KANSAS CROP PRODUCTION VARIATION IN RESPONSE TO COMMODITY PRICE CHANGES

By

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TABLE OF CONTENTS

LIST OF TABLES

Table | Page

LIST OF FIGURES

CHAPTER I

INTRODUCTION

What crop to plant may be the most important decision a farm manager makes in his many management decisions. Two things influence the gross income of a farmer: the amount marketed and the price received for the commodity. Price received for an output is not normally controllable by farmers. With few exceptions, today's farmer is a price taker. Although various forward contracting and hedging agreements make pricing of the commodity more certain, most farmers still have the risk of price movement. Logically, if a farmer cannot control prices, he is left with the other alternative, that of controlling what he will plant.

In a purely competitive market such as agriculture, the prices fluctuate to equate the quantity supplied and the quantity of a good demanded. Quantity supplied is that quantity which producers are ready and able to sell at a given price, other factors being constant. Assuming in the short run that capital and technology remain constant, an individual producer will produce the amount he expects to market at a price which covers his average variable costs. Expectations of price levels that are profitable may cause increased production and similarly low price expectations may lead to decreasing production of a crop. This response in the short run is determined by the producer's costs. In the long run, supply of an agricultural commodity will depend on shifts in capital and changes in technology.

If only average variable costs are recovered through the marketing revenue, eventually the farmer will have to switch to a profitable enterprise or go bankrupt. In the short run no alternatives may be available, but in the long run a farmer will have alternatives for production. This shifting from one enterprise to another may require time, but eventually it will happen. Expectations of future prices may cause producers to switch production to other crops.

Once a producer decides to produce what he feels is a profitable crop, he must decide what quantity to produce. For each individual farm, there is a limit to the resources available for production. Land may be limiting, along with the other factors of production. To increase production on current holdings of land a farmer has two alternatives, either plant on marginal ground or take crop land away from other uses. Additional land, acquired through a purchase or lease, may be available to increase production in some cases.

Labor, capital, equipment and management also limit expansion potential for each farm. Each additional acre planted to a crop takes away the marginal production resources from another crop, unless there is an over abundance of resources. As in the case of land, eventually over time, the production resource can usually be expanded to meet the needs of additional crop production.

Selection of what crop to plant, one of the many suggested variables of production, forms a basis for a farm's income. Production does vary, as with wheat in 1979, when 9,593,000 acres were planted in Kansas as compared to 13,200,000 acres in 1977.[1] Alternative explanations for this variance may include changes in livestock utilization or needs, changes in crop rotation systems, changes in government programs and changes in prices.

Input prices vary and so do prices received for crops. In 1970, a bushel of wheat sold for an average of $1.25 in Kansas compared to $4.23 in 1974. These changes, in output prices and their influence on crop decisions, form the objectives of this study.

1. Determining if farmers respond to changes in commodity prices when making crop production or planting decisions.

2. Establishing whether farmers respond to either current or deflated prices.

3. Analyzing dissimilar agricultural regions of Kansas for their response to changes in price levels.

4. Determining if dry land crop decisions vary from irrigated land crop decisions with response to price changes.

With these objectives, a study was conducted utilizing data available for 1973-1978 on the Kansas Farm Management Association data bank at Kansas State University. The records provide acreage for each of the six years. Two of the six Kansas Farm Management Associations were selected to represent the differences in agriculture within the state of Kansas.

A number of farms from the two associations were then selected to be analyzed based on several characteristics of the individual

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[1]Kansas State Board of Agriculture, 61st Annual Report and Farm Facts (Topeka, Kansas: Kansas State Board of Agriculture, 1977), p. 234.

farms. From this analysis, a determination was made with respect to production changes associated with varying prices of commodities between short run and long run production periods.

CHAPTER II

REVIEW OF LITERATURE

Since the 1950's, attention to agricultural supply analysis has centered around determining what changes in production would be beneficial to farmers. Studies about the behavior of farmers to production changes have received less analysis. Agricultural output can be expressed as a function of inputs. These inputs are either variable or fixed, with the fixed inputs making the distinction between short-run and long-run production periods.

A farmer's production period can be classified into two lengths. A short-run is considered the length of time when at least one resource or input is varied while the other resources or inputs of production are fixed. Long-run production periods are of a length of time that all resources or inputs are variable.[2]

Fixed inputs are considered variable in the long-run, but the factors remain fixed in the short-run. "Unfortunately, the empirical application of theories of investment, i.e., of variation of fixed

[2]John P. Doll and Frank Orazem, Production Economics, Theory with Application (Columbus, Ohio: Grid Inc., 1978), p. 17.

factors of production is not at all well developed. This is especially true in the agricultural sphere."[3]

Uncertainty

The relationship between production and the prices farmers expect to receive for outputs and pay for inputs is one which is difficult to correctly specify. Theory and actual practice are not easily related. Agriculture's inputs must be committed before output is received. This series of events causes the farmer to plan his production on the price which he expects to receive. This farmer, along with others, creates the farmers' supply schedule. What farmers think as a group is subjective and not directly measurable.

