G2	84	80	70
	lfs	B	A1					F6	G2	55*	70	21
	lfs	C	A1					F6	G3	41*	53	06
La Casa	cl	B					E8	F11	G2	81	66	50*
	cl	C					E8	F11	G3	67	49	45*
Lawton	fsl	A					E8	F8		106	98	102
	fsl	B					E8	F8	G2	96	86	91
	fsl	C					E8	F8	G3	81	69	77
Lela	c	A	A7				E8	F1		87*	87*	62*
Lincoln	lfs	A		B5			E17	F6		55*	78*	33*
Mangum	c	A				D13	E8	F1		87	87*	62*
Mansic	cl	A			C5			F11		92*	96	61*
	cl	B			C5			F11	G2	81*	83*	50*
	cl	C			C5			F11	G3	67*	54*	35*
Manter	fsl	B				D11		F8	G2	108	104	120
	fsl	C				D11		F8	G3	96	87	104
Meno	lfs	A	A1			D20		F6		78*	100	81*

TABLE IV "CONTINUED"

Series	Texture	Slope	Soil characteristics reference codes A	B	C	D	E	F	G	Wheat Pred. Index*	Grain Sorghum Pred. Index*	Cotton Pred. Index*
Miles	fsl	A	A1					F8		94	93	81
	fsl	B	A1					F8	G2	84	80	70
	fsl	C	A1					F8	G3	70	63	55
	fsl	D	A1					F8	G4	52	42	37
	lfs	B	A1					F6	G2	55	70	28
Miller	c	A				D13	E8	F1		87*	87*	62*
Minco	l	C							G3	77	84*	63
Nobscot	fs	B	A1			D2		F5	G2	49	55*	14
	fs	C	A1			D2		F5	G3	35*	29*	
Norwood	sil	A								102	114	89
Otero	fsl	B			C20			F8	G2	61*	48*	56*
	fsl	C			C20			F8	G3	48*	31*	32*
	fsl	D			C20			F8	G4	30*	10*	
Port	l	A				D8				104*	124	97
	cl	A				D8		F11		106*	106*	97
Pratt	fsl	A	A1			D17	E17	F8		93	115	81
	fsl	B	A1			D17	E17	F8	G2	82	102	69
	fsl	C	A1			D17	E17	F8	G3	68	85	55
	fsl	D	A1			D17	E17	F8	G4	34	62	
	lfs	B	A1			D17	E17	F6	G2	53*	82*	21*
	lfs	C	A1			D17	E17	F6	G3	39*	65*	

TABLE IV "CONTINUED"

Series	Texture	Slope	Soil characteristics reference codes A	B	C	D	E	F	G	Wheat Pred. Index*	Grain Sorghum Pred. Index*	Cotton Pred. Index*
Pratt	lfs	D	A1			D17	E17	F6	G4	21*	44*	
Quanah	sicl	A			C5			F12		92*	6*	62*
	sicl	B			C5			F12	G2	81*	4*	50*
Quinlan	l	A		B5			E16			68*	89	55
	l	B		B5			E16		G2	57*	76	44
	l	C		B5			E16		G3	43*	59	30
	l	D		B5			E16		G4	25*	38	
Reinach	vfsl	A				D9		F9		131	148	165
Roscoe	sil	A	A7				E12			87*	87*	52*
Ruella	l	A		B5						81*	89	60*
	l	B		B5					G2	70*	76	46*
	l	C		B5					G3	56*	56	30*
	l	D		B5					G4	41*		
Springer	lfs	A	A1					F6		66*	91	40
	lfs	B	A1					F6	G2	55*	70	21
	lfs	C	A1					F6	G3	41*	61	14
Spur	sil	A								102	114	89
Occasionally flooded	sil	A							G14	92	96*	80
	cl	A						F11		102*	114	89
	l	A								102*	114	89

TABLE IV "CONTINUED"

Series	Texture	Slope	Soil characters reference codes A	B	C	D	E	F	G	Wheat Pred. Index*	Grain Sorghum Pred. Index*	Cotton Pred. Index*
Stamford	c	A	A7				E12	F1		87*	86	62
St Paul	sil	A				D9				104	124	97
	sil	B				D9			G2	93	112	86
	sil	C				D9			G3	79	95	71
Tillman	cl	A					E8	F11		92	79	62*
	cl	B					E8	F11	G2	81	66	50*
	cl	C					E8	F11	G3	67*	28	45*
Tipton	sil	A				D9				104	124	97
	sil	B				D9			G2	93	112	86
	fsl	A				D9		F8		121	127*	138
Vanoss	l	A								102	114*	89
	l	B							G2	91	101*	78
	l	C							G3	77	84*	63
Vernon	cl	A		B5			E8	F11		70	54	52
	cl	B		B5			E8	F11	G2	59	41	41
	cl	C		B5			E8	F11	G3	45*	24	26
	cl	D		B5			E8	F11	G4	27*	17	
Wann	l	A								102	114	89
Waurika	sil	A					E12			90	96	61

TABLE IV "CONTINUED"

Series	Texture	Slope	Soil characteristics reference codes A	B	C	D	E	F	G	Wheat Pred. Index*	Grain Sorghum Pred. Index*	Cotton Pred. Index*
Weymouth	cl	B		B5				F11	G2	72	59	44*
	cl	C		B5				F11	G3	58	42	29*
	cl	D		B5				F11	G4	40	21	08*
Windthorst	fsl	B	A1				E8	F8	G2	72*	61	43
	fsl	C	A1				E8	F8	G3	58*	44*	
Woodward	1	B		B5					G2	70	76	44
Yahola	fsl	A						F8		118	116	130
Zaneis	1	B							G2	91	101	78
	1	C							G3	77	84	63
Zavala	fsl	A								102	114	89

*Values calculated using data in Table III.
The following values were considered as 100 percent for index calculations:
Wheat, 15 bushels/A;
Grain Sorghum, 23 bushels/A;
Cotton lint, 250 lbs./A.

Data not considered in the index evaluations.

Computations for the "Soil Classification Model"

Representative soils with limited or no deficiencies or sufficiencies are the key soils of the resource area, and all soils occurring in the area are compared to the reference soils. Yield values for deficiencies and sufficiencies above or below the normal soil yield may be established for the soil property (Table III). With complete data to represent all independent variables the value for all individual soil characteristics may be isolated and predicted. In this study some properties are estimated by comparisons to predicted values.
A particular problem existed in observed yield data for cotton because the average temperature increases from north to south in the resource area, thus similar soils in the southern part of the study area produced larger lint yields than did the more northerly soils with similar characteristics. Since the index was based on yields receiving little or no addition of commercial fertilizers, the greatest possible emphasis was placed on basic soil properties. Ratings established for the resource area primarily ranges from 0 to 138 percent. The exception was Reinach very fine sandy loam which ranged 165 in a cotton index prediction.

Soil Index Values Using the "Soil Classification Model"

The predicted values resulting in the "Soil Classification Model" emphasize the relationship between soil characteristics, thus, the relationship maximizes consistency in productivity index ratings.

Where the surface soil horizon was extra thick and contained more than one percent organic matter (pachic, D9) and where surface textures were very fine sandy loam (F9) or fine sandy loam (F8), an increase in the index value was determined above the yield of a normal soil from evaluations of all soil data having this characteristic.

Values in the aridic modifier in the classification of the Dalhart and Manter series indicate those soils to be out of their normal geographic territory. The computations are in agreement with yields experienced for the soils in this resource area after removal of the aridic deficiency value.

Spur silt loam has no obvious classification qualities that suggest its having a yield above the key soils for the area, yet almost all data indicate the productivity of Spur to be considerably greater than other "normal soil" yields of the area. The position of the soil on lower lying landscapes may account for the increase in yield because it would therefore receive extra runoff water. This factor could not be taken into account in the predicted yields. The predicted yield of Spur is the same as that of other "normal soils" of the area which is less than reports indicate (13).

The Altus series, according to its classification and surface texture, receives an exceedingly high index rating. This is because Altus contains the favorable properties of pachic (D9) and fine sandy loam surface texture (f8) Table III).

Limits and Potentials of the "Soil Classification Model"

This model may be used in making immediate soil comparisons.

Values are based on categories of the National Classification System (37), but some of those categories have broad limits. This means a soil having properties toward the lower end of the scale is evaluated equally with soils on the higher end. The program computes the value to be used for all soils having this characteristic. It is possible that some soils in the lower end of the category, pachic, are overrated, while those on the higher end of the scale are decreased in vlaue. High percentages of clay in the Family category seems to cause major problems. Fine, mixed, thermic is defined as having a range from 35 to 59 percent clay. In the "Soil Properties Model" a clay content of 37 percent in a Miller soil contained a high yield while 47 percent clay in Hollister contained a low yield. Considering these qualities, there could be a wide difference in response to clay in crop production in the prediction for the category of fine, mixed, thermic. Fortunately laboratory data indicate close similarities in most soil properties of categories in Southwestern Oklahoma. Where data can be insufficient to complete the "Soil Properties Model", the "Soil Classification Model" will produce uniform comparisons of soils in an area. A compilation of similar characteristics is needed to have fewer entries in the program. For example, a soil having fine, mixed, thermic could be combined with fine, montmorillonitic, thermic and fine, calcareous, thermic. It would also be a major improvement if a fertility measure would be included as a variable. The purpose of Table III, "Soil Properties in Classification Categories", is to define the categories and assign values. Estimates are made by using values of similar soil characteristics or characteristics that would induce the same effect to crop production. For example, the value for cumulic

(D8), was estimated from the computed value for pachic (D9). In the computer program the variables would be entered as equal for the estimate of the dependent variable associated with cumulic (D8).

The index data in Table IV have been adjusted by using observed data to estimate independent variables that do not contain data (Table III). The indexes were established using the "Soil Classification Model" for all the soils in Southwestern Oklahoma (Table IV). The soil properties reference code indicates the soil characteristic that decreases or increases the yield from the "normal soil" of the area. These reference codes are described in Table III. For example, code Al is shown to have the properties for Alfisols. The improvement of this deficiency requires management to increase the percent organic matter of the surface soil. Soils having the high clay properties (E8) show deficiencies because of these properties. Management of moisture to correct these deficiencies is important to improve yields. Deficiency values associated by slope are improved by practices that increase the amount of water in the soil and reduce the amount lost in runoff.

CHAPTER V

STATISTICAL EVALUATIONS OF THE "SOIL PROPERTIES MODEL" AND "SOIL CLASSIFICATION MODEL"

The "Soil Properties Model" and "Soil Classification Model" were tested by evaluating the same set of data in both models for predictions of wheat, grain sorghum, and cotton (Tables V, and VII-XVIII). A comparison of analysis of variance data of the two models is given in Table V. Detail analysis of variance data is given for wheat without calcium in the composition model in Table VIII and with Calcium in the comparison model Table X; for grain sorghum without calcium in the composition model Table XII, with calcium XIV; cotton without calcium in the composition model Table XVI, and with calcium in the composition model the data is given in Table XVIII. There is a conceptual relationship between the two models used to predict yields, in that each requires a substantial number of observations. The variation of analysis is shown in Table V. The values change due to a number of independent variables, and also the number of observations. This is indicated in the analysis of variance (Table V). For example, a greater number of observations increased the R^2 value in the "Soil Classification Model". Where calcium was removed from the "Soil Properties Model" a greater number of observations could be evaluated but resulted in a smaller R^2 value. In the "Soil Properties Model" (calcium included in the model) with 35 observations concerning wheat, the R^2 = .83. With 61 observations (calcium excluded from the model) the R^2 = .58. In the "Soil Classification Model" with 35 observations the R^2 = .78 and with 61 observations, the R^2 = .84. The coefficient of variation and standard deviation values show a relation similar to the R^2 values. As shown in Table V, analysis of variance had similar results for sorghum and cotton lint studies. Because of the complexity of the analyses, it is difficult to determine the most significant indicators in the analysis of variance. It does, however, indicate the need for a sufficient number of observations and special observations that represent significant soil properties that affect crop yield.

The limitation of the "Soil Properties Model" is insufficient data to produce a prediction equation that will include the range of significant variables of all the soils in the study area. The limitations of the "Soil Classification Model" are the large number of variables used and broad limits of categories associated with each of the variables as defined in the National Classification System (37). Soil variation is reduced by confining the study to a particular geographical area. The program does indicate the effect of the presence of a particular characteristic. This will be a concern in research of varieties and crop yields on particular soils (Tables III, IV). The actual laboratory analysis may be compared with yields in the "Soil Properties Model" (Table VI). Since yields are predicted from measured data in this model it allows increment evaluations of the relationship between yields and soil properties in a particular parameter. The success of either model depends upon sufficient representative data. Accuracy may be more easily achieved with the "Soil Properties Model" if the data are available. Unfortunately, soil laboratory data and associated yield information are limited in most areas of Oklahoma.

TABLE V

ANALYSIS OF VARIANCE OF TWO PRODUCTIVITY INDEX MODELS

# Obs.	Variation	"Soil Properties Model"	"Soil Classification Model"
		Wheat Indices	
35	R^2	0.83	0.78
	C.V	10.75	12.29
	std. dev.	8.95	10.23
	mean	83.23	83.23
	df	34	34
61	R^2	0.58	0.84
	C.V	15.70	13.67
	std. dev.	13.22	11.50
	mean	84.15	84.15
	df	60	60
		Sorghum Indices	
34	R^2	0.90	0.85
	C.V	11.47	14.62
	std. dev.	9.71	12.34
	mean	84.65	84.65
	df	33	33
60	R^2	0.71	0.85
	C.V	16.85	12.94
	std. dev.	3.31	2.54
	mean	85.36	85.36
	df	59	59
		Lint Indices	
32	R^2	0.76	0.63
	C.V	17.02	21.17
	std. dev.	12.29	15.28
	mean		
	df	31	31
55	R^2	0.47	0.72
	C.V	24.64	19.30
	std. dev.	19.03	14.91
	mean		
	df	54	54

CHAPTER VI

APPLICATION OF INDEX PREDICTIONS

Information determined in this study may be used in many dimensions in land appraisal and spatial planning (5,43). Spatial planning includes evaluations of soils to achieve the most efficient production of a geographic area. Spatial planning for other research and development uses may include weather modifications and environmental qualify considerations (7,10,25). Production includes both crop and native vegetation (17,19). Spatial evaluations for food production will increase in importance as agricultural demands are increased by population expansion. It will be important to plan to use each soil according to its most efficient potential. Each of the variables used in the analysis must be evaluated in planning the use of each soil. The "Soil Properties Model" establishes the basic factors that are of interest to the appraiser concerning the soils. In the study area the slope and percent clay of a soil are basic. It is demonstrated in the "Soil Classification Model" that other soil properties are important. However, according to the statistical data of the "Soil Properties Model", if a soil is cultivated, relatively level, and is medium in clay texture, other soil characteristics are related to optimum production. It must be emphasized that this data is only applicable to the study area.

General significance of various soil characteristics are established in the "Soil Classification Model". For example, pachic or cumulic, the formative elements in the National Classification System which indicate the presence of a thick dark surface horizon, were assigned high positive values in the model exemplifying the significance of this characteristic in production. Under dryland conditions very fine sandy loam and fine sandy loam textures were valuable characteristics in production. Extremes in clay, sand, lime, soda, slopes and low organic levels were major soil characteristics in reducing crop yields.

The land appraiser or planner may utilize the index values established for series and phases on a comparative basis. The researcher may use the statistical analyses to determine the effects of soil properties, or compare effects of soil properties according to the crop.