Supply Analysis

Research in supply analysis can broadly be divided into relating production functions to individual behavior of farmers and the analysis of time series data. Measuring inputs for production functions creates a problem, as technological changes and management decisions are not readily measurable. Management input, when omitted from the function, causes specification bias.[4] Glenn Johnson's suggestion for selecting the sample to remove intercorrelations between input levels and the

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[3]Marc Nerlove and Kenneth L. Bachman, "The Analysis of Changes in Agricultural Supply: Problems and Approaches," Journal of Farm Economics, Vol. 42 No. 3 (August 1960), p. 538.

[4]Zvi Griliches, "Specification Bias in Estimates of Production Functions," Journal of Farm Economics, Vol. 39 No. 1 (February 1957), p. 21.

residuals of the production function, should work around the problems of input from managers. Some inputs are used in more than one production process, for example, a farm pickup truck. Allocation of usage between crops, livestock, and marketing purposes is at best arbitrary. Management input would also be very hard to allocate between various activities. Capital, measured by the flow of services used, consists of various things. The stock of available capital is different from use, as it is possible to have either an overabundance or shortage of capital needed in the firm.[5]

Budgeting, developed to avoid some of the problems discussed above, seeks to allocate resources to the most profitable situation. Problems arise when the economist must subjectively decide, assuming certain conditions, what will happen. These assumptions and conditions are then used to create a supply function. Linear programs used to simulate production situations generally focus on limiting resources. Models generated with limiting resources are easily adapted to changes in output prices and input costs. As in budgeting, the aggregation problem exists. Linear programs were designed to compare observed events with optimum production. Determining optimum production creates many problems in itself, as many assumptions must be made. Assumptions include the effects of technology, changing size and the fixed nature of the farm investment.

Linear programming, by its theory and nature, maximizes (or minimizes) one certain objective, subject to various constraints

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[5]Ibid., p. 24.

imposed by the resource use.[6] These constraints create several problems associated with linear programming models designed to predict supply response to changes in price. For each resource or input restricted, a separate equation must specify the resources relationship to output. Farm supply models are designed, as a rule, to predict optimum production. This production is subject to restraints caused by limited resources and their allocation. Comparing these results to actual results may be of importance, but is criticized for comparing what they should do rather than what farmers actually will do on this situation.[7]

Statistical Analysis Based on Time-Series Data

Many economists have used time-series analysis, including Marc Nerlove. This type of analysis uses only a few of the variables which are relevant, and this presents another aggregation problem. Nerlove and Bachman agree that limiting variables constitutes the greatest drawback of this approach. Substitution and complementary inputs are difficult to measure, along with changes in technology. Uncertainty, flexibility of fixed inputs, and changing technology are all problems

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[6]For a discussion of linear programming theory, uses, limitations, and assumption see:
R. C. Agrawal and Earl O. Heady, Operations Research Methods for Agricultural Decisions, (Ames, Iowa: Iowa State University Press, 1972), and additionally,
Raymond Benke and Ronald Winterboer, Linear Programming Application Agriculture, (Ames, Iowa: Iowa State University Press, 1972).

[7]Earl O. Heady et al., Agricultural Supply Functions-Estimating Techniques and Interpretations, (Ames, Iowa: Iowa State University Press, 1961), p. 168.

associated with time-series data analysis. Statistical analysis handles fixed inputs by a distributed lag in the model. Aggregation relates primarily to including all relevant variables. "Analysis of supply for small geographic areas offers a partial solution to this problem." Aggregated data, for several states of the nation as a whole, tends to have complex competitive relationships between crop and livestock enterprises. Use of smaller geographic areas makes it possible to include the relevant variables for that location. Smaller areas of study have problems associated with the changes of technology and other changes affecting agriculture.[8]

Total Supply of Agricultural Products

"The aggregate response of output to prices depends on total resource adjustments in agriculture. Because farm resources are much more easily allocated among farm commodities than between farm and non-farm commodities, it follows that aggregate supply response, which tends to determine total resource earnings in agriculture, is less than the supply response for individual commodities."[9] This theory is the basis for determining the elasticity of farm output with respect to price changes in the short-run and long-run. Nerlove's regression analysis of cotton, corn and wheat acres in the United

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[8]Marc Nerlove and Kenneth L. Bachman, "The Analysis of Changes in Agricultural Supply: Problems and Approaches," Journal of Farm Economics, Vol. 42 No. 3 (August 1960), p. 547.

[9]Luther G. Tweeten and C. Leroy Quance, "Positivistic Measures of Aggregated Supply Elasticities, Some New Approaches," American Journal of Agricultural Economics, Vol. 58 (May 1969), p. 342.