Soil Associations and General Soil Maps in Soil Index Displays

Productivity indexes used in soil associations are prepared according to the nature of the soil association. Each soil association area contains the same major component soils occurring in a particular kind of land pattern (29). Where index values are assigned to the soil associations, the values should represent the range of the indexes of the major soils within that association. The result would be a wide and irregular range of values, traceable to the variation of soils within the areas. The component soils of an association are together by mode of occurrence rather than by similarity in characteristics (29) (Table XXI).

General soils maps may contain a number of general soils areas.

Simonson (29) referred to general soils maps as those that provide less than detailed soils information on the distribution of soils in a given land area.

The general soils map and soil association may be a practical means of displaying crop yields over broad areas. The index interval grouping is a more detailed means of grouping soils for a display. These values may be grouped within a smaller number of soil groups with shorter intervals of values. Maps produced by computer cartography lose in contrast where more than seven shades appear on the same map. The more contrast produced on a map, the more values the display will have for spatial analysis (24).

Soil association groupings of soils of the study area are in Table XXI. Interval index ratings using data from the "Soil Properties Model" and "Soil Classification Model" are in Tables XXII through XXV. Spatial displays of the interval rating of wheat are shown in Figures 4 and 5. The spatial displays, according to interval ratings of soils in Jackson County, Oklahoma, demonstrate similar results of both models in regard to the major soil associations of the county (35). The soil properties or soil characteristics that affect yield may be studied in Tables III, IV and VI.

Index rating models as prepared in this study have many potentials in assisting in planning of land use and production. If weather modifications are implemented over massive areas the index models may be used in planning for the maximum efficiency of available moisture and other energy sources. Environmental quality decisions may be guided by qualities of the soil.

These index models have been effective in locating influential properties of the soil. With an increase in observations and other associated information the values will be tested and improvements should make for more dependable ratings of soils. The index rating systems are, therefore, dynamic. As practices and methods of soil treatment change, the values are likely to change. The ordered rank of soils in the set are not likely to be changed drastically. The important aspects of the programs are the establishment of a method to compare the potential of soils and to isolate the significant soil properties that have a major effect on use and crop yields.

CHAPTER VII

SUMMARY AND CONCLUSIONS

Increased demands on agricultural land require a uniform method of comparing soils. Land appraisers, spatial planning groups, and producers of agricultural commodities have long been concerned with comparing the potentials of soils for various purposes. As the population expands, greater emphasis will be placed on soil ratings for urban expansion, crop production, roads, highways, industrial expansion, and public facilities.

The utilization of soil characteristics in computing productivity ratings of soils were tested for wheat, grain sorghum, and cotton in the Central Rolling Red Plains Resource Area of Oklahoma. A suitability rating of soils for corn was also tested in the Cherokee Prairie Resource Area of Oklahoma. Soil characteristics were evaluated using two methods, the "Soil Properties Model" and the "Soil Classification Model". The "Soil Properties Model" compares actual crop yields to observed and laboratory data of soil series. The "Soil Classification Model" compares yields to property categories of the National Classification System (13,37). The analyses were made using a multiple linear regression program. This program is useful in maintaining consistency (i.e., minimum variance) between various levels for selected soil properties that contribute to crop yields. The "Soil Properties Model" is an objective method that should yield direct results in predicting yields and ratio measurements between soils. Laboratory analyses and crop yield observations are necessary on a number of soils to complete a parameter that will facilitate the measurements of all soils in a study area. At present, data are insufficient to complete the program in Southwestern Oklahoma. For obtaining immediate estimates, the "Soil Properties Model" offers a systematic method to establish interval index ratings of soils in the area. With the limited data, predicted indices were sufficient to establish interval values for wheat, grain sorghum, and cotton. Predictions placed most soils in the expected intervals based on available information of series in published soil survey reports. Ordered rank was not expected in some of the soils because of limited observed data for the type of properties in these soils. For example, Roscoe had a wheat index of 108, a higher yield than expected, when compared with Altus, 101, and Farnum, an index of 99. Reinach was also rated slightly lower than expected with an index of 94. The ordered rank in grain sorghum was more easily correlated to yield values reported for soils. This is probably because more representative observed data were available for determining the prediction equation.

The "Soil Classification Model" offers a systematic method to correlate estimates of yields for index rating of soils. The system is based on the National Soil Classification System (37). Each category of classification contains broad areas of criteria to accommodate relatively wide ranges of soils. This is one of the primary limitations of the program since only one value is assigned to each category. These values are then assigned to every soil in the set having those properties. All soils in Southwestern Oklahoma have been assigned an index rating based on the utilization of this program. The ordered rank was fairly consistent with experienced observations.

The penalty point system devised by Committee VII of the Southern Regional Conference was evaluated by a linear correlation coefficient with yields published in the soil series descriptions of the USDA Soil Conservation Service (9). The correlation coefficient was 0.5 indicating the limited value between calculated values using the Committee VII Report (9) and the actual published yield information.

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APPENDIX A

DATA OF THE "SOIL PROPERTIES MODEL" AND "SOIL CLASSIFICATION MODEL"

TABLE VI

DATA MATRIX FOR BOTH MODELS

											SOIL CLASSIFICATION MODEL										
	SOIL PROPERTIES MODEL																				
SERIES	RF 1/	PG	SMP	SLP 2/	CLAY	SAND	CA	THK	SOLM	PH	A 1	BC 55	C 1B 32	D D1 91	DD 11 36	D 1E 78	E E1 92	EE 1 67	FF 56	FF 89	FF 11 12
ABILENE	1	45	1	0.5	41.6	15.6	12.7*	10	074	7.5	0	00	00	10	00	01	00	00	00	00	10
ABILENE	1	45	2	2.0	41.6	15.6	12.7*	10	074	7.5	0	00	00	10	00	01	00	00	00	00	10
CANADIAN	2	39	3	0.5	8.7	50.2	12.7*	12	072	7.3*	0	00	00	00	00	00	00	00	00	10	00
CAREY	2	27	4	2.0	19.8	28.2	14.0	13	058	8.0	0	00	00	00	00	00	00	00	00	00	00
CAREY	2	27	5	4.0	19.8	28.2	14.0	12	057	8.0	0	00	00	00	00	00	00	00	00	00	00
CAREY	2	27	6	6.5	19.8	28.2	14.0	11	056	8.0	0	00	00	00	00	00	00	00	00	00	00
COBB	2	30	7	2.0	22.9	68.3	05.3	09	056	6.8	1	00	00	00	00	00	00	00	00	10	00
COBB	2	30	8	4.0	22.9	68.3	05.3	08	055	6.8	1	00	00	00	00	00	00	00	00	10	00
DALHART	1	39	9	0.5	32.0	46.0	09.2	08	053	7.5	1	00	00	01	00	00	00	00	00	10	00
DALHART	1	39	10	2.0	32.0	46.0	09.2	08	053	7.5	1	00	00	00	00	00	00	00	00	10	00
DALHART	1	39	11	4.0	32.0	46.0	09.2	06	050	7.5	1	00	00	00	00	00	00	00	00	10	00
DILL	2	33	12	2.0	12.8	69.3	05.5	08	034	7.5	0	10	00	00	00	00	00	00	00	10	00
DILL	2	33	13	4.0	12.8	69.3	05.5	07	034	7.5	0	10	00	00	00	00	00	00	00	10	00
FOARD	3	30	14	0.5	44.0	13.4	18.6	10	056	6.4	0	00	10	00	00	00	01	00	00	00	00
NOBSCOT	2	45	15	3.0	9.1	87.2	03.6	05	054	6.6	1	00	01	00	00	00	00	00	10	00	00
QUINLAN	2	34	16	4.0	10.1	72.2	12.7*	08	014	7.3*	0	10	00	00	00	00	00	10	00	00	00
REINACH	1	42	17	0.5	22.9	31.6	12.7*	11	055	7.2	0	00	00	10	00	00	00	00	00	01	00
STPAUL	3	74	18	0.5	23.8	23.6	12.3	20	058	6.3	0	00	00	10	00	00	00	00	00	00	00
STPAUL	3	74	19	2.0	23.8	23.6	12.3	19	057	6.3	0	00	00	10	00	00	00	00	00	00	00
STPAUL	3	74	20	4.0	23.8	23.6	12.3	18	056	6.3	0	00	00	10	00	00	00	00	00	00	00
MILES	1	40	21	0.5	22.3	67.5	11.4*	10	050	7.0	1	00	00	00	00	00	00	00	00	10	00
MILES	1	40	22	2.0	22.3	67.5	11.4*	10	050	7.0	1	00	00	00	00	00	00	00	00	10	00
MILES	1	40	23	4.0	22.3	67.5	11.4*	10	050	7.0	1	00	00	00	00	00	00	00	00	10	00
STPAUL	5	64	24	0.5	30.6	23.0	13.5	20	055	6.2	0	00	00	10	00	00	00	00	00	00	00
STPAUL			25	2.0	30.6	23.0	13.5	20	055	6.2	0	00	00	10	00	00	00	00	00	00	00
CAREY	2	26	26	0.5	22.9	36.2	10.2	07	030	7.8	0	00	00	00	00	00	00	00	00	00	00

TABLE VI "CONTINUED"

											SOIL CLASSIFICATION MODEL										
					SOIL PROPERTIES MODEL																
SERIES	RF	PG	SMP	SLP	CLAY	SAND	CA	THK	SOLM	PH	A 1	BC 55	C 1B 32	D D1 91	DD 11 36	D 1E 78	E E1 92	EE 11 67	FF 56	FF 89	FF 11 12
CAREY	2	26	27	2.0	22.9	36.2	10.2	07	030	7.8	0	00	00	00	00	00	00	00	00	00	00
CAREY	2	26	28	4.0	22.9	36.2	10.2	10*	030	7.8	0	00	00	00	00	00	00	00	00	00	00
CAREY	2	26	29	6.5	22.9	36.2	10.2	10*	030	7.8	0	00	00	00	00	00	00	00	00	00	00
TILLMAN	6	1	30	0.5	40.4	11.4	22.7	08	080	7.7	0	00	00	00	00	01	00	00	00	00	10
TILLMAN	6	1	31	2.0	40.4	11.4	22.7	08	080	7.7	0	00	00	00	00	01	00	00	00	00	10
GRANDFIELD	7	69	32	0.5	10.0	61.8	09.9	08	080	7.5	1	00	00	00	00	00	00	00	00	10	00
ENTERPRISE	8	114	33	0.5	10.9	39.0	45.5	30	084	8.1	0	10	00	00	00	00	00	00	00	01	00
MILES	9	2	34	0.5	27.1	52.1	12.7	06	066	8.0	1	00	00	00	00	00	00	00	00	10	00
MILES	9	2	35	2.0	27.1	52.1	12.7	06	066	8.0	1	00	00	00	00	00	00	00	00	10	00
MILES	9	2	36	4.0	27.1	52.1	12.7	05	065	8.0	1	00	00	00	00	00	00	00	00	10	00
MILES	9	2	37	6.5	27.1	52.1	12.7	04	064	8.0	1	00	00	00	00	00	00	00	00	10	00
MILES	9	3	38	0.5	29.4	39.9	11.5	07	073	7.8	1	00	00	00	00	00	00	00	00	10	00
GRANDFIELD	9	4	39	0.5	31.0	48.3	11.5	14	076	7.8	1	00	00	00	00	00	00	00	00	10	00
HOLDREDGE	8	114	40	0.5	19.9	41.0	13.9	23	076	6.8	0	00	00	00	00	00	00	00	00	00	00
CARWILE	10	6	41	0.5	40.1	20.6*	20.8	19	055	6.2	0	00	00	00	00	01	00	00	00	00	10
CARWILE	10	8	42	0.5	42.0	20.6*	22.9	17	075	5.7	0	00	00	00	00	01	00	00	00	00	10
FARNUM	10	22	43	0.5	27.0	35.0	14.4	22	087	6.0	0	00	00	10	00	00	00	00	00	00	00
FARNUM	10	24	44	0.5	32.0	35.0	18.6	21	078	5.2	0	00	00	10	00	00	00	00	00	00	00
PRATT	10	56	45	2.0	8.3	80.0*	04.3	19	038	6.8	1	00	00	00	00	10	00	01	01	00	00
PRATT	10	56	46	6.5	8.3	80.0*	04.3	19	038	6.8	1	00	00	00	00	10	00	01	01	00	00
TILLMAN	11	8	47	0.5	38.0	11.4*	22.7*	10	063	7.6	0	00	00	00	00	01	00	00	00	00	10
MILES	11	6	48	0.5*	23.9	54.7	09.6	08	072	7.6	1	00	00	00	00	00	00	00	00	10	00
MILES	11	6	49	2.0	23.9	54.7	09.6	08	072	7.6	1	00	00	00	00	00	00	00	00	10	00
MILES	11	6	50	4.5	23.9	54.7	09.6	08	072	7.6	1	00	00	00	00	00	00	00	00	10	00
TILLMAN	11	8	51	0.5	38.0	11.4*	22.7*	10	063	7.6	0	00	00	00	00	01	00	00	00	00	10
VERNON	25	1	74	2.0	48.8	17.6	17.4	06	018	6.3	0	10	00	00	00	01	00	00	00	00	10

TABLE VI "CONTINUED"

											SOIL CLASSIFICATION MODEL										
	SOIL PROPERTIES MODEL																				
													C	D	DD	D	E	EE			FF
											A	BC	1B	D1	11	1E	E1	11	FF	FF	11
SERIES	RF	PG	SMP	SLP	CLAY	SAND	CA	THK	SOLM	PH	1	55	32	91	36	78	92	67	56	89	12
YAHOLA	4	58	100	0.5	17.0	17.0	12.7*	10	060	8.0	0	00	00	00	00	00	00	00	00	10	00
WEYMOUTH	12	52	101	2.0	31.0	20.0	12.7*	11	021	8.2	0	10	00	00	00	00	00	00	00	00	10
WOODWARD	5	44	104	2.0	27.0	6.0	12.7*	12	030	8.3	0	10	00	00	00	00	00	00	00	00	00
WOODWARD	5	44	105	4.0	27.0	6.0	12.7*	12	030	8.3	0	10	00	00	00	00	00	00	00	00	00
ENTERPRISE	14	37	128	2.0	31.2	31.0	45.5*	12	084	7.3	0	10	00	00	00	00	00	00	00	01	00
ENTERPRISE	14	37	129	4.0	31.2	31.0	45.5*	12	084	7.3	0	10	00	00	00	00	00	00	00	01	00
HOLLISTER	12	52	144	0.5	49.0	8.0*	12.7*	05	030	7.0	0	00	00	10	00	01	00	00	00	00	00
LACASA	6	39	149	2.0	41.0	12.0	12.7*	10	027	8.2	0	00	00	00	00	01	00	00	00	00	10
LAWTON	12	52	151	0.5	38.0	20.0	12.7*	06	035	6.2	0	00	00	00	00	01	00	00	00	10	00
LAWTON	12	52	152	2.0	38.0	20.0	12.7*	06	035	6.2	0	00	00	00	00	01	00	00	00	10	00
LAWTON	12	52	153	4.0	38.0	20.0	12.7*	06	035	6.2	0	00	00	00	00	01	00	00	00	10	00
LINCOLN	22	22	154	0.5	8.0	88.0	12.7*	08	180	8.1	0	10	00	00	00	00	00	01	01	00	00
MANGUM	12	52	155	0.5	55.0	.3	12.7*	08	033	8.3	0	00	00	00	10	01	00	00	00	00	00
PRATT	15	58	169	0.5	11.0	80.0	04.3*	12	032	6.8	1	00	00	00	00	10	00	01	00	10	00
PRATT	15	58	170	2.0	11.0	80.0	04.3*	12	032	6.8	1	00	00	00	00	10	00	01	00	10	00
SPUR	4	58	187	0.5	16.0	25.0	12.7*	18	060	8.2	0	00	00	00	00	00	00	00	00	00	00
TIPTON	6	38	195	0.5	21.0	35.0	12.7*	18	061	7.5	0	00	00	10	00	00	00	00	00	00	00
TIPTON	6	38	196	2.0	21.0	35.0	12.7*	18	061	7.5	0	00	00	10	00	00	00	00	00	00	00
ZANEIS	18	52	301	2.0	37.0	38.0	12.7*	07	032	6.8	0	00	00	00	00	00	00	00	00	00	00
WEYMOUTH	12	52	303	6.5	31.0	20.0	12.7*	11	021	8.2	0	10	00	00	00	00	00	00	00	00	10
WOODWARD	5	44	306	6.5	27.0	6.0	12.7*	12	030	8.3	0	10	00	00	00	00	00	00	00	00	00
PORT	5	42	307	0.5	25.0	6.0	12.7*	14	052	7.5	0	00	00	10	00	00	00	00	00	00	00
BERTHOUD	4	58	308	2.0	13.0	54.0	17.4*	08	026	8.2	0	00	00	00	00	00	00	00	00	00	00
BROWNFIELD	4	58	309	2.0	24.0	52.0	04.3*	04	046	6.0	1	00	00	00	00	00	00	00	10	00	00
BROWNFIELD	4	58	310	4.0	24.0	52.0	04.3*	04	046	6.0	1	00	00	00	00	00	00	00	10	00	00
ZANEIS	18	52	311	4.0	37.0	38.0	12.7*	07	032	6.8	0	00	00	00	00	00	00	00	00	00	00