States is based on the assumption that farmers respond to changes in price. The changes, or expected future events, are not an observable event and thus must be calculated. Hicks recognized that a particular past price may or may not have anything to do with people's notion of the normal price. This is the basis of Nerlove's hypothesis that each period farmers revise their expected normal price in proportion to the difference between the current price and their previous idea of the normal price:

$$P^*_t = P^*_{t-1} + A(P_{t-1} - P^*_{t-1}) \qquad (1)$$

where: P^*_t = expected price of the commodity

A = coefficient of expectation

P_t = observed price

Adjustments to a change in price do not usually occur quickly; it generally requires changing a resource allocation over time. The resulting elasticity of supply may be broken down into long-term and short-term supply. In the short-run, most or all of the resources are fixed and as time passes the resources may be allocated to alternative enterprises or crops. Short-run elasticity of supply for individual farmers is always less than or equal to the long-run elasticity of supply. The minimum cost of producing the last unit of output cannot be less when a farmer's choice is limited (short-run) than when he has various alternatives. In the long-run, he still has the alternatives he had originally, including the alternative(s) he had in the short-run.

THIS BOOK CONTAINS NUMEROUS PAGES WITH DIAGRAMS THAT ARE CROOKED COMPARED TO THE REST OF THE INFORMATION ON THE PAGE.

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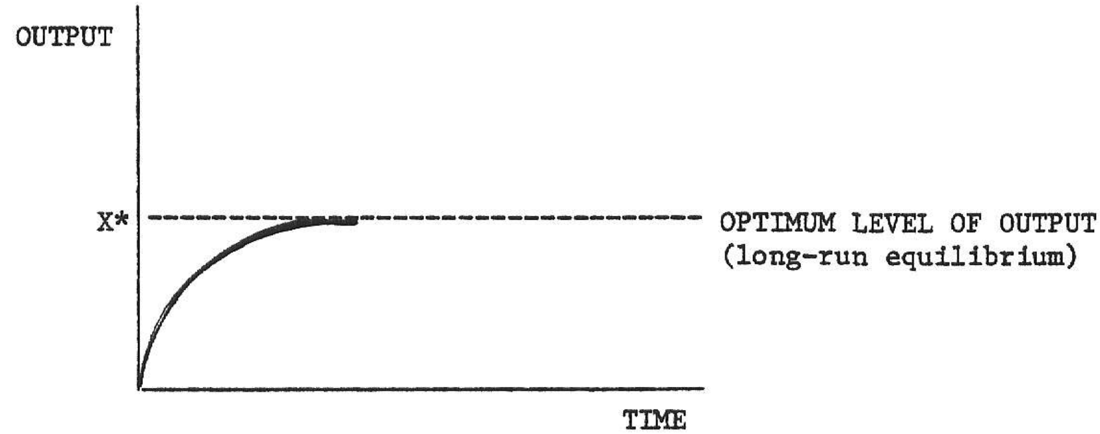

Figure 1. Adjustments of output to long-run equilibrium output.[10]

Output response changes until a long-run equilibrium is reached (see Figure 1). The change in output to the new level of output is distributed over time. The change of output, or response to price changes, is then considered a distributed lag. The output level depends on the level of the long-run equilibrium and time. Not knowing the long-run equilibrium, but knowing output, it is necessary to determine the relationship between long-run equilibrium and the present output. Nerlove presents this equation:

$$X_t - X_{t-1} = B(X^*_t - X_{t-1}) \qquad (2)$$

where: B = elasticity of adjustment

X_t = present output

X^*_t = long-run equilibrium output

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[10]Marc Nerlove, <u>The Dynamics of Supply: Estimation of Farmers' Response to Price</u>, (Baltimore: John Hopkins Press, 1958), p. 264.

Current output depends on the levels of long-run equilibrium output desired in the past. Implicitly long-run output is a function of expected normal price; expected normal price is a function of last year's actual price and last year's expected normal price. Actual output is a function of the long-run equilibrium output and last year's output. Long-run equilibrium output and expected normal prices are not measurable. Assuming a relationship exists between expected future prices and the long-run level of output that is proportional:

$$X^*_t = a\ P^*_t \tag{3}$$

where: a = coefficient of adjustment

X^*_t = desired level of long-run equilibrium output

P^*_t = expected level of future prices

The coefficient of adjustment will certainly be positive for an individual farmer and probably for the industry according to Nerlove. With this relationship between output and prices, Nerlove forms the basis for his testing production response to changes in commodity prices.

The Bean and Strauss price series was used, deflated by the Fisher Ideal Index of Prices received for twelve important crops. Wheat, corn, oats, barley, rye, buckwheat, flaxseed, hay, potatoes, sweet potatoes, cotton, tobacco, and cottonseed were the twelve crops in this index. The price series was deflated to remove changes in the general price level from cotton, corn, and wheat prices and to account for the effects of changes in the price of other products, or alternatives to these crops. Deflating a price with any index using the same commodities price reduces the variance of the prices.

Four alternative regressions were used by Nerlove to estimate response to price. All the equations used by Nerlove have a constant or intercept term and a trend term. The trend term is used to summarize geographic shifts in acreage and changes in mechanization. Nerlove's first equation has expected "normal" price as the independent variable.

Nerlove's first equation: (4)

$$X_t = C_0 + C_1 P^*_t + E_t$$

where: X_t = current acres

P^*_t = expected "normal" price

In the second equation that Nerlovė uses the lagged acres and prices as the independent variables.

Nerlove's second equation: (5)

$$X_t = D_0 + D_1 P_{t-1} + D_2 X_{t-1} + E_t$$

where: X_t = current acres

P_{t-1} = price lagged one year

X_{t-1} = acres lagged one year

In the third equation the independent variable is the price lagged one year. In this equation Nerlove assumed the last year's price is the same as expected "normal" price. This equation was used by Nerlove to compare with his first equation. In the first equation an expected "normal" price was calculated.

Nerlove's third equation: (6)

$$X_t = F_0 + F_1P_{t-1} + E_t$$

where: X_t = current acres

P_{t-1} = price lagged one year

Prices lagged one and two years were the independent variables used in Nerlove's fourth equation.

Nerlove's fourth equation: (7)

$$X_t = G_0 + G_1P_{t-1} + G_2P_{t-2} + E_t$$

where: X_t = current acres

P_{t-1} = price lagged one year

P_{t-2} = price lagged two years

Nerlove's results indicate that there is significant response of acres produced to changes in the price of the commodity. The results of Nerlove's study are presented in the appendix.

Survey of Farmers

Glenn Johnson conducted a study in the 1950's which was a survey of farmers to determine whether they respond to price changes. Each of the one hundred seventy-two farmers were asked, "Could you tell me how you made up your mind about what or how much of each product to produce this year?"[11] The results are presented in Tables 1 and 2.

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[11]Glenn Johnson et al., Managerial Processes of Midwestern Farmers, (Ames, Iowa: Iowa State University Press, 1961), p. 163.

TABLE 1

RESPONSES TO PRODUCTION PLANNING SURVEY

Percent n of Farmers	Response Categories
15.1	Adjustments or conformed to price, price expectations, or price changes
7.6	Adjusted or conformed to income and/or debt repayment needs
52.9	Responded or conformed to land and cropping patterns
57.0	Responded or conformed to feed supply or livestock programs
14.9	Responded or conformed to government allotments and programs
9.9	Responded or conformed to insect, disease, or weather conditions
8.9	Responded or conformed to habit or custom
8.7	Responded or conformed to labor limitations

TABLE 2

CATEGORIES OF FARMS BY ORGANIZATIONAL APPROACH[12]

Percentage of Farmers	General Approach to Organization
45.0	Land use approach
11.1	Livestock approach
17.0	Combinations resolved by simultaneous solution
4.7	Price expectations or outlook approach
6.4	All other methods and approaches
15.8	Method not ascertainable from answer given
100.0	

Conclusions from this survey found that most farmers relied on an organizational structure which fitted the characteristics of their fixed assets. The major fixed assets of importance here include land, livestock, labor and equipment. Conclusions were reached that these assets were used without accounting for their interactions with other production variables. This emphasis on fixed assets is one of the downfalls of function analysis, budgeting, and linear programming which, according to their approach, usually do not distinguish between short-run and long-run costs. Some inputs which are fixed under certain economic conditions and variable under other economic conditions are not covered by the usual forms of static marginal economic theory

[12]Each of the responses reported in Table 1 were classified into their general farm organization and reported by categories in Table 2.

or by typical empirical techniques based on that theory, such as continuous functional analysis, budgeting, and linear programming.[13]

Farm Aggregation Problems

Representative farm aggregation for farms supply analysis causes several problems, according to Sharples.[14] Some problems are caused by assuming individual farmer's input costs and physical transformation rates are constant at all levels of aggregate production. The aggregate level of production has an impact on prices, which directly effect each farm's supply function. The larger the area studied, the greater the impact. In a single state the aggregate production is not likely to have much effect on prices received or paid.

Changing farm size creates another type of problem with aggregation of farms, because changing size of a farm would compete with other alternatives for the use of capital. Assumptions of most supply studies; that farmers are profit-maximizers, they have no enterprise preference, farmers have perfect knowledge of all the alternatives, and that uncertainty does not enter into crop decisions are criticized for being restrictive. According to this view, models should consider alternative assumptions. Selection of farms for analysis is generally by size, soil type, major crop produced, etc. This type of selection may lead to a set of farms which have about the same optimum

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[13]Ibid., p. 164.

[14]Jerry A. Sharples, "The Representative Farm Approach to Estimation of Supply Response," American Journal of Agricultural Economics, Vol. 51 No. 2 (May 1969), p. 355.

organizational structure. Differences in motivations, crop and livestock preferences, ability of each farmer, and other human factors should be built into the selection of farms.

CHAPTER III

METHODOLOGY

In collecting and analyzing the data and results for this study, references are made to various common terms. The following definitions are provided to clarify the terms used and to explain their use in the study.