TABLE VI "CONTINUED"

											Soil Classification Model										
	Soil Properties Model																				
SERIES	RF	PG	SMP	SLP	CLAY	SAND	CA	THK	SOLM	PH	A 1	BC 55	C 1B 32	D D1 91	DD 11 36	D 1E 78	E E1 92	EE 11 67	FF 56	FF 89	FF 11 12
CHICKASH	19	48	312	0.5	26.0	54.0	12.7*	12	034	5.8	0	00	00	00	00	00	00	00	00	00	00
ZAVALA	5	44	313	0.5	8.0	82.0	12.7	18	036	7.5	0	00	00	00	00	00	00	00	00	00	00
WINDTHORST	17	51	314	2.0	37.0	53.0	12.7*	08	048	6.0	1	00	00	00	00	01	00	00	00	00	00
WINDTHORST	17	51	315	4.5	37.0	53.0	12.7*	08	048	6.0	1	00	00	00	00	01	00	00	00	00	00
STAMFORD	17	44	316	0.5	47.0	33.0	12.3*	12	040	8.3	0	00	00	00	00	00	01	00	00	00	00
MILLER	18	52	317	0.5	37.0	35.0	17.4*	24	052	8.3	0	00	00	00	10	00	10	00	00	00	00
EUFAULA	16	58	318	2.0	8.2	88.8	04.5*	06	068	6.6	1	00	00	00	00	10	00	01	01	00	00
BRAZOS	5	11	319	0.5	8.0	80.0	12.7*	18	038	7.5	0	00	00	00	00	00	00	00	00	10	00
CANADIAN	2	39	321	0.5	8.7	50.2	12.7*	12	072	7.2	0	00	00	00	00	00	00	00	00	10	00
WAURIKA	18	64	322	0.5	49.0	12.8	17.4*	10	045	8.0	0	00	00	00	00	01	00	00	00	00	00
FOARD	3	30	334	2.0	44.0	13.4	18.6*	09	056	6.4	0	00	10	00	00	00	01	00	00	00	00
HARDEMAN	2	41	337	0.5	12.7	54.4	17.4*	04	036	8.0	0	10	00	00	00	00	00	00	00	10	00
HARDEMAN	2	41	338	2.0	12.7	54.4	17.4*	04	036	8.0	0	10	00	00	00	00	00	00	00	10	00
HARDEMAN	2	41	339	4.0	12.7	54.4	17.4*	04	063	8.0	0	10	00	00	00	00	00	00	00	10	00
HINKLE	23	1	340	0.5	42.5	11.6	14.1*	08	022	6.3	0	00	10	00	00	01	00	00	00	00	00
HOLLISTER	12	52	345	2.0	49.0	8.0*	12.7*	05	030	7.0	0	00	00	10	00	01	00	00	00	00	00
LACASA	6	39	350	4.0	41.0	12.0	12.7*	10	027	8.2	0	00	00	00	00	01	00	00	00	00	10
REINACH	1	42	351	0.5	22.9	31.6	12.7*	11	055	7.2	0	00	00	10	00	00	00	00	00	01	00
VERNON	15	58	352	2.0	25.0	60.0	17.4*	06	016	8.3	0	10	00	00	00	01	00	00	00	00	10
LELA	13	44	355	0.5	68.0	2.2	17.4*	08	060	8.3	0	00	00	00	00	01	00	00	00	00	00
MANSIC	15	58	356	0.5	20.0	27.0	17.4*	07	027	8.3	0	01	00	00	00	00	00	00	00	00	10
MANSIC	15	58	357	2.0	20.0	27.0	17.4*	07	027	8.3	0	01	00	00	00	00	00	00	00	00	10
MANSIC	15	58	358	4.0	20.0	27.0	17.4*	07	027	8.3	0	01	00	00	00	00	00	00	00	00	10
PRATT	10	56	374	4.0	8.3	86.0	04.3*	19	038	6.8	1	00	00	00	00	10	00	01	00	10	00
QUINLAN	5	44	378	2.0	16.0	17.0	12.7*	05	020	8.2	0	10	00	00	00	00	00	10	00	00	00
ROSCOE	11	24	380	0.5	47.9	25.5	17.3*	30	045	7.5	0	00	00	00	00	00	01	00	00	00	10

TABLE VI "CONTINUED"

		SOIL PROPERTIES MODEL									SOIL CLASSIFICATION MODEL										
SERIES	RF	PG	SMP	SLP	CLAY	SAND	CA	THK	SOLM	PH	A 1	BC 55	C 1B 32	D D1 91	DD 11 36	D 1E 78	E E1 92	EE 11 67	FF 56	FF 89	FF 11 12
SPRINGER	12	52	384	0.5	18.0	72.0	04.3*	19	033	7.8	1	00	00	00	00	00	00	00	01	00	00
SPRINGER	12	52	385	2.0	18.0	72.0	04.3*	19	033	7.8	1	00	00	00	00	00	00	00	01	00	00
SPRINGER	12	52	386	4.0	18.0	72.0	04.3*	19	033	7.8	1	00	00	00	00	00	00	00	01	00	00
WAURIKA	3	103	388	0.5	42.4	15.3	17.4*	10	039	7.3	0	00	00	00	00	01	00	00	00	00	00
VERNON	13	44	397	0.5	56.0	5.0	17.4*	06	015	8.3	0	10	00	00	00	01	00	00	00	00	10
VERNON	13	44	398	2.0	56.0	5.0	17.4*	06	015	8.3	0	10	00	00	00	01	00	00	00	00	10
VERNON	13	44	399	4.0	56.0	5.0	17.4*	06	015	8.3	0	10	00	00	00	01	00	00	00	00	10
WANN	5	58	400	0.5	21.0*	35.0*	17.4*	22	052	8.1	0	00	00	00	00	00	00	00	00	00	00
ACME	12	59	403	2.0	34.0	21.0	17.4*	10	024	8.2	0	00	00	01	00	00	00	00	00	00	01
ACME	12	59	404	4.0	34.0	21.0	17.4*	10	024	8.2	0	00	00	00	00	00	00	10	00	00	00
ACME	12	59	405	6.5	34.0	21.0	17.4*	10	015	8.2	0	00	00	00	00	00	00	10	00	00	00
ALTUS	6	42	406	0.5	30.0	35.0	12.7*	08	042	7.5	0	00	00	10	00	00	00	00	00	10	00
ALTUS	6	42	407	2.0	30.0	35.0	12.7*	08	042	7.5	0	00	00	10	00	00	00	00	00	10	00
DEVOL	21	1	422	0.5	10.0	60.0	11.4*	14	040	7.0	1	00	00	00	00	00	00	00	01	00	00
DEVOL	21	1	423	2.0	10.0	60.0	11.4*	14	040	7.0	1	00	00	00	00	00	00	00	01	00	00
KONAWA	17	51	424	2.0	23.0	54.7*	09.6*	08	041	6.5	1	00	00	00	00	00	00	00	00	10	00
ELSMERE	22	17	426	0.5	10.0	79.0	12.7*	12	058	8.4	0	00	00	00	00	00	00	00	01	00	00
LUCIEN	17	53	453	2.0	24.9*	48.0*	12.7*	10	010	7.0	0	00	00	00	00	00	00	10	00	00	00
OTERO	15	18	467	2.0	8.0	80.0	17.4*	06	016	8.3	0	11	00	00	00	00	00	00	00	10	00
OTERO	15	18	468	4.0	8.0	80.0	17.4*	06	016	8.3	0	11	00	00	00	00	00	00	00	10	00
WEYMOUTH	12	52	502	4.0	31.0	20.0	12.7*	11	021	8.2	0	10	00	00	00	00	00	00	00	00	10
ENTERPRISE	14	37	530	6.5	31.2	31.0	45.5*	12	084	7.3	0	10	00	00	00	00	00	00	00	01	00
PRATT	15	58	571	4.0	11.0	80.0	04.3*	12	032	6.8	1	00	00	00	00	10	00	01	00	10	00
PRATT	15	58	572	6.5	11.0	80.0	04.3*	12	032	6.8	1	00	00	00	00	10	00	01	00	10	00

*Estimated values for missing data.

1 Slope values are used for both Models.

2 References used to obtain data.

(1) Productivities of horizons of seven benchmark soils of the Southern Great Plains. Report No. 11. 1967. USDA.

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(3) Soil survey laboratory data and descriptions for some soils of Oklahoma. Soil Survey Investigations Report No. 11, May, 1967. USDA.

(4) Soil survey Ellis County, Oklahoma. April, 1966. USDA.

(5) Soil survey Roger Mills County, Oklahoma. August, 1963. USDA.

(6) Soil survey Jackson County, Oklahoma. June, 1961. USDA.

(7) Voss, D. A. 1974. Utilizing the morphology of selected Oklahoma soils for the interpretation of some engineering qualities. M.S. thesis, Oklahoma State University.

(8) Stahnke, C. R. 1968. The genesis of a chrono-climo-sequence of mollisols in West-Central Oklahoma. Ph.D. dissertation, Oklahoma State University.

(9) Soil survey investigation unit. 1973. Soil Conservation Service, USDA. Lincoln, Nebraska.

(10) Soil survey laboratory data and descriptions for some soils of Kansas. Report No. 4. August, 1966. Soil Conservation Service, USDA.

(11) Estimated crop yields on selected soils of the Central Rolling Red Prairies, (West) Cross-timbers, and Central Rolling Red Plains areas. 1974. Soil Conservation Service, USDA.

(12) Soil survey Greer County, Oklahoma. March, 1967. USDA.

(13) Soil survey Oklahoma County, Oklahoma. February, 1969. USDA.

(14) Soil survey Kiowa County, Oklahoma. Series 1931. USDA.

(15) Soil survey Beaver County, Oklahoma. August, 1969. USDA.

(16) Soil survey Kingfisher County, Oklahoma. June, 1962. USDA.

(17) Soil survey Comanche County, Oklahoma. August, 1967. USDA.

(18) Soil survey Cotton County, Oklahoma. December, 1963. USDA.

(19) Soil survey Stephens County, Oklahoma. November, 1964 USDA.

(20) Soil survey project 1383, Canadian County, Oklahoma. 1968. Oklahoma State University Soils Lab.

(21) Soil series analyses. 1973. Soil Conservation Service State Office. Stillwater, Oklahoma.

(22) Soil survey Major County, Oklahoma, October, 1968. USDA.

(23) Laboratory data. Soil Morphology Department, Oklahoma State University. Sample collected by Carl Fisher, Canadian County, Oklahoma, 1968.

(24) Gray, Fenton and Clyde Stahnke (1970) Classification of soils in the Savanna-Forest transition in Eastern Oklahoma, Agr. Ex. Station, Oklahoma State University Bul. B672 (Samples omitted from this study).

(25) Computer print-out laboratory data, Soil laboratory, Oklahoma State University.

TABLE VII

PREDICTED INDEXES FOR WHEAT YIELDS USING
TWO DIFFERENT REGRESSION EQUATIONS
WITHOUT CALCIUM IN THE MODEL

			PROPERTIES MODEL			CLASSIFICATION MODEL		
SOIL SERIES	SAMP NO.	OBS. INDEX	PRED. INDEX	LOWER LIMIT	UPPER LIMIT	PRED. INDEX	LOWER LIMIT	UPPER LIMIT
ABILENE	1	106	93	65	121	93	67	119
ABILENE	2	93	82	55	110	82	57	108
CANADIAN	3		91	59	122	118	90	146
CAREY	4	86	88	61	116	91	66	115
CAREY	5	73	73	46	101	77	52	101
CAREY	6	53	55	26	84	59	33	85
COBB	7	93	85	57	112	83	59	107
COBB	8	80	70	42	97	69	45	93
DALHART	9	100	99	71	127	100	67	132
DALHART	10	86	88	61	116	83	59	107
DALHART	11	66	73	45	100	69	45	93
DILL	12	93	79	51	107	86	60	112
DILL	13	80	64	36	92	72	45	98
FOARD	14	93	90	62	118	93	60	126
NOBSCOT	15	46	59	30	89	46	13	79
QUINLAN	16		62	33	91	55	29	82
REINACH	17		99	71	126	131	101	160
STPAUL	18	93	103	75	131	103	79	128
STPAUL	19	86	91	64	119	93	68	117
STPAUL	20	66	77	48	105	78	54	103
MILES	21	100	96	68	124	94	70	118
MILES	22	86	86	58	113	83	59	107
MILES	23	66	71	44	99	69	45	93
STPAUL	24	93	104	76	132	103	79	128
STPAUL	25	86	93	65	121	93	68	117
CAREY	26	100	97	69	126	101	77	126
CAREY	27	86	87	59	114	91	66	115
CAREY	28		75	47	102	77	52	101
CAREY	29		57	28	85	59	33	85
TILLMAN	30	93	91	63	119	91	66	117
TILLMAN	31	73	80	52	108	81	55	106
GRANDFIELD	32	53	88	58	118	94	70	118
ENTERPRIZE	33	100	106	74	138	107	81	134
MILES	34	100	98	70	126	94	70	118
MILES	35	86	87	59	114	83	59	107
MILES	36	66	72	44	100	69	45	93
MILES	37	46	53	25	82	51	26	76
MILES	38	100	98	71	126	94	70	118

TABLE VII CONTINUED

			PROPERTIES MODEL			CLASSIFICATION MODEL		
SOIL SERIES	SAMP NO.	OBS. INDEX	PRED. INDEX	LOWER LIMIT	UPPER LIMIT	PRED. INDEX	LOWER LIMIT	UPPER LIMIT
GRANDFIELD	39	100	103	75	132	94	70	118
HOLDREDGE	40	113	106	78	134	101	77	126
CARWILE	41		100	72	129	91	66	117
CARWILE	42		97	69	126	91	66	117
FARNUM	43	106	106	78	135	103	79	128
FARNUM	44	106	105	76	134	103	79	128
PRATT	45		79	49	108	65	35	95
PRATT	46		47	16	78	33	3	64
TILLMAN	47		93	65	121	91	66	117
MILES	48		98	70	125	94	70	118
MILES	49	86	87	60	114	83	59	107
MILES	50	66	69	42	97	66	41	90
TILLMAN	51		93	65	121	91	66	117
VERNON	74	46	75	45	105	59	32	86
YAHOLA	100	120	93	63	122	118	90	146
WEYMOUTH	101	66	88	60	116	71	45	98
WOODWARD	104	80	84	54	114	69	43	96
WOODWARD	105	60	70	40	100	55	29	82
ENTERPRIZE	128	86	90	62	117	97	71	123
ENTERPRIZE	129	66	75	48	103	83	57	108
HOLLISTER	144		82	53	111	91	62	120
LACASA	149	93	83	54	111	81	55	106
LAWTON	151	100	92	64	121	106	80	132
LAWTON	152	93	81	53	110	95	69	121
LAWTON	153	73	67	39	96	81	55	107
LINCOLN	154	66	77	43	111	66	33	99
MANGUM	155	86	77	44	109	86	53	119
PRATT	169	93	87	58	116	92	66	119
PRATT	170	86	76	48	105	82	56	108
SPUR	187	120	100	72	128	101	77	126
TIPTON	195	113	104	76	131	103	79	128
TIPTON	196	100	93	66	120	93	68	117
ZANEIS	301		86	58	114	91	66	115
WEYMOUTH	303		56	27	85	40	12	67
WOODWARD	306		52	21	83	37	10	65
PORT	307		95	65	125	103	79	128
BERTHOUD	308		82	53	112	91	66	115
BROWNFIELD	309		83	54	112	67	38	95
BROWNFIELD	310		69	40	98	53	24	81
ZANEIS	311		72	44	100	77	52	101
CHICKASHA	312		100	71	128	101	77	126
ZAVALA	313		89	58	119	101	77	126
WINDTHORST	314		86	58	114	54	17	92
WINDTHORST	315		68	39	97	37	-0	74
STAMFORD	316		96	64	129	118	90	146
MILLER	317		110	77	143	98	62	135

TABLE VII CONTINUED

			PROPERTIES MODEL			CLASSIFICATION MODEL		
SOIL SERIES	SAMP NO.	OBS. INDEX	PRED. INDEX	LOWER LIMIT	UPPER LIMIT	PRED. INDEX	LOWER LIMIT	UPPER LIMIT
EUFAULA	318		65	36	95	65	35	95
BRAZOS	319		89	59	119	118	90	146
CANADIAN	321		91	59	122	118	90	146
WAURIKA	322		88	58	118	89	60	118
FOARD	334		79	51	107	82	49	115
HARDEMAN	337		90	59	120	96	70	123
HARDEMAN	338		79	49	109	86	60	112
HARDEMAN	339		64	34	94	72	45	98
HINKLE	340		89	61	118	81	44	117
HOLLISTER	345		71	42	101	80	51	109
LACASA	350		69	40	97	67	41	92
REINACH	351		99	71	126	131	101	160
VERNON	352		87	58	116	59	32	86
LELA	355		59	6	112	91	66	117
MANSIC	356		95	66	124	104	74	133
MANSIC	357		85	56	113	93	63	122
MANSIC	358		70	42	99	79	49	109
PRATT	374		62	32	93	68	42	93
QUINLAN	378		79	48	109	69	43	96
ROSCOE	380		106	68	144	104	74	133
SPRINGER	384		101	70	132	77	49	106
SPRINGER	385		90	59	121	67	38	95
SPRINGER	386		76	45	107	53	24	81
WAURIKA	388		93	65	120	89	60	118
VERNON	397		76	42	111	70	43	97
VERNON	398		66	31	100	59	32	86
VERNON	399		51	16	87	45	18	72
WANN	400		107	78	136	101	77	126
ACME	403		88	60	116	96	62	131
ACME	404		73	45	101	77	52	101
ACME	405		56	27	85	59	33	85
ALTUS	406		99	71	126	120	91	148
ALTUS	407		88	61	115	109	81	138
DEVOL	422		93	63	122	77	49	106
DEVOL	423		82	53	111	67	38	95
KONAWA	424		86	58	114	83	59	107
ELSMERE	426		88	59	117	101	77	126
LUCIEN	453		89	61	117	91	66	115
OTERO	467		71	42	101	86	60	112
OTERO	468		57	27	86	72	45	98
WEYMOUTH	502	46	74	46	102	57	31	84
ENTERPRIZE	530	100	57	28	86	65	38	91
PRATT	571	66	62	34	91	68	42	93
PRATT	572	46	44	15	74	50	23	76

TABLE VIII

ANALYSIS OF VARIANCE FOR WHEAT YIELD INDEXES
USING TWO DIFFERENT REGRESSION EQUATIONS
WITHOUT CALCIUM IN THE MODEL

SOIL PROPERTIES MODEL				SOIL CLASSIFICATION MODEL			
SOURCE	DF	SEQUENTIAL MEAN SQ.	PROB F	SOURCE	DF	SEQUENTIAL MEAN SQ.	PROB F
SLOPE LIN.	1	10026.48	.000	SLOPE LIN.	1	10026.48	.000
CLAY LIN.	1	0.91	.943	A1	1	314.88	.130
SAND LIN.	1	392.17	.140	B5	1	926.68	.011
CLAY QUAD.	1	1564.02	.004	C5	0		
SAND QUAD.	1	372.90	.150	C13	1	51.64	.535
THKNS LIN.	1	408.79	.132	B2	1	871.35	.014
SOLUM LIN.	1	3.14	.894	D9	1	12.04	.764
PH LIN.	1	22.34	.722	D11	1	50.95	.538
				D13	1	188.57	.239
				D16	0		
				D17	1	12.87	.757
				E8	1	469.43	.066
				E9	0		
				E12	0		
				E16	0		
				E17	1	632.25	.034
				F5	0		
				F6	0		
				F8	1	544.96	.048
				F9	1	1678.95	.001
				F11	1	8.13	.805
				F12	0		
ERROR	52	174.82		ERROR	46	132.44	
R-SQUARE		0.58		R-SQUARE		0.72	
MEAN		84.15		MEAN		84.15	
C. V.		15.71		C. V.		113.68	

TABLE IX

PREDICTED INDEXES FOR WHEAT YIELDS USING TWO DIFFERENT REGRESSION EQUATIONS WITH CALCIUM IN THE MODEL

			PROPERTIES MODEL			CLASSIFICATION MODEL		
SOIL SERIES	SAMP NO.	OBS. INDEX	PRED. INDEX	LOWER LIMIT	UPPER LIMIT	PRED. INDEX	LOWER LIMIT	UPPER LIMIT
ABILENE	1		84	61	108	86	57	114
ABILENE	2		72	48	96	74	45	103
CANADIAN	3		62	36	88	136	99	173
CAREY	4	86	86	66	105	90	67	112
CAREY	5	73	69	49	89	74	51	97
CAREY	6	53	48	27	69	55	31	80
COBB	7	93	91	71	111	83	61	105
COBB	8	80	75	54	95	68	46	90
DALHART	9	100	101	81	120	100	70	129
DALHART	10	86	89	69	108	83	61	105
DALHART	11	66	71	51	91	68	46	90
DILL	12	93	79	59	100	94	68	120
DILL	13	80	62	42	83	79	53	104
FOARD	14	93	77	57	98	93	63	123
NORSCOT	15	46	58	35	82	46	16	76
QUINLAN	16		62	39	85	43	9	78
REINACH	17		94	74	115	127	86	169
STPAUL	18	93	101	81	121	98	75	121
STPAUL	19	86	88	68	108	87	64	109
STPAUL	20	66	71	51	92	71	48	95
MILES	21		108	86	129	95	72	117
MILES	22		96	75	117	83	61	105
MILES	23		80	59	101	68	46	90
STPAUL	24	93	105	85	125	98	75	121
STPAUL	25	86	94	74	114	87	64	109
CAREY	26	100	99	78	121	101	78	124
CAREY	27	86	88	67	108	90	67	112
CAREY	28		77	56	97	74	51	97
CAREY	29		57	36	79	55	31	80
TILLMAN	30	93	85	64	107	89	63	115
TILLMAN	31	73	74	52	95	77	51	103
GRANDFIELD	32	53	65	41	90	95	72	117
ENTERPRIZE	33	100	103	77	129	100	70	129
MILES	34	100	100	80	120	95	72	117
MILES	35	86	88	69	108	83	61	105
MILES	36	66	72	52	91	68	46	90
MILES	37	46	51	30	72	49	25	72
MILES	38	100	94	75	114	95	72	117

TABLE IX CONTINUED

SOIL SERIES	SAMP NO.	OBS. INDEX	PROPERTIES MODEL PRED. INDEX	PROPERTIES MODEL LOWER LIMIT	PROPERTIES MODEL UPPER LIMIT	CLASSIFICATION MODEL PRED. INDEX	CLASSIFICATION MODEL LOWER LIMIT	CLASSIFICATION MODEL UPPER LIMIT
GRANDFIELD	39	100	108	85	130	95	72	117
HOLDREDGE	40	113	102	81	123	101	78	124
CARWILE	41		98	77	118	89	63	115
CARWILE	42		83	61	104	89	63	115
FARNUM	43	106	99	79	120	98	75	121
FARNUM	44	106	96	74	119	98	75	121
PRATT	45		83	55	112	48	10	86
PRATT	46		48	17	79	13	-25	52
TILLMAN	47		96	74	118	89	63	115
MILES	48		97	77	116	95	72	117
MILES	49	86	85	66	104	83	61	105
MILES	50	66	65	46	85	64	42	86
TILLMAN	51		96	74	118	89	63	115
VERNON	74	46	55	31	79	46	16	76
YAHOLA	100		86	63	109	136	99	173
WEYMOUTH	101		103	79	127	59	24	93
WOODWARD	104		103	74	132	59	24	93
WOODWARD	105		88	59	117	43	9	78
ENTERPRIZE	128		89	52	126	88	58	118
ENTERPRIZE	129		73	37	110	73	42	104
HOLLISTER	144		67	41	92	86	57	114
LACASA	149		91	63	119	77	51	103
LAWTON	151		84	61	107	124	78	169
LAWTON	152		72	50	95	112	67	158
LAWTON	153		57	34	79	97	51	143
LINCOLN	154		59	21	97	70	35	105
MANGUM	155		60	13	106	89	63	115
PRATT	169		96	72	119	95	72	117
PRATT	170		84	61	107	83	61	105
SPUR	187		97	73	121	101	78	124
TIPTON	195		104	83	124	98	75	121
TIPTON	196		92	72	112	87	64	109
ZANEIS	301		83	62	103	90	67	112
WEYMOUTH	303		68	42	93	24	-10	59
WOODWARD	306		68	39	98	24	-10	59
PORT	307		105	79	131	98	75	121
BERTHOUD	308		80	58	102	90	67	112
BROWNFIELD	309		72	46	98	48	10	86
BROWNFIELD	310		56	31	82	33	-5	71
ZANEIS	311		67	46	88	74	51	97
CHICKASHA	312		102	77	128	101	78	124
ZAVALA	313		102	73	130	101	78	124
WINDTHORST	314		80	57	103	35	2	69
WINDTHORST	315		60	37	84	16	-17	51
STAMFORD	316		90	53	126	136	99	173
MILLER	317		126	91	162	101	78	124

TABLE IX CONTINUED

			PROPERTIES MODEL			CLASSIFICATION MODEL		
SOIL SERIES	SAMP NO.	OBS. INDEX	PRED. INDEX	LOWER LIMIT	UPPER LIMIT	PRED. INDEX	LOWER LIMIT	UPPER LIMIT
EUFAULA	318		62	38	87	48	10	86
BRAZOS	319		99	72	127	136	99	173
CANADIAN	321		61	35	87	136	99	173
WAURIKA	322		78	47	109	89	63	115
FOARD	334		64	43	85	81	51	111
HARDEMAN	337		81	55	106	105	79	132
HARDEMAN	338		69	45	93	94	68	120
HARDEMAN	339		46	22	70	79	53	104
HINKLE	340		85	63	107	80	46	115
HOLLISTER	345		55	29	81	74	45	103
LACASA	350		76	47	104	62	35	88
REINACH	351		94	74	115	127	86	169
VERNON	352		107	81	134	46	16	76
LELA	355		-15	-99	68	89	63	115
MANSIC	356		99	75	123	101	78	124
MANSIC	357		87	64	111	90	67	112
MANSIC	358		72	49	94	74	51	97
PRATT	374		74	42	106	68	46	90
QUINLAN	378		76	51	101	59	24	93
ROSCOE	380		108	58	158	101	78	124
SPRINGER	384		126	94	158	59	21	98
SPRINGER	385		114	82	147	48	10	86
SPRINGER	386		99	65	132	33	-5	71
WAURIKA	388		91	70	113	89	63	115
VERNON	397		57	14	100	58	28	88
VERNON	398		45	2	89	46	16	76
VERNON	399		29	-14	74	31	1	61
WANN	400		117	93	141	101	78	124
ACME	403		101	77	124	94	63	126
ACME	404		85	61	108	74	51	97
ACME	405		68	42	93	55	31	80
ALTUS	406		101	81	121	133	95	172
ALTUS	407		89	69	109	122	83	160
DEVOL	422		81	59	103	59	21	98
DEVOL	423		69	48	91	48	10	86
KONAWA	424		84	62	106	83	61	105
ELSMERE	426		98	72	124	101	78	124
LUCIEN	453		99	74	123	90	67	112
OTERO	467		81	55	108	94	68	120
OTERO	468		66	40	92	79	53	104
WEYMOUTH	502		87	63	112	43	9	78
ENTERPRIZE	530		54	17	91	54	21	86
PRATT	571		68	45	92	68	46	90
PRATT	572		49	24	74	49	25	72

TABLE X

ANALYSIS OF VARIANCE FOR WHEAT YIELD INDEXES
USING TWO DIFFERENT REGRESSION EQUATIONS
WITH CALCIUM IN THE MODEL

SOIL PROPERTIES MODEL				SOIL CLASSIFICATION MODEL			
SOURCE	DF	SEQUENTIAL MEAN SQ.	PROB F	SOURCE	DF	SEQUENTIAL MEAN SQ.	PROB F
SLOPE LIN.	1	6085.60	.000	SLOPE LIN.	1	6085.60	.000
CLAY LIN.	1	48.01	.446	A1	1	108.93	.318
SAND LIN.	1	20.63	.616	B5	1	106.21	.324
CLAY QUAD.	1	2453.05	.000	C5	0		
SAND QUAD.	1	4.21	.821	C13	1	22.45	.648
CALC. LIN.	1	231.36	.102	B2	1	827.48	.010
THKNS LIN.	1	137.42	.202	D9	1	0.61	.940
SOLUM LIN.	1	312.96	.059	D11	1	30.06	.597
PH LIN.	1	203.84	.123	D13	0		
				D16	0		
				D17	0		
				E8	1	1228.60	.002
				E9	0		
				E12	0		
				E16	0		
				E17	0		
				F5	0		
				F6	0		
				F8	1	262.12	.127
				F9	1	313.43	.097
				F11	0		
				F12	0		
ERROR	25	80.10		ERROR	24	104.76	
R-SQUARE		0.83		R-SQUARE		0.78	
MEAN		83.24		MEAN		83.23	
C. V.		10.75		C. V.		12.30	