Regression equation - An equation that relates X to Y is a regression equation. Regression is concerned with the dependence of a random variable or variables on X, which is also a variable, but not a random variable. The relationship between the dependent variable (Y) and the independent variables (X_1, X_2, ...X_n) may be of this form:

$$Y = f\ (X_1,\ X_2,\ \ldots\ldots.X_n) \qquad (8)$$

or alternatively;

$$Y = B_0 + (B_1X_1 + B_2X_2 + \ldots\ldots\ldots + B_nX_n + E_t)$$

Distributed lag - A relationship in which the influence of a change in an independent variable is spread over a length of time is considered a lag. The lag depends on the difference between the change in the independent variable and the corresponding change in the dependent variable.[15]

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[15]Potluri Rao and Roger LeRoy Miller, Applied Econometrics, (Belmont, California: Wadsworth Publishing Company, Inc., 1966), p. 160.

Independent variable - Variables that are either set to a desired value or take values that can be observed but not controlled.[16]

Dependent variable - Also called response variable(s), a change in the variable is transmitted to the other variable. The variable which is influenced is called a dependent or response variable.[17]

Multiple correlation coefficient (R^2) - Measures the proportion of variation in the dependent variable that is explained by the independent variables in the regression equation. Generally, the larger the value of R^2, the better the fitted equation explains the variation in the data. This is a valid interpretation as a summary statistic only when the regression equation contains the constant term.[18]

Current price - Price of a commodity, taken from the Kansas Farm Facts, monthly average series of prices called "Prices Received by Farmers." This price series is published annually. A simple non-weighted average of each of the twelve months was calculated and considered that year's price. See Table 3.

Deflated price - The current price of a commodity deflated by the Index Number of Prices Received by Farmers, published in the 1978 Agricultural Statistics (USDA). Corn and wheat were deflated by the food grain index; grain sorghum, soybeans, alfalfa, and silage were deflated by the feed grains and hay index. Cattle, calves and

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[16]Norman Drapper and Harry Smith, Applied Regression Analysis, (New York, John Wiley and Son, Inc., 1966), p. 3.

[17]Ibid., p. 4.

[18]Ibid., p. 117.

hogs were deflated by the meat animal index. For the index used, see Table 5, and for the deflated price series, see Table 4.

Current acres - Acres planted to crops and feed, as reported to K-MAR-105 data bank.

Kansas Farm Management Associations cover the entire state of Kansas. The Kansas Farm Management Associations divide Kansas into areas, associations one through six. The Kansas Farm Management service is a part of the Kansas State University Cooperative Extension Service. Members of the Kansas Farm Management Association, which is voluntary, pay an annual fee to join. The Extension Service employs fieldmen to help members with their management and marketing decisions. The fieldmen collect data from each individual farm and these data are compiled on a computer at Kansas State University in Manhattan. Data are stored in the K-MAR-105 (Kansas-Management, Analysis, Research) Whole Farm and Enterprise data bank. K-MAR-105 was implemented for these reasons: to provide detailed information to each member about this farm and its situation; to provide information and reports to the various associations; and to provide extension, teaching, and research people with a data bank for information on the Kansas Farm Management Associations.[19]

K-MAR-105 contains four hundred and twenty-seven variables per farm for the years 1973, 1974, 1975, 1976, 1977 and 1978. For purposes of this study, Kansas Farm Management Associations three and

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[19]Larry N. Langemeier, "The K-MAR-105 Whole-Farm and Enterprise Data Bank and Retrieval System, User Manual and Request Forms," Kansas State Cooperative Extension Service, Farm Management Studies, (mimeograph), p. 1.

four were selected to represent two different agricultural situations in Kansas. Kansas Farm Management Association four, in northeast Kansas, receives an annual rainfall of thirty or more inches compared to Kansas Farm Management Association three, with an average of twenty or less inches.

Rainfall in excess of 30 inches annually creates a situation with more crop alternatives. Wheat and grain sorghum, which can be grown in semi-arid conditions, plus soybeans, corn, silage and alfalfa are the alternative crops. With this amount of rainfall summer fallowing is not normally required to retain adequate soil moisture for crop production. With numerous crops suited to this climate, farmers have more alternatives to consider. When weighing the alternative crops, farmers may use deflated prices to analyze their potential profits in each crop enterprise. Farmers may respond to a difference between the price of crops and not their current price.

Rainfall limited to less than 20 inches annually tends to restrict feasible crop alternatives. Semi-arid land's production without supplemental irrigation is normally limited to the production of either wheat or grain sorghum as cash crops. Under these circumstances, farmers may respond to current prices rather than deflated. Prices of other crops, which are not feasible because of the climate, may not be relevant to these farmer's production decisions.

Kansas Farm Management Association four, typically dryland agriculture with limited irrigated land, is commonly referred to as part of the corn belt that extends through the middle of America. In southwestern Kansas, summer fallow wheat and irrigated crops comprise land utilization. This area of the state is part of the plains wheat country, which without water for irrigation is considered only summer fallow wheat ground. Private and commercial feedlots are very abundant in this area of the state. See Figure 2, the Kansas Farm Management Association map.