TABLE XI

PREDICTED INDEXES FOR GRAIN SORGHUM YIELDS USING TWO DIFFERENT REGRESSION EQUATIONS WITHOUT CALCIUM IN THE MODEL

			PROPERTIES MODEL			CLASSIFICATION MODEL		
SOIL SERIES	SAMP NO.	OBS. INDEX	PRED. INDEX	LOWER LIMIT	UPPER LIMIT	PRED. INDEX	LOWER LIMIT	UPPER LIMIT
SOIL SERIES	SAMP NO.	OBS. INDEX	PRED. INDEX	LOWER LIMIT	UPPER LIMIT	PRED. INDEX	LOWER LIMIT	UPPER LIMIT
ABILENE	1	95	87	57	117	89	64	113
ABILENE	2	73	76	46	106	76	51	101
CANADIAN	3		102	67	136	115	89	142
CAREY	4	86	90	60	120	101	77	124
CAREY	5	78	74	44	104	84	60	108
CAREY	6	65	54	23	86	63	38	88
COBB	7	86	87	57	117	80	57	103
COBB	8	73	70	40	100	63	40	86
DALHART	9	95	91	61	121	95	64	127
DALHART	10	78	80	50	110	80	57	103
DALHART	11	60	62	32	92	63	40	86
DILL	12	78	80	49	110	78	53	103
DILL	13	65	63	33	94	61	36	86
FOARD	14	69	89	59	120	69	38	101
NORSCOT	15	47	67	35	99	47	16	79
QUINLAN	16		64	32	96	59	34	84
REINACH	17		'1	71	131	147	119	176
STPAUL	18	17	122	92	152	124	101	147
STPAUL	19	8	109	79	140	111	88	135
STPAUL	20	69	93	62	124	94	71	118
MILES	21	95	98	68	129	92	69	116
MILES	22	78	87	57	117	80	57	103
MILES	23	60	73	43	103	63	40	86
STPAUL	24	17	120	90	151	124	101	147
STPAUL	25	08	109	79	140	111	88	135
CAREY	26		89	58	120	113	89	137
CAREY	27	86	79	48	109	101	77	124
CAREY	28		70	40	100	84	60	108
CAREY	29		52	21	83	63	38	88
TILLMAN	30	69	83	52	113	78	54	102
TILLMAN	31	56	72	41	102	65	41	90
GRANDFIELD	32	69	93	60	126	92	69	116
ENTERPRISE	33	108	134	99	168	112	86	137
MILES	34	95	87	56	117	92	69	116
MILES	35	78	76	46	106	80	57	103
MILES	36	60	60	30	90	63	40	86
MILES	37	52	40	9	71	42	18	66
MILES	38	95	90	59	120	92	69	116

TABLE XI CONTINUED

			PROPERTIES MODEL			CLASSIFICATION MODEL		
SOIL SERIES	SAMP NO.	OBS. INDEX	PRED. INDEX	LOWER LIMIT	UPPER LIMIT	PRED. INDEX	LOWER LIMIT	UPPER LIMIT
GRANDFIELD	39	95	102	72	133	92	69	116
HOLDREDGE	40	121	128	97	158	113	89	137
CARWILE	41		112	81	143	78	54	102
CARWILE	42		110	79	141	78	54	102
FARNUM	43	152	129	98	160	124	101	147
FARNUM	44	152	129	97	160	124	101	147
PRATT	45		101	69	133	99	70	128
PRATT	46		69	35	103	61	32	91
TILLMAN	47		88	58	118	78	54	102
MILES	48		94	64	124	92	69	116
MILES	50	60	65	35	95	59	35	82
TILLMAN	51		88	58	118	78	54	02
VERNON	74	34	65	32	98	41	15	66
YAHOLA	100	113	94	61	126	115	89	142
WEYMOUTH	101	56	80	49	110	58	33	84
WOODWARD	104	78	80	48	113	76	50	101
WOODWARD	105	60	66	33	98	59	34	84
ENTERPRIZE	128	95	90	61	120	99	74	124
ENTERPRIZE	129	78	76	46	106	82	57	107
HOLLISTER	144		69	37	101	106	78	134
LACASA	149	86	70	39	101	65	41	90
LAWTON	151	95	88	56	119	98	73	123
LAWTON	152	91	77	46	108	85	60	110
LAWTON	153	65	63	32	94	68	43	93
LINCOLN	154	86	88	51	125	86	55	118
MANGUM	155	86	59	23	95	86	55	118
PRATT	169	108	99	67	130	114	89	139
PRATT	170	104	88	57	119	101	76	126
SPUR	187	139	109	78	140	113	89	137
TIPTON	195	121	114	84	143	124	101	147
TIPTON	196	100	103	73	133	111	88	135
ZANEIS	301		78	48	108	101	77	124
WEYMOUTH	303		48	16	79	20	-5	47
WOODWARD	306		48	15	82	38	12	64
PORT	307		100	68	133	124	101	147
BERTHOOD	308		78	46	110	101	77	124
BROWNFIELD	309		82	50	114	78	50	105
BROWNFIELD	310		68	36	100	61	33	88
ZANEIS	311		64	33	94	84	60	108
CHICKASHA	312		108	77	139	113	89	137
ZAVALA	313		105	72	138	113	89	137
WINDTHORST	314		84	54	115	60	24	96
WINDTHORST	315		67	35	98	39	3	75
STAMFORD	316		82	47	117	115	89	142
MILLER	317		114	78	151	104	69	139

TABLE XI CONTINUED

			PROPERTIES MODEL			CLASSIFICATION MODEL		
SOIL SERIES	SAMP NO.	OBS. INDEX	PRED. INDEX	LOWER LIMIT	UPPER LIMIT	PRED. INDEX	LOWER LIMIT	UPPER LIMIT
EUFAULA	318		76	43	108	99	70	128
BRAZOS	319		106	73	138	115	89	142
CANADIAN	321		102	68	137	115	89	412
WAURIKA	322		75	43	108	96	68	124
FOARD	334		77	46	107	56	25	88
HARDEMAN	337		82	49	115	91	65	116
HARDEMAN	338		71	38	104	78	53	103
HARDEMAN	339		82	49	115	91	65	116
HINKLE	340		85	54	116	51	16	87
HOLISTER	345		58	26	90	94	66	122
LACASA	350		56	25	87	48	24	73
REINACH	351		101	71	131	147	119	176
VERNON	352		72	40	104	41	15	66
LELA	355		107	23	191	85	52	118
MANSIC	356		86	54	118	96	67	124
MANSIC	357		75	44	107	83	55	112
MANSIC	358		61	30	92	66	37	95
PRATT	374		85	51	118	84	60	109
QUINLAN	378		70	36	104	76	50	101
ROSCOE	380		119	78	161	96	67	124
SPRINGER	384		110	76	144	90	63	118
SPRINGER	385		99	66	133	78	50	105
SPRINGER	386		85	51	119	61	33	88
WAURIKA	388		86	55	116	96	68	124
VERNON	397		54	17	91	53	27	79
VERNON	398		43	6	81	41	15	66
VERNON	399		29	-8	67	24	-1	50
WANN	400		118	86	149	113	89	137
ACME	403		76	46	107	103	70	136
ACME	404		62	32	93	84	60	108
ACME	405		44	12	76	63	38	88
ALTUS	406		91	61	121	126	99	153
ALTUS	407		80	51	110	113	86	141
DEVOL	422		105	73	137	90	63	118
DEVOL	423		95	63	126	78	50	105
KONAWA	424		87	57	117	80	57	103
ELSMERE	426		92	60	123	113	89	137
LUCIEN	453		87	56	118	101	77	124
OTERO	467		67	35	99	78	53	103
OTERO	468		53	20	85	61	36	86
WEYMOUTH	502	43	65	35	96	41	16	67
ENTERPRIZE	530	73	58	27	90	61	36	87
PRATT	571	86	74	43	105	84	60	109
PRATT	572	65	56	24	88	63	38	89

TABLE XII

ANALYSIS OF VARIANCE FOR GRAIN SORGHUM YIELD INDEXES USING TWO DIFFERENT REGRESSION EQUATIONS WITHOUT CALCIUM IN THE MODEL

SOIL PROPERTIES MODEL				SOIL CLASSIFICATION MODEL			
SOURCE	DF	SEQUENTIAL MEAN SQ.	PROB F	SOURCE	DF	SEQUENTIAL MEAN SQ.	PROB F
SLOPE LIN.	1	13296.41	.000	SLOPE LIN	1	13296.41	.000
CLAY LIN.	1	2071.10	.003	A1	1	521.79	.044
SAND LIN.	1	1361.29	.013	B5	1	2283.71	.000
CLAY QUAD.	1	1691.31	.006	C5	0		
SNAD QUAD.	1	560.57	.106	C13	1	1379.25	.002
THKNS LIN.	1	5716.58	.000	B2	1	785.24	.015
SOLUM LIN.	1	10.82	.820	D9	1	1871.44	.000
PH LIN.	1	575.72	.102	D11	1	1.13	.924
				D13		166.33	.249
				D16	0		
				D17	1	1379.00	.002
				E8	1	5402.52	.000
				E9	0		
				E12	0		
				E16	0		
				E17	1	39.35	.573
				F5	0		
				F6	0		
				F8	1	232.12	.175
				F9	1	2454.41	.000
				F11	1	536.56	.042
				F12	0		
ERROR	51	206.98		ERROR	45	122.02	
R-SQUARE		0.71		R-SQUARE		0.85	
MEAN		85.36		MEAN		85.36	
C. V.		16.85		C. V.		12.94	

TABLE XIII

PREDICTED INDEXES FOR GRAIN SORGHUM YIELDS USING
TWO DIFFERENT REGRESSION EQUATIONS
WITH CALCIUM IN THE MODEL

			PROPERTIES MODEL			CLASSIFICATION MODEL		
SOIL SERIES	SAMP NO.	OBS. INDEX	PRED. INDEX	LOWER LIMIT	UPPER LIMIT	PRED. INDEX	LOWER LIMIT	UPPER LIMIT
SOIL SERIES	SAMP	OBS. INDEX	PRED. INDEX	LOWER LIMIT	UPPER LIMIT	PRED. INDEX	LOWER LIMIT	UPPER LIMIT
ABILENE	1		63	37	89	86	51	121
ABILENE	2		52	25	78	73	37	108
CANADIAN	3		85	57	113	115	70	159
CAREY	4	86	85	63	107	96	68	124
CAREY	5	78	70	48	91	79	51	107
CAREY	6	65	51	27	74	57	27	87
COBB	7	86	91	69	112	80	53	107
COBB	8	73	75	53	97	63	36	90
DALHART	9	95	93	71	114	95	59	131
DALHART	10	78	82	61	103	80	53	107
DALHART	11	60	66	44	87	63	36	90
DILL	12	78	69	46	91	80	48	111
DILL	13	65	53	31	75	63	31	94
FOARD	14	69	70	47	92	69	33	105
NOBSCOT	15	47	48	22	73	47	11	84
QUINLAN	16		53	27	78	57	15	99
REINACH	17		106	83	130	147	96	197
STPAUL	18	117	122	101	144	125	98	153
STPAUL	19	108	111	89	132	113	85	140
STPAUL	20	69	95	73	117	95	67	124
MILES	21		103	79	128	93	66	120
MILES	22		93	69	116	80	53	107
MILES	23		78	55	101	63	36	90
STPAUL	24	117	119	98	141	125	98	153
STPAUL	25	108	108	87	130	113	85	140
CAREY	26		95	70	120	109	80	138
CAREY	27	86	84	60	108	96	68	124
CAREY	28		72	49	94	79	51	107
CAREY	29		54	30	77	57	27	87
TILLMAN	30	69	66	42	89	69	38	100
TILLMAN	31	56	55	31	78	56	25	88
GRANDFIELD	32	69	79	52	105	93	66	120
ENTERPRIZE	33	108	114	86	142	108	72	144
MILES	34	95	92	70	114	93	66	120
MILES	35	78	81	60	102	80	53	107
MILES	36	60	66	44	87	63	36	90
MILES	37	52	46	24	69	41	12	70
MILES	38	95	93	71	115	93	66	120

TABLE XIII CONTINUED

			PROPERTIES MODEL			CLASSIFICATION MODEL		
SOIL SERIES	SAMP NO.	OBS. INDEX	PRED. INDEX	LOWER LIMIT	UPPER LIMIT	PRED. INDEX	LOWER LIMIT	UPPER LIMIT
GRANDFIELD	39	95	97	72	121	93	66	120
HOLDREDGE	40	121	122	100	145	109	80	138
CARWILE	41		99	77	122	69	38	100
CARWILE	42		99	76	122	69	38	100
FARNUM	43	152	132	109	154	125	98	153
FARNUM	44	152	138	113	162	125	98	153
PRATT	45		68	36	99	74	28	121
PRATT	46		35	-0	70	36	-11	83
TILLMAN	47		76	52	100	69	38	100
MILES	48		98	76	119	93	66	120
MILES	49	78	87	66	108	80	53	107
MILES	50	60	68	47	90	59	31	86
TILLMAN	51		76	52	100	69	38	100
VERNON	74	34	37	10	63	34	-1	71
YAHOLA	100		85	59	111	115	70	159
WEYMOUTH	101		73	46	100	74	32	116
WOODWARD	104		67	35	99	74	32	116
WOODWARD	105		53	21	84	57	15	99
ENTERPRIZE	128		108	66	149	95	59	132
ENTERPRIZE	129		93	53	134	78	40	116
HOLLISTER	144		28	0	56	86	51	121
LACASA	149		43	12	73	56	25	88
LAWTON	151		90	64	116	75	19	130
LAWTON	152		79	54	104	62	6	118
LAWTON	153		65	40	89	45	-11	101
LINCOLN	154		50	59	94	87	44	130
MANGUM	155		-26	-78	25	69	38	100
PRATT	169		80	55	106	93	66	120
PRATT	170		69	44	95	80	53	107
SPUR	187		91	65	117	109	80	138
TIPTON	195		108	86	130	125	98	153
TIPTON	196		97	75	119	113	85	140
ZANEIS	301		81	58	104	96	68	124
WEYMOUTH	303		40	12	67	35	-6	78
WOODWARD	306		35	3	67	35	-6	78
PORT	307		91	62	120	125	98	153
BERTHOUD	308		72	47	98	96	68	124
BROWNFIE	309		102	73	131	74	28	121
BROWNFIE	310		87	59	115	57	11	104
ZANEIS	311		66	43	89	79	51	107
CHICKASHA	312		126	97	154	109	80	138
ZAVALA	313		71	40	102	109	80	138
WINDTHORST	314		92	67	116	34	-6	76
WINDTHORST	315		73	48	99	13	-28	55
STAMFORD	316		39	-1	79	115	70	159
MILLER	317		88	49	127	109	80	138