By use of the K-MAR-105 whole farm retrieval system program, a list of all the Kansas Farm Management Association three and four farms and their acres was obtained for 1973 and 1978. This listing contained each farm type, gross income, operator's age, total acres operated, total crop acres operated, and total acres of pasture operated. With this, farms were selected that operated the same number of acres in 1978 as they did in 1973. Kansas Farm Management Association three had fifty-four farms that met the qualification, operating an average of 1,012 acres in cropland and 426 acres of pasture. Operator's average age was fifty-six, and the average gross income was $94,000. In Kansas Farm Management Association four, sixty-one farms were selected with an average of 368 cropland acres and 267 acres of pasture. Average gross income was $107,753, and average age of the operators was fifty-three.

Selection of constant size farms helps to isolate the effects of response to price through acreage changes. Other farms may have decreased or increased acres operated, and such change may or may not be considered a direct response to changes in price. Such changes might be a result of planned retirement or expansion not directly associated with the changes in commodity prices.

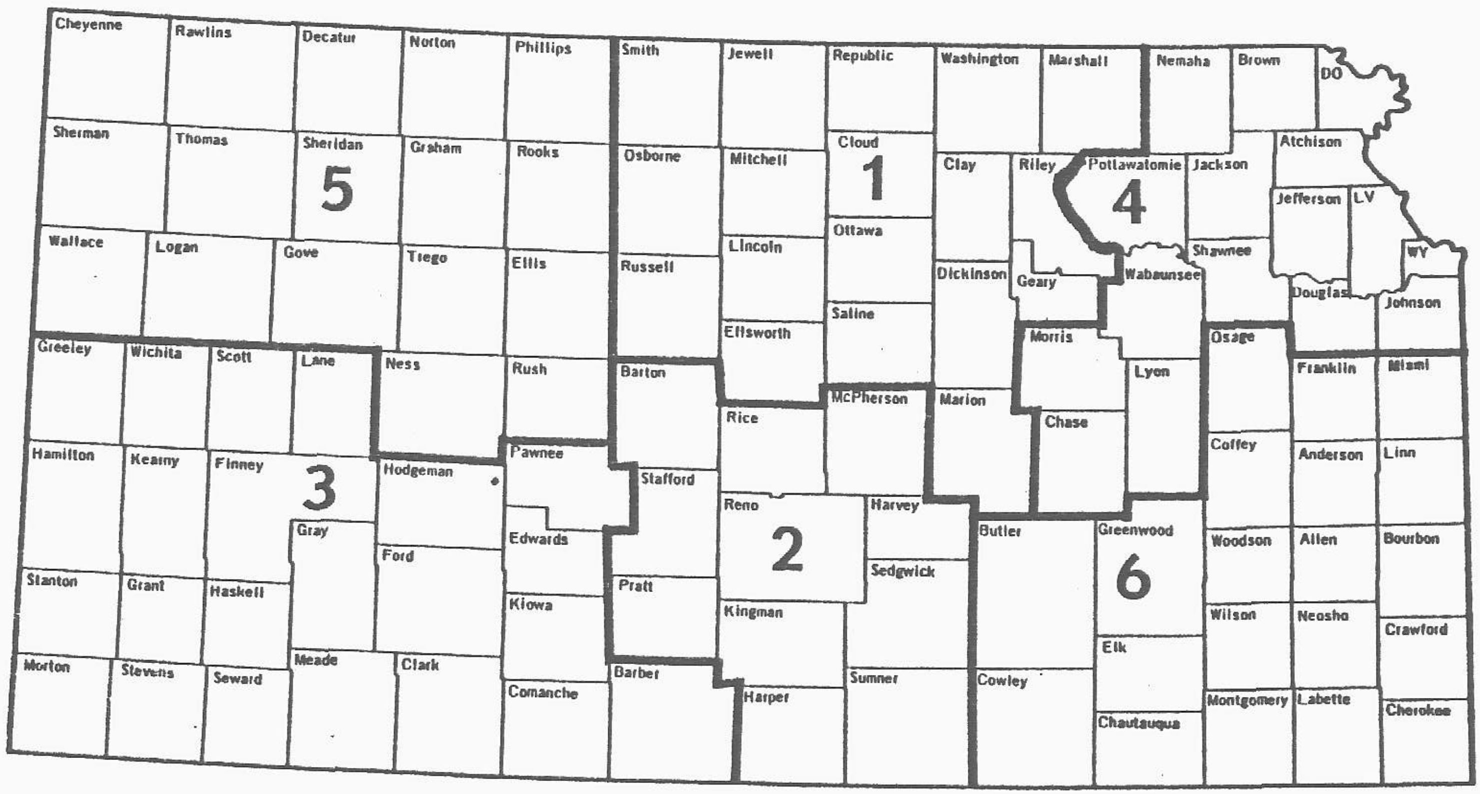

Figure 2. Kansas Farm Management Association Districts.[20]

[20]Source: Kansas Farm Management Service, Kansas State University, Manhattan, Kansas, 1978.