TABLE XIII CONTINUED

			PROPERTIES MODEL			CLASSIFICATION MODEL		
SOIL SERIES	SAMP NO.	OBS. INDEX	PRED. INDEX	LOWER LIMIT	UPPER LIMIT	PRED. INDEX	LOWER LIMIT	UPPER LIMIT
EUFAULA	318		52	25	79	74	28	121
BRAZOS	319		72	42	102	115	70	159
CANADIAN	321		86	58	115	115	70	159
WAURIKA	322		25	-9	60	69	38	100
FOARD	334		58	35	81	56	20	93
HARDEMAN	337		82	52	111	93	61	125
HARDEMAN	338		71	43	99	80	48	111
HARDEMAN	339		56	30	82	63	31	94
HINKLE	340		72	47	96	29	-12	72
HOLLISTER	345		17	-10	45	73	37	108
LACASA	350		28	-2	59	39	7	71
REINACH	351		106	83	130	147	96	197
VERNON	352		79	49	109	34	-1	71
LELA	355		-120	-217	-22	69	38	100
MANSIC	356		89	60	118	109	80	138
MANSIC	357		78	51	105	96	68	124
MANSIC	358		63	37	89	79	51	107
PRATT	374		48	12	84	63	36	90
QUINLAN	378		66	36	95	74	32	116
ROSCOE	380		60	3	117	109	80	138
SPRINGER	384		91	56	126	87	40	134
SPRINGER	385		80	45	116	74	28	121
SPRINGER	386		65	29	102	57	11	104
WAURIKA	388		65	41	88	69	38	100
VERNON	397		-27	-75	19	47	11	84
VERNON	398		-38	-87	9	34	-1	71
VERNON	399		-53	-103	-2	17	-19	54
WANN	400		106	80	133	109	80	138
ACME	403		70	44	96	98	59	137
ACME	404		55	29	81	79	51	107
ACME	405		37	9	65	57	27	87
ALTUS	406		97	74	120	131	84	178
ALTUS	407		86	64	108	118	71	165
DEVOL	422		91	67	115	87	40	134
DEVOL	423		80	57	104	74	28	121
KONAWA	424		101	76	126	80	53	107
ELSMERE	426		62	34	91	109	80	134
LUCIEN	452		99	71	127	96	68	124
OTERO	467		44	15	73	80	48	111
OTERO	468		29	1	58	63	31	94
WEYMOUTH	502		58	31	85	57	15	99
ENTERPRIZE	530		75	34	115	57	16	97
PRATT	571		55	29	81	63	36	90
PRATT	572		37	9	64	41	12	70

TABLE XIV

ANALYSIS OF VARIANCE FOR GRAIN SORGHUM YIELD INDEXES USING TWO DIFFERENT REGRESSION EQUATIONS WITH CALCIUM IN THE MODEL

SOIL PROPERTIES MODEL				SOIL CLASSIFICATION MODEL			
SOURCE	DF	SEQUENTIAL MEAN SQ.	PROB F	SOURCE	DF	SEQUENTIAL MEAN SQ.	PROB F
SLOPE LIN.	1	8421.95	.000	SLOPE LIN.	1	8421.95	.000
CLAY LIN.	1	992.23	.004	A1	1	1220.49	.010
SAND LIN.	1	1431.25	.001	B5	1	1735.76	.003
CLAY QUAD.	1	6582.18	.001	C5	0		
SAND QUAD.	1	69.40	.736	C13	1	1695.43	.003
CALC. LIN.	1	138.73	.237	B2	1	539.95	.073
THKNS LIN.	1	3705.33	.000	D9	1	2808.46	.000
SOLUM LIN.	1	0.00	.999	D11	1	14.70	.760
PH LIN.	1	638.81	.016	D13	0		
				D16	0		
				D17	0		
				E8	1	4077.63	.000
				E9	0		
				E12	0		
				E16	0		
				E17	0		
				F5	0		
				F6	0		
				F8	1	45.25	.592
				F9	1	158.30	.320
				F11	0		
				F12	0		
ERROR	24	94.31		ERROR	23	153.28	
R-SQUARE		0.91		R-SQUARE		0.85	
MEAN		84.65		MEAN		84.65	
C. V.		11.47		C. V.		14.62	

TABLE XV

PREDICTED INDEXES FOR COTTON LINT YIELDS USING TWO DIFFERENT REGRESSION EQUATIONS WITHOUT CALCIUM IN THE MODEL

			PROPERTIES MODEL			CLASSIFICATION MODEL		
SOIL SERIES	SAMP NO.	OBS. INDEX	PRED. INDEX	LOWER LIMIT	UPPER LIMIT	PRED. INDEX	LOWER LIMIT	UPPER LIMIT
SOIL SERIES	SAMP	OBS. INDEX	PRED. INDEX	LOWER LIMIT	UPPER LIMIT	PRED. INDEX	LOWER LIMIT	UPPER LIMIT
ABILENE	1	94	87	47	127	93	59	127
ABILENE	2	88	78	38	118	82	48	116
CANADIAN	3		96	49	142	129	92	166
CAREY	4	64	80	40	120	77	45	110
CAREY	5	50	67	27	108	62	29	95
CAREY	6		52	9	95	44	9	79
COBB	7	86	69	29	109	70	39	101
COBB	8	60	56	16	96	55	23	86
DALHART	9	80	92	52	132	80	37	122
DALHART	10	70	83	43	123	70	39	101
DALHART	11	50	70	30	110	55	23	86
DILL	12	80	67	26	107	85	50	119
DILL	13	68	54	13	95	70	35	105
FOARD	14	70	92	51	133	70	27	112
NOBSCOT	15	30	36	-7	79	30	-12	72
QUINLAN	16		54	11	97	29	-5	64
REINACH	17		92	52	132	165	125	204
STPAUL	18	100	97	57	137	97	65	128
STPAUL	19	70	87	47	128	85	54	117
STPAUL	20	40	75	34	116	71	38	103
MILES	21	80	78	38	119	81	49	112
MILES	22	70	70	30	110	70	39	101
MILES	23	50	58	17	98	55	23	86
STPAUL	24	100	99	58	139	97	65	128
STPAUL	25	70	90	49	130	85	54	117
CAREY	26		89	47	130	88	56	121
CAREY	27	64	80	39	120	77	45	110
CAREY	28		70	30	110	62	29	95
CAREY	29		55	13	98	44	9	79
TILLMAN	30	80	79	38	120	85	52	118
TILLMAN	31	50	70	30	111	74	41	107
GRANDFIELD	32	40	84	40	127	81	49	112
ENTERPRIZE	33	100	106	60	151	123	89	158
MILES	34	80	84	44	125	81	49	112
MILES	35	80	76	36	115	70	39	101
MILES	36	70	63	23	103	55	23	86
MILES	37	50	48	6	89	36	3	70
MILES	38	80	89	49	130	81	49	112

TABLE XV CONTINUED

			PROPERTIES MODEL			CLASSIFICATION MODEL		
SOIL SERIES	SAMP NO.	OBS. INDEX	PRED. INDEX	LOWER LIMIT	UPPER LIMIT	PRED. INDEX	LOWER LIMIT	UPPER LIMIT
GRANDFIELD	39	80	93	52	134	81	49	112
HOLDREDGE	40	108	103	62	143	88	56	121
CARWILE	41		102	61	143	85	52	118
CARWILE	42		104	62	146	85	52	118
FRANUM	43	110	104	64	145	97	65	128
FRANUM	44	110	109	67	151	97	65	128
PRATT	45		64	20	108	28	-14	71
PRATT	46		38	-10	87	4	-49	39
TILLMAN	47		79	39	120	85	52	118
MILES	48		85	45	125	81	49	112
MILES	49	70	76	37	116	70	39	101
MILES	50	50	62	22	101	51	19	83
TILLMAN	51		79	39	120	85	52	118
VERNON	74		91	45	137	40	3	78
YAHOLA	100	126	79	36	122	129	92	166
WEYMOUTH	101	80	75	34	116	68	31	104
WOODWARD	104	50	58	14	102	44	8	79
WOODWARD	105	20	46	2	90	29	-5	64
ENTERPRIZE	128	132	84	45	123	112	78	146
ENTERPRIZE	129	96	72	32	112	97	64	131
HOLLISTER	144		86	43	129	69	29	109
LACASA	149	86	73	31	114	74	41	107
LAWTON	151	100	91	50	133	102	68	136
LAWTON	152	90	82	41	124	91	57	125
LAWTON	153	92	71	29	112	76	42	110
LINCOLN	154	40	43	-6	93	40	-2	82
MANGUM	155	80	80	31	129	80	37	122
PRATT	169	80	67	25	109	80	43	117
PRATT	170	70	58	16	100	69	32	106
SPUR	187	120	90	50	131	88	56	121
TIPTON	195	108	96	57	136	97	65	128
TIPTON	196	100	87	48	127	85	54	117
ZANEIS	301		89	48	129	77	45	110
WEYMOUTH	303		48	5	91	34	-3	73
WOODWARD	306		31	-14	77	11	-25	47
PORT	307		70	26	114	97	65	128
BERTHOUD	308		78	35	121	77	45	110
BROWNFIELD	309		82	39	124	29	-8	66
BROWNFIELD	310		70	27	112	14	-23	52
ZANEIS	311		77	36	118	62	29	95
CHICKASHA	312		96	55	138	88	56	121
ZAVALA	313		67	22	112	88	56	121
WINDTHORST	314		89	48	130	1	-51	54
WINDTHORST	315		74	32	116	16	-69	35
STAMFORD	316		104	57	151	129	92	166
MILLER	317		103	55	151	107	57	156

TABLE XV CONTINUED

			PROPERTIES MODEL			CLASSIFICATION MODEL		
SOIL SERIES	SAMP NO.	OBS. INDEX	PRED. INDEX	LOWER LIMIT	UPPER LIMIT	PRED. INDEX	LOWER LIMIT	UPPER LIMIT
EUFAULA	318		39	-3	83	28	-14	71
BRAZOS	319		70	26	114	129	92	166
CANADIAN	321		96	49	143	129	92	166
WAURIKA	322		91	58	135	61	21	101
FOARD	334		82	41	123	58	16	101
HARDEMAN	337		84	40	129	96	61	131
HARDEMAN	338		75	31	119	85	50	119
HARDEMAN	339		63	19	107	70	35	105
HINKLE	340		88	46	130	42	-6	92
HOLLISTER	345		77	34	121	58	18	98
LACASA	350		61	19	103	59	25	93
REINACH	351		92	52	132	165	125	204
VERNON	352		70	28	113	40	3	78
LELA	355		107	23	191	85	52	118
MANSIC	356		84	41	126	112	72	153
MANSIC	357		75	32	116	101	60	142
MANSIC	358		63	21	105	86	44	128
PRATT	374		42	-4	89	54	16	92
QUINLAN	378		67	22	112	44	8	79
ROSCOE	380		117	61	173	112	72	153
SPRINGER	384		77	32	123	40	1	78
SPRINGER	385		68	23	114	29	-8	66
SPRINGER	386		57	10	103	14	-23	52
WAURIKA	388		89	49	130	61	21	101
VERNON	397		88	36	140	51	13	90
VERNON	398		79	27	132	40	3	78
VERNON	399		68	13	122	26	-11	63
WANN	400		97	55	139	88	56	121
ACME	403		76	36	117	76	31	121
ACME	404		65	24	105	62	29	95
ACME	405		50	6	93	44	9	79
ALTUD	406		91	51	132	138	99	176
ALTUD	407		82	43	122	126	88	165
DEVOL	422		92	49	136	40	1	78
DEVOL	423		83	40	127	29	-8	66
KONAWA	424		81	41	121	70	39	101
ELSMERE	426		63	20	105	88	56	121
LUCIEN	453		85	44	126	77	45	110
OTERO	467		51	7	94	85	50	119
OTERO	468		39	-4	83	70	35	105
WEYMOUTH	502		63	22	104	53	16	90
ENTERPRIZE	530	86	57	15	100	79	44	114
PRATT	571		46	4	89	54	26	92
PRATT	572		31	-13	77	36	-3	76

TABLE XVI

ANALYSIS OF VARIANCE FOR COTTON LINT YIELD INDEXES USING TWO DIFFERENT REGRESSION EQUATIONS WITHOUT CALCIUM IN THE MODEL

SOIL PROPERTIES MODEL				SOIL CLASSIFICATION MODEL			
SOURCE	DF	SEQUENTIAL MEAN SQ.	PROB F	SOURCE	DF	SEQUENTIAL MEAN SQ.	PROB F
SLOPE LIN.	1	6594.95	.000	SLOPE LIN.	1	6594.95	.000
CLAY LIN.	1	870.89	.128	A1	1	2574.69	.002
SAND LIN.	1	753.98	.156	B5	1	91.87	.524
CLAY QUAD.	1	1508.16	.047	C5	0		
SAND QUAD.	1	3691.69	.003	C13	1	538.01	.128
THKNS LIN.	1	878.64	.126	B2	1	1066.41	.034
SOLUM LIN.	1	61.61	.682	D9	1	57.00	.615
PH LIN.	1	268.81	.394	D11	1	1.89	.927
				D13	1	160.07	.401
				D16	0		
				D17	1	1.47	.936
				E8	1	30.06	.715
				E9	0		
				E12	0		
				E16	0		
				E17	1	2799.20	.001
				F5	0		
				F6	0		
				F8	1	841.66	.059
				F9	1	6871.23	.000
				F11	1	775.99	.069
				F12	0		
ERROR		362.24		ERROR	40	222.19	
R-SQUARE		0.47		R-SQUARE		0.72	
MEAN		77.24		MEAN		77.24	
C. V.		24.64		C. V.		19.30	

TABLE XVII

PREDICTED INDEXES FOR COTTON LINT YIELDS USING TWO DIFFERENT REGRESSION EQUATIONS WITH CALCIUM IN THE MODEL

			PROPERTIES MODEL			CLASSIFICATION MODEL		
SOIL SERIES	SAMP NO.	OBS. INDEX	PRED. INDEX	LOWER LIMIT	UPPER LIMIT	PRED. INDEX	LOWER LIMIT	UPPER LIMIT
ABILENE	1		60	26	94	79	36	123
ABILENE	2		49	14	84	67	23	111
CANADIAN	3		51	14	88	78	23	133
CAREY	4	64	63	35	91	72	37	107
CAREY	5	50	47	18	75	56	20	92
CAREY	6		26	-4	58	36	-3	75
COBB	7	86	81	53	109	70	38	103
COBB	8	60	65	37	93	54	21	88
DALHART	9	80	88	60	116	80	35	124
DALHART	10	70	77	49	104	70	38	103
DALHART	11	50	59	31	88	54	21	88
DILL	12	80	64	35	92	82	43	121
DILL	13	68	47	18	76	65	26	104
FOARD	14	70	68	36	100	70	25	114
NOBSCOT	15	30	43	10	75	30	-14	74
QUINLAN	16		55	21	89	71	24	118
REINACH	17		80	50	109	93	59	127
STPAUL	18	100	88	60	116	93	59	127
STPAUL	19	70	75	48	103	81	47	115
STPAUL	20	40	59	31	88	64	29	100
MILES	21		101	69	132	83	49	116
MILES	22		89	59	119	70	38	103
MILES	23		74	45	103	54	21	88
STPAUL	24	100	95	67	123	93	59	127
STPAUL	25	70	84	56	111	81	47	115
CAREY	26		82	50	114	84	48	120
CAREY	27	64	70	40	100	72	37	107
CAREY	28		59	30	88	56	20	92
CAREY	29		40	8	71	36	-3	75
TILLMAN	30	80	65	35	95	71	32	109
TILLMAN	31	50	53	23	83	58	20	97
GRANDFIELD	32	40	52	18	85	83	49	116
ENTERPRIZE	33	100	107	71	142	100	55	144
MILES	34	80	86	58	115	83	49	116
MILES	35	80	75	48	102	70	38	103
MILES	36	70	59	31	86	54	21	88
MILES	37	50	38	8	68	34	-1	71
MILES	38	80	78	50	106	83	49	116