These sixty-one Kansas Farm Management Association four farms and fifty-four Kansas Farm Management Association three farms were then used to create a data set listing each farm's annual acres of both nonirrigated and irrigated wheat, corn, grain sorghum, soybeans, alfalfa, and silage. Additionally, the number of cows, numbers of swine litters, average number of feeder cattle handled, and feeder pigs were retrieved. These data were then sorted by farm number for years 1973 through 1978, then combined to make a data set for the Statistical Analysis System (SAS).

Years 1973 through 1978 were chosen because this is all the information readily available without researching the hand-written farm management records before 1973. The 1970's were affected by the Russian grain deal that spurred massive planting of wheat, possibly in response to anticipated higher grain prices. In 1974 through 1976 the commodity prices were high enough so that government price supports were overridden by the market price. By 1977, commodity prices had decreased and farmers requested a new price support, loan rate and set aside program. For farmers to participate in this program, they had to set aside or reduce their acres of wheat by 10% in 1978. This caused the production of wheat to decline from 13,200,000 acres in 1977 to 9,593,000 acres in 1979. The years of 1967-1974 were an accumulation period for all cattle and calves on the farm, followed in 1975-1978 by a liquidation of cattle and calves. The numbers of hogs on farms declined from 1965 through late 1974, when an accumulation phase started that continues through 1979.[21] Both the cattle and hog market experienced a wide range of prices, as the supply changed drastically. In the early and mid-1970's, technology of crop production changed little, as no new crop practices were introduced or no new hybrid seed varieties radically changed crop yields.

Price of fuel and other petroleum based products such as oil, grease and some fertilizer rose rapidly in this time period. A shortage of crude oil caused these input prices to almost double; for example in 1973, the average farm price for a gallon of gasoline was 34¢ and by 1978, the price had risen to 59.8¢.[22] Other production inputs, such as seed, equipment, and custom hire costs, rose noticeably, but not as rapidly as fuel and petroleum products.

Data on planted acres of crops rather than harvested acres were used to help eliminate, at least partially, the effects of weather, disease, and other uncontrollable events on production. Intended production or planted acres of crop does not vary as much as does yield per acre expressed in tons or bushels per acre. An individual farmer has more control over planting where, without weather or other disasters, he may plant exactly the amount desired. Controllable to a certain extent through planting date, proper tillage and timely harvest, actual yield still depends on weather to a great extent.

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[21]John H. McCoy, Livestock and Meat Marketing, (Westport, Connecticut: AVI Publishing Company, Inc., 1979), p. 72.

[22]Kansas State Board of Agriculture, 62nd Annual Report and Farm Facts, (Topeka, Kansas: Kansas State Board of Agriculture, 1978), p. 234.

Acres, the dependent variable in this study, are taken to represent planned response to changes in production goals.

With this data about Kansas Farm Management Associations three and four and the calculated price series, a data set was created to study the effects of price changes on crop acreage allocation among competitive crops. Current prices used are shown in Table 3, deflated prices in Table 4, and the index for deflation in Table 5. Current prices were calculated from a non-weighted monthly price series published by the Kansas State Board of Agriculture. This series of annual prices was then deflated by this respective index of prices received: wheat and corn by the food grains index; grain sorghum, soybeans, alfalfa and silage by the feed grains and hay index; hogs, cattle and calves by the meat animal index.

Kansas Farm Management Association Three

In Kansas Farm Management Association three, wheat is the major crop on dryland with grain sorghum being an alternative. Alfalfa and silage are grown to a limited extent and may be considered a primary input for livestock production. Grain sorghum is a competitive output which, if produced, causes resources to be diverted away from the production of wheat. Wheat and grain sorghum compete for land, labor, capital, equipment and the inputs of management. Planting additional acres of wheat in the fall would reduce the available acres for grain sorghum production unless summer fallow ground is used or grain sorghum is cropped immediately following the wheat harvest the next summer.

TABLE 3

CURRENT PRICES FOR VARIOUS AGRICULTURAL COMMODITIES RECEIVED BY KANSAS FARMERS, 1972-1978[23]

	Year						
Commodity	1972	1973	1974	1975	1976	1977	1978
Wheat $/bushel	1.55	3.08	4.23	3.42	3.00	2.12	2.17
Corn $/bushel	1.23	1.97	2.85	2.67	2.44	1.96	2.21
Grain sorghum $/bushel	1.91	3.14	4.42	4.12	3.88	3.02	3.30
Soybean $/bushel	3.24	6.49	6.37	5.72	5.52	6.61	6.20
Alfalfa $/ton	24.46	38.79	47.46	49.50	54.50	48.10	42.00
Hogs $/cwt.	26.05	39.73	34.36	47.92	43.25	40.52	47.50
Cattle $/cwt.	38.02	44.86	35.05	30.66	34.80	34.90	52.45
Calves $/cwt.	43.10	55.71	37.29	26.98	35.98	38.55	53.30

[23] Kansas Farm Facts, "Prices Received by Farmers, Mid Monthly Averages," 1972-1978 were used to calculate a simple, non-weighted average for each year.