TABLE XVII CONTINUED

			PROPERTIES MODEL			CLASSIFICATION MODEL		
SOIL SERIES	SAMP NO.	OBS. INDEX	PRED. INDEX	LOWER LIMIT	UPPER LIMIT	PRED. INDEX	LOWER LIMIT	UPPER LIMIT
GRANDFIELD	39	80	93	62	124	83	49	116
HOLDREDGE	40	108	93	64	122	84	48	120
CARWILE	41		94	64	125	71	32	109
CARWILE	42		86	53	118	71	32	109
FARNUM	43	110	95	67	124	93	59	127
FARNUM	44	110	104	73	136	93	59	127
PRATT	45		68	28	109	76	25	128
PRATT	46		34	-12	81	40	-16	97
TILLMAN	47		76	45	106	71	32	109
MILES	48		83	55	111	83	49	116
MILES	49	70	71	45	98	70	38	103
MILES	50	50	52	25	80	50	16	84
TILLMAN	51		76	45	106	71	32	109
VERNON	74		53	3	103	74	20	127
YAHOLA	100		55	21	89	78	23	133
WEYMOUTH	101		76	42	110	87	42	133
WOODWARD	104		63	21	105	87	42	133
WOODWARD	105		48	6	89	71	24	118
ENTERPRIZE	128		101	48	154	87	42	133
ENTERPRIZE	129		86	34	138	71	24	118
HOLLISTER	144		46	1	91	79	36	123
LACASA	149		61	21	101	58	20	97
LAWTON	151		76	41	110	65	8	121
LAWTON	152		64	31	98	53	-2	108
LAWTON	153		49	16	83	36	-17	91
LINCOLN	154		31	-29	93	100	55	144
MANGUM	155		23	-55	102	71	32	109
PRATT	169		81	48	114	83	49	116
PRATT	170		70	38	102	70	38	103
SPUR	187		69	35	102	84	48	120
TIPTON	195		87	58	115	93	59	127
TIPTON	196		75	47	103	81	47	115
ZANEIS	301		79	46	112	72	37	107
WEYMOUTH	303		42	5	78	51	0	102
WOODWARD	306		29	-13	71	51	0	102
PORT	307		70	30	109	93	59	127
BERTHOUD	308		69	36	102	72	37	107
BROWNFIELD	309		69	32	106	76	25	128
BROWNFIELD	310		53	17	90	60	7	113
ZANEIS	311		64	30	97	56	20	92
CHICKASHA	312		108	70	145	84	48	120
ZAVALA	313		87	47	127	84	48	120
WINDTHORST	314		86	52	120	63	4	122
WINDTHORST	315		67	31	103	42	-18	104
STAMFORD	316		73	12	134	78	23	133
MILLER	317		109	58	160	84	48	120

TABLE XVII CONTINUED

			PROPERTIES MODEL			CLASSIFICATION MODEL		
SOIL SERIES	SAMP NO.	OBS. INDEX	PRED. INDEX	LOWER LIMIT	UPPER LIMIT	PRED. INDEX	LOWER LIMIT	UPPER LIMIT
EUFAULA	318		46	11	80	76	25	128
BRAZOS	319		85	47	124	78	23	133
CANADIAN	321		51	14	88	78	23	133
WAURIKA	322		56	3	108	71	32	109
FOARD	334		55	22	88	57	12	103
HARDEMAN	337		71	34	109	94	54	134
HARDEMAN	338		60	24	96	82	43	121
HARDEMAN	339		36	3	70	65	26	104
HINKLE	340		72	38	107	56	3	109
HOLLISTER	345		35	-11	81	67	23	111
LACASA	350		46	4	87	42	2	83
REINACH	351		80	50	109	93	59	127
VERNON	352		98	59	136	74	20	127
LELA	355		-40	-199	118	71	32	109
MANSIC	356		78	42	115	84	48	120
MANSIC	357		67	32	102	72	37	107
MANSIC	358		52	19	85	56	20	92
PRATT	374		56	10	102	54	21	88
QUINLAN	378		46	8	84	87	42	133
ROSCOE	380		96	15	177	84	48	120
SPRINGER	384		105	60	150	88	37	139
SPRINGER	385		93	48	138	76	25	128
SPRINGER	386		78	31	124	60	7	113
WAURIKA	388		75	42	107	71	32	109
VERNON	397		30	-48	109	86	33	139
VERNON	398		19	-61	100	74	20	127
VERNON	399		4	-80	88	58	2	113
WANN	400		99	66	132	84	48	120
ACME	403		79	46	113	69	20	118
ACME	404		64	31	97	56	20	92
ACME	405		48	10	85	36	-3	75
ALTUS	406		88	58	117	87	34	140
ALTUS	407		76	48	104	75	23	127
DEVOL	422		74	42	106	88	37	139
DEVOL	423		62	30	94	76	25	128
KONAWA	424		81	49	113	70	38	103
ELSMERE	426		76	40	112	84	48	120
LUCIEN	453		94	58	130	72	37	107
OTERO	467		67	30	105	82	43	121
OTERO	468		52	16	89	65	26	104
WEYMOUTH	502		61	27	95	71	24	118
ENTERPRIZE	530		67	15	118	51	0	102
PRATT	571		55	22	88	54	21	88
PRATT	572		36	-0	72	34	-1	71

TABLE XVIII

ANALYSIS OF VARIANCE FOR COTTON LINT YIELD INDEXES USING TWO DIFFERENT REGRESSION EQUATIONS WITH CALCIUM IN THE MODEL

SOIL PROPERTIES MODEL				SOIL CLASSIFICATION MODEL			
SOURCE	DF	SEQUENTIAL MEAN SQ.	PROB F	SOURCE	DF	SEQUENTIAL MEAN SQ.	PROB F
SLOPE LIN.	1	5846.98	.000	SLOPE LIN.	1	5846.98	.000
CLAY LIN.	1	20.23	.718	A1	1	382.43	.213
SAND LIN.	1	0.02	.990	B5	1	256.07	.306
CLAY QUAD.	1	1937.87	.002	C5	0		
SAND QUAD.	1	113.51	.395	C13	1	281.02	.285
CALC. LIN.	1	1051.03	.015	B2	1	988.41	.052
THKNS LIN.	1	1075.19	.014	D9	1	556.69	.137
SOLUM LIN.	1	351.06	.142	D11	1	7.50	.859
PH LIN.	1	5.57	.849	D13	0		
				D16	0		
				D17	0		
				E8	1	246.60	.315
				E9	0		
				E12	0		
				E16	0		
				E17	0		
				F5	0		
				F6	0		
				F8	1	20.90	.768
				F9	0		
				F11	0		
				F12	0		
ERROR	22	150.97		ERROR	22	233.47	
R-SQUARE		0.76		R-SQUARE		0.63	
MEAN		72.19		MEAN		72.19	
C. V.		17.02		C. V.		21.17	

APPENDIX B

INDEX RATINGS FOR CORN

A SYSTEM FOR RATING SOILS FOR POTENTIAL CORN PRODUCTION

Methods and Procedures of Committee VII System for Rating Soils for Potential Corn Production

A system of rating soils for corn was prepared by the Southern Regional Work-Planning Conference (9). The rating system consists of three sections designated as A, B, and C (Table XIII). Section A refers to soil characteristics to be evaluated for corn index values. Section B evaluates development difficulties and problems associated with land development for the production of corn. Section C is related to maintenance of the land under corn production. Sections B and C are directly related to economics.

Limited amounts of corn are grown in Oklahoma and, as a result, data is insufficient to scrutinize the functions designed in the system. The system was developed by using yield values listed in soil series published by the Soil Survey Staff, USDA, Soil Conservation Service. Soils having the highest yield values were rated as 100 percent and by a process of evaluating yields, penalty points were derived in the various sections of the program (Table XIII).

The only method of testing the system in Oklahoma was to select several series descriptions where corn yields were available and to compute penalty points to determine the confidence of published yield values to the computed values. Corn yields are available for several series descriptions published by the USDA, Soil Conservation Service, for the Cherokee Prairies Resource Area of Northeastern Oklahoma. The Committee VII system of rating soils for potential production of corn was evaluated on some soils occurring in this region. The Cherokee Prairie Resource Area in Oklahoma includes Craig, Nowata, Washington, Rogers, Wagoner, Muskogee and parts of Ottawa, Mays, Tulsa, and Okmulgee counties. The average rainfall is about 40 to 42 inches annually across these counties.

The index values were taken from the system of rating soils for potential corn production (Table XIII). Soil values for potential production of corn and corn yields as listed in published soil series by the USDA, Soil Conservation Service are listed in Table XIV.

TABLE XIX

A SYSTEM FOR RATING SOILS FOR POTENTIAL CORN PRODUCTION

Subsystem	Penalty points	Weighting factor
A. Soil Characteristic		
1. Available water capacity in upper 40 inches		
More than 5 inchs	0	1
4 to 5 inches	1	3
2 to 4 inches	3	3
Less than 2 inches	5	3
2. Coarse fragments in the upper 10 inches		
Less than 2 percent	0	
2 to 15 percent	1	3
15 to 35 percent	3	3
More than 35 percent	5	3
3. Depth to restrictive layer		
3.1 Depth to bedrock, hardpan, or petrocalcic horizon		
More than 40 inches	0	
20 to 40 inches	1	5
10 to 20 inches	5	5
Less than 10 inches	12	5
3.2 Depth to fragipan		
More than 40 inches	0	
30 to 40 inches	1	3
20 to 30 inches	2	3
4. Exchange capacity of upper 20 inches (per 100 grams of soil)		
More than 7 m.e.	0	
3 to 7 m.e.	1	1
1 to 2.9 m.e.	3	1
Less than 1 m.e.	5	1
5. Mineral reserves as weatherable minerals in the 0.2-2mm fraction of the control section		
More than 20 percent	0	
10 to 20 percent	1	1
Less than 10 percent	2	1

TABLE XIX "CONTINUED"

Subsystem	Penalty points	Weighting factor
A. Soil Characteristics		
6. Organic matter content in the upper 10 inches		
More than 1 percent	0	
0.5 to 1 percent	1	2
Less than 0.5 percent	2	2
7. Soil loss		
Less than 3 tons per year	0	
3 to 6 tons per year	1	5
6 to 10 tons per year	3	5
More than 10 tons per year	5	5
8. Soil moisture regime*		
Udic - less than 2 inches growing season moisture deficit	0	
Udic - 2 to 4 inches growing season moisture deficit	1	10
Udic - 4 to 6 inches growing season moisture deficit	2	10
Udic ustic soil moisture regime	5	10
Typic ustic soil moisture regime	7	10
Aridic ustic soil moisture regime	9	10
9. Soil permeability		
See figure 3 on page 111.		
10. Soil reaction		
5.6 to 7.3	0	
4.5 to 5.6	1	1
Less than 4.5	2	1
7.3 to 8.4	1	1
8.4 to 9.0	5	2
More than 9.1	9	2
11. Soluble salts		
Less than 2 mmhos/cm conductivity	0	
2 to 3.9 mmhos/cm conductivity	2	5
4 to 7.9 mmhos/cm conductivity	8	5
8 to 16 mmhos/cm conductivity	12	5

TABLE XIX "CONTINUED"

Subsystem	Penalty points	Weighting factor
A. Soil Characteristic		
12. Soil slope		
A 0 to 1%	0	
B 1 to 3%	1	5
C 3 to 5%	2	5
D 5 to 8%	4	5
E 8 to 12%	6	5
F 12+	10	5
13. Flooding		
None	0	
Moderate hazards, yield reduced less than 10 percent	1	10
Severe, yields reduced 10 to 30 percent	2	10
Very severe, yields reduced 30 to 50 percent	4	10
Extremely severe, yields reduced more than 50 percent	6	10
14. Wetness - Continuing problems of excess water		
Little or no continuing limitations, yields not restricted	0	
Slight limitations, yields slightly limited	1	10
Moderate limitations, yields moderately limited	2	10
Severe limitations, yields severely limited	4	10
Very severe limitations, yields very severely limited	6	10
B. Development difficulty		
1. Irrigation		
1.1. Leaching soluble salts	1	3
1.2. Land leveling		
1.21. Minor amount	1	5
1.22. Moderate amount	2	5
1.23. Major amount	3	5
2. Drainage		
2.1. Surface	1	5
2.2. Tile	2	5

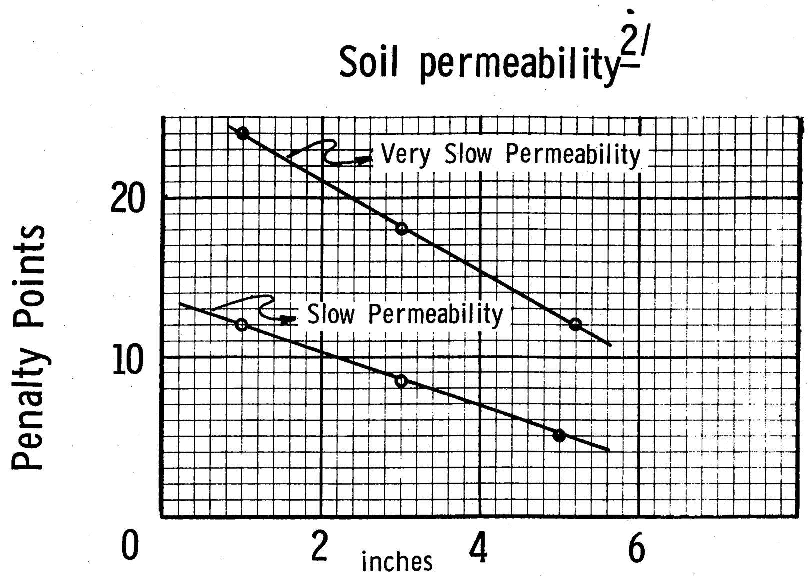
TABLE XIX "CONTINUED"

Subsystem	Penalty points	Weighting factor
B. Development difficulty		
3. Terrace system	1	2
4. Forest - Stump clearing, root plowing, and smoothing	1	5
5. Stones - clearing		
Classes of stoniness (46)		
0	0	5
1	2	5
2	4	5
3	5	5
4	6	5
5	8	5
6. Gullies		
None	0	
Common	1	5
Many	3	4
C. Maintenance		
1. Irrigation		
1.1. Water cost - supplemental	1	1
1.2. Water cost - total		
Low cost	2	1
Medium cost	3	1
High cost	4	1
2. Drainage		
2.1. Surface	1	1
2.2. Tile	1	1
3. Terrace system	1	1
4. Fertilization		
Low amount	0	
Medium amount	1	1
High amount	2	1

TABLE XIX "CONTINUED"

Subsystem	Penalty points	Weighting factor
5. Lime requirement		
None required	0	0
Application required	1	1

*Not used if the land is irrigated. Use permeability for soils not penalized for having a wetness factor. Do not use both permeability and wetness factors.



2/ Use permeability for soils not penalized for having a wetness factor. Do not use both permeability and wetness factors.

Figure 3. Growing season moisture deficit

Results and Discussion of the System for Rating Soils for Potential Corn Production

The system has potential for maintaining uniformity in yield values. There are a number of limitations in conducting analyses in this program. One of the major ones is the vague and undefined terminology used in some sections. For example, what are the definitions among the different levels of fertilization? Construction and maintenance values have similar numbers. Some of the practices in the B and C sections have the same values for seemingly wide ranges of conditions.

The value used for average moisture deficit was 3.4 inches. The method of evaluating permeability and seasonal moisture deficit is an excellent method for deriving values for the clay textures of a soil. In the Central Rolling Red Plains Resource study, it was difficult to isolate values associated with clayey soils. Vertic properties and fine textures in the control section tended to fall in one variable.

Yield values and index values do not have the same percentage of variation. Values for the Hartsells series are lower than those for the Dennis series, but yield values are the opposite (Table XX). Predicted corn yield values derived using this method and yield values listed within the published series descriptions by the USDA Soil Conservation Service were compared by computing a linear correlation coefficient. The comparison estimated a coefficient of 0.5 which indicates a sizable correlation between the two sets of data. However, if $r = 0.5$, $r^2 = 0.25$, only 25% of the corn yield variation actually observed is accounted for by this system for rating soils for potential corn production.