TABLE 4

DEFLATED PRICES FOR VARIOUS AGRICULTURAL COMMODITIES RECEIVED BY KANSAS FARMERS, 1972-1978[24]

	Year						
Commodity	1972	1973	1974	1975	1976	1977	1978
Wheat $/bushel	1.42	1.43	1.41	1.41	1.48	1.36	1.43
Corn $/bushel	1.13	.92	.95	1.10	1.21	1.25	1.16
Grain sorghum $/bushel	1.84	1.93	1.81	1.79	1.78	1.67	1.79
Soybean $/bushel	3.11	3.98	2.62	2.48	2.53	3.65	3.37
Alfalfa $/ton	25.44	23.80	19.53	21.52	25.00	26.57	22.83
Hogs $/cwt.	17.60	20.07	20.82	28.35	25.44	20.65	21.00
Cattle $/cwt.	25.69	22.65	21.24	18.14	20.47	22.81	23.21
Calves $/cwt.	29.12	28.14	22.60	15.47	21.16	22.81	23.58

[24]Current Price Series deflated by the Index of Prices Received by Farmers, Agricultural Statistics 1978, USDA. (See Table 5)

TABLE 5

INDEX NUMBERS BY GROUPS OF COMMODITIES FOR PRICES RECEIVED BY UNITED STATES FARMERS BASE YEAR 1967, (1967=100)[25]

	Commodity Group		
Year	Food Grains	Feed Grains and Hay	Meat Animals
1972	109	104	148
1973	215	163	198
1974	300	243	165
1975	242	230	164
1976	202	218	170
1977	156	181	164
1978	191	184	226

[25]Agricultural Statistics 1978, United States Department of Agriculture, Washington, D.C., p. 455.

TABLE 6

KANSAS FARM MANAGEMENT ASSOCIATION 3
SUMMARY OF FIFTY-FOUR FARMS BY CROPLAND
UTILIZATION FOR THREE OR MORE OF THE YEARS STUDIED

Irrigated Cropland Utilization	Number of Farms	Dryland Crop Utilization	Number of Farms
Wheat	21	Wheat	50
Corn	20	Grain sorghum	14
Grain sorghum	17	Alfalfa	5
Alfalfa	9	All silage	7
All silage	9		

Dryland farms in Kansas Farm Management Association three will be statistically analyzed to determine if changes in the crop's price and the price of competitive crops influence the decision on what to plant. These factors are not by any means all of the variables that influence the planting decisions of farmers. Price changes are assumed to be one of the more important factors influencing planting decisions.

Irrigated cropland in Kansas Farm Management Association three was utilized almost equally for the production of wheat, corn and grain sorghum. Alfalfa and silage on irrigated ground comprised less of the production acres. Corn and grain sorghum, the two spring crops, compete for resources between themselves and with fall wheat. Generally, in southwestern Kansas, corn can be planted three weeks in advance of grain sorghum and forage feeds.[26] Comparison of non-irrigated land response is another objective of this study.

Kansas Farm Management Association Four

Two farms of the sixty-one in association 4 (northeastern Kansas) reported irrigated crops of a majority of the years. Hence, all alternative analysis of Kansas Farm Management Association four will be limited to nonirrigated crops. Major dryland crop alternatives are wheat, corn, grain sorghum and soybeans. More than fifty percent of the farms report planting these crops during the years studied. Alfalfa and silage, with few exceptions, are primary inputs for livestock production and not a cash crop on these farms. With the various alternatives, farmers may respond to the relative or deflated prices. Assuming this fact, means that the absolute (or current) prices are not the only price considered in planting decisions. Assuming farmers do respond to price changes, do they respond to the relative or the absolute price level. Determining which they respond to is an objective of this study.

All alternative nonirrigated crops compete for land, labor, capital and management inputs. An additional acre of wheat planted in the fall of year one will reduce the available land for spring crops in year two. Except if grain sorghum is double cropped after the wheat harvest in year two, or unless fallow land is used, then additional acres of wheat will reduce the land available for the

[26]"Planting Crops in Kansas," Kansas State Cooperative Extension Service, September 1979.

TABLE 7

KANSAS FARM MANAGEMENT ASSOCIATION 4
SUMMARY OF SIXTY-ONE FARMS BY CROPLAND
UTILIZATION FOR THREE OR MORE OF THE YEARS STUDIED

Dryland Crop Utilization	Number of Farms
Wheat	57
Corn	57
Grain sorghum	49
Soybeans	35
Alfalfa	40
All silage	23

production of spring crops. Double cropping is possible, but generally only for grain sorghum, as the recommended planting dates for corn and soybeans occur before the wheat harvest is completed.[27] Without these exceptions