TABLE XX

RATING OF CORN PRODUCTION ON SOILS IN THE CHEROKEE PRAIRIES RESOURCE AREA OF OKLAHOMA

	Soil series, sections, and penalty references A	B	C	Total product (Penalty points X weighting factor)	Index	Corn Yield
	Choteau series					
	12,8,9	1.2,3	1,4			
Slopes						
A	18	5	7	30	70	65
B	23	17	8	48	52	50
C	28	17	8	53	47	45
	Dennis series					
	8,9,10,12	1.2,3	1,3,4,5			
A′	19	5	7	31	69	60
B	24	17	8	49	51	60
C	29	17	8	54	46	55
	Eram series					
	3.1,8,9,12	1.2,3	1.2,3			
B	28	17	8	53	47	50
C	33	17	8	58	42	40
D	43	17	8	68	32	—
	Verdigris series					
	8,13	1.2	1,4,5			
A	20	5	6	31	69	85

TABLE XX "CONTINUED"

	Soil series sections, and penalty references A	B	C	Total product (Penalty points X weighting factor)	Index	Corn Yield*
	Hartsells series					
	3.1,4,5,6	1.3	1,2,3,4,5			
Slopes						
A	20	5	8	33	67	—
B	25	17	8	50	50	90
C	30	17	8	55	45	—
D	40	17	8	65	35	80

*Corn yields established series description USDA Soil Conservation Service, State Office, Stillwater, Oklahoma.

APPENDIX C

INDEX INTERVAL RATINGS AND MAPS

TABLE XXI

SOIL ASSOCIATION GROUPING OF SOILS IN THE CENTRAL ROLLING RED PLAINS RESOURCE AREA

Group 1	Group 2	Group 3	Group 4	Group 5
Abilene	Vernon	Cobb	Brownfield	Acme
Altus	Waurika	Quinlan	Hardeman	La Casa
Devol			Miles	Quanah
Foard			Nobscot	Weymouth
Grandfield			Springer	
Hinkle				
Hollister				
Indiahoma				
Lawton				
Roscoe				
Ruella				
Tillman				
Vernon				

Group 6	Group 7	Group 8	Group 9	Group 10
Dill	Norwood	Carey	Quinlan	Carwile
Enterprise	Sput	St. Paul	Woodward	Meno
Kenesaw				Pratt
Lela				
Mangum				
Miller				
Tipton				

Group 11	Group 12	Group 13	Group 14
Dalhart	Berthoud	Elsmere	Chickasha
Farnum	Mansic	Lincoln	Konawa
Holdredge	Manter	Port	Vanoss
Minco	Otero	Wann	Windthorst
Zavala		Yahola	Zaneis

TABLE XXII

WHEAT INTERVAL RATING ACCORDING TO THE "SOIL PROPERTIES MODEL"*

100 - 125 Group 1	75 - 100 Group 2	50 - 75 Group 3	25 - 50 Group 4
Altus	Abilene	Brownfield	Hardeman
Chickasha	Berthoud	Canadian	
Dalhart	Brazos	Eufaula	
Enterprise	Brownfield	Foard	
Grandfield	Carey	Hardeman	
Holdredge	Carwile	Hollister	
Port	Cobb	Lincoln	
Roscoe	Devol	Mangum	
Springer	Dill	Nobscot	
St. Paul	Elsmere	Vernon	
Tipton	Farnum		
Wann	Foard		
Weymouth	Hardeman		
Zavala	Hinkle		
	Konawa		
	La Casa		
	Lawton		
	Lucien		
	Mansic		
	Miles		
	Otero		
	Pratt		
	Reinach		
	Spur		
	Stamford		
	Tillman		
	Waurika		
	Weymouth		
	Windthorst		
	Yahola		
	Zaneis		

*Soils having sample characteristics outside the series range were omitted. Soils are grouped according to the highest predicted value of the series.

TABLE XXIII

GRAIN SORGHUM INTERVAL RATING ACCORDING TO THE "SOIL PROPERTIES MODEL"*

100 - 125 Group 1	75 - 100 Group 2	50 - 75 Group 3	25 - 50 Group 4	0 - 25 Group 5
Brownfield	Altus	Abilene	Hollister	Mangum
Chickasha	Carey	Berthoud	La Casa	
Enterprise	Carwile	Brazos	Otero	
Farnum	Cobb	Dill	Stamford	
Holdredge	Dalhart	Elsmere	Vernon	
Konawa	Devol	Eufaula		
Reinach	Grandfield	Foard		
St. Paul	Hardeman	Hinkle		
Tipton	Lawton	Lincoln		
Wann	Lucien	Quinlan		
	Mansic	Roscoe		
	Miles	Waurika		
	Miller	Weymouth		
	Port	Woodward		
	Pratt	Zavala		
	Springer			
	Spur			
	Tillman			
	Windthorst			
	Yahola			
	Zaneis			

*Soils having sample characteristics outside the series range were omitted. Soils are grouped according to highest predicted value of the series.

TABLE XXIV

COTTON INTERVAL RATING ACCORDING TO THE "SOIL PROPERTIES MODEL"*

100 - 125 Group 1	75 - 100 Group 2	50 - 75 Group 3	25 - 50 Group 4
Chickasha	Altus	Abilene	Hollister
Enterprise	Brazos	Brownfield	Lincoln
Miller	Carey	Canadian	Vernon
Springer	Carwile	Cobb	
	Dalhart	Devol	
	Elsmere	Foard	
	Farnum	Hardeman	
	Grandfield	Hinkle	
	Holdredge	La Casa	
	Lawton	Otero	
	Mansic	Quinlan	
	Miles	Spur	
	Pratt	Weymouth	
	Reinach	Windthorst	
	Roscoe	Yahola	
	St. Paul	Zaneis	
	Tillman		
	Tipton		
	Wann		
	Waurika		
	Zavala		

*Soils having sample characteristics outside the series range were omitted. Soils are group according to highest predicted value for the series.

TABLE XXV

INTERVAL INDEX RATING OF SOILS FOR WHEAT ACCORDING TO THE "SOIL CLASSIFICATION MODEL"**

100 - 125 Group 1	75 - 100 Group 2	50 - 75 Group 3	25 - 50 Group 4
Altus	Abilene	Brownfield	Nobscot
Carey	Acme	Devol	
Chickasha	Berthoud	Indiahoma	
Elsmere	Carwile	Konawa lfs	
Enterprise	Cobb	Lincoln	
Farnum	Dalhart	Otero	
Holdredge	Dill	Pratt lfs	
Kenesaw	Foard	Quinlan	
Lawton	Grandfield	Springer	
Meno	Hardeman	Vernon	
Miles fsl	Hinkle	Weymouth	
Norwood	Hollister	Windthorst	
Port	Konawa fsl	Woodward	
Reinach*	La Casa		
Spur	Lela		
St. Paul	Mangum		
Tipton	Mansic		
Vanoss	Manter		
Wann	Miles lfs		
Yahola	Miller		
Zavala	Minco (C slope)		
	Pratt fsl		
	Quanah		
	Roscoe		
	Ruella		
	Stamford		
	Tillman		
	Waurika		
	Zaneis		

*131 index for series with very fine sandy loam texture.
**Soils are grouped according to the highest predicted yield of the series.

TABLE XXVI

INTERVAL INDEX RATING OF SOILS FOR GRAIN SORGHUM ACCORDING TO THE "SOIL CLASSIFICATION MODEL"*

125 - 150 Group 1	100 - 125 Group 2	75 - 100 Group 3	50 - 75 Group 4
Altus	Brazos	Abilene	Foard
Reinach	Canadian	Acme	Hinkle
Tipton fsl	Carey	Berthoud	Indiahoma
	Chickasha	Brownfield	La Casa
	Elsmere	Carwile	Nobscot
	Enterprise	Cobb	Vernon
	Farnum	Dalhart	Weymouth
	Holdredge	Devol	Windthorst
	Kenesaw	Dill	
	Manter	Grandfield	
	Meno	Hardeman	
	Norwood	Konawa	
	Port	Lela	
	Pratt	Lincoln	
	Spur	Mangum	
	St. Paul	Mansic	
	Vanoss	Miles	
	Yahola	Miller	
	Zaneis	Minco	
	Zavala	Otero	
		Pratt lfs	
		Quanah	
		Quinlan	
		Roscoe	
		Ruella	
		Springer	
		Stamford	
		Tillman	
		Waurike	
		Woodward	

*Soils are grouped according to the highest predicted yield of the series.

TABLE XXVII

INTERVAL INDEX RATING OF SOILS FOR COTTON ACCORDING TO THE "SOIL CLASSIFICATION MODEL"*

125 - 165 Group 1	100 - 125 Group 2	75 - 100 Group 3	50 - 75 Group 4	25 - 50 Group 5
Altus	Lawton	Abilene	Brownfield	Devol
Enterprise	Meno	Brazos	Cobb	Hinkle
Manter	Port	Canadian	Foard	Lincoln
Reinach		Carey	Hollister	Springer
Ripton		Carwile	Indiahoma	Windthorst
Yahola		Chickasha	Konawa	Woodward
		Dalhart	La Casa	
		Dill	Minco (C Slope)	
		Elsmere	Nobscot	
		Farnum	Quinlan	
		Grandfield	Roscoe	
		Hardeman	Ruella	
		Holdredge	Vernon	
		Kenesaw	Waurika	
		Mangum	Weymouth	
		Mansic		
		Miles		
		Miller		
		Norwood		
		Pratt		
		Spur		
		Stamford		
		St. Paul		
		Tillman		
		Vanoss		
		Wann		
		Zaneis		
		Zavala		

*Soils are grouped according to the highest predicted yield of the series.

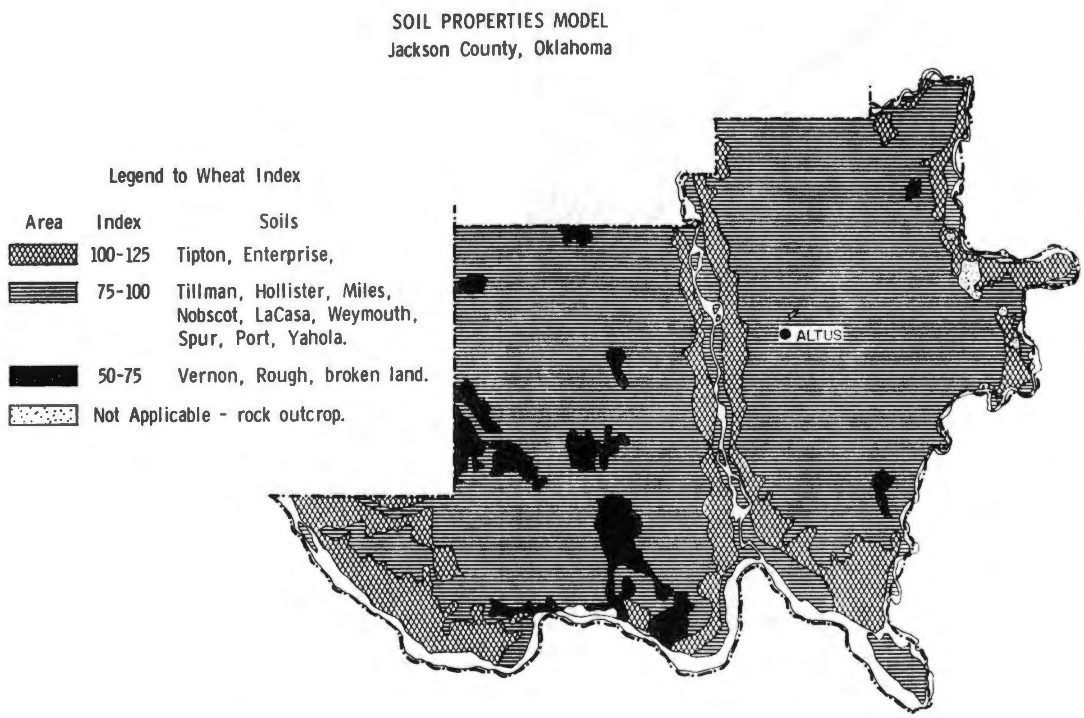


Figure 4. Map showing index ratings of soils for wheat according to the "Soil Properties Model"

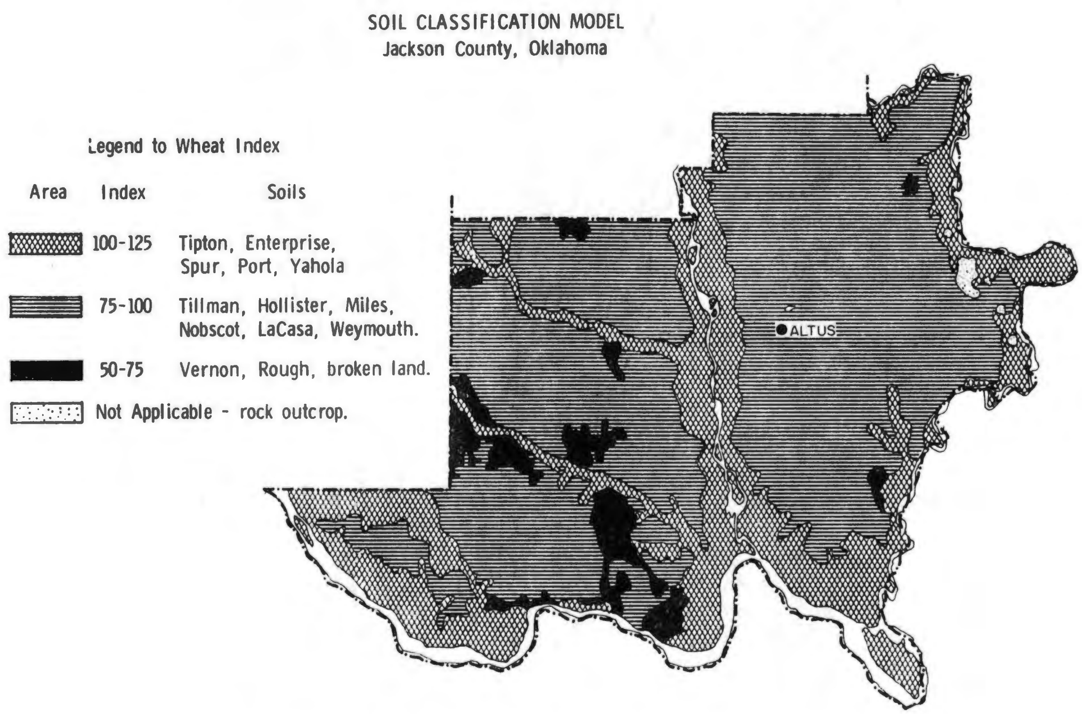


Figure 5. Map showing index ratings of soils for wheat according to the "Soil Classification Model"

VITA

Ferris Paul Allgood

Candidate for the Degree of

Doctor of Philosophy

Thesis: THE UTILIZATION OF SOIL CHARACTERISTICS IN COMPUTING PRODUCTIVITY RATINGS OF OKLAHOMA SOILS

Major Field: Soil Science

Biographical:

Personal Data: Born in Devol, Oklahoma, the son of William L. and Ella A. M. Allgood.

Education: Graduated from Union Valley High School, Randlett, Oklahoma; received Bachelor of Science degree in Agronomy with a major in Soils from Oklahoma State University; completed the requirements for a Master of Science degree in May, 1972; enrolled in doctoral program at Oklahoma State University 1972; completed requirements for the Doctor of Philosophy degree at Oklahoma State University in May, 1975.

Professional Experience: Reared and worked on a farm near Devol, Oklahoma; employee of the USDA Soil Conservation Service August, 1955-1972; party chief and author of Beaver and Major Counties, Oklahoma Soil Survey Reports.

Member: American Society of Agronomy, Soil Conservation Society of America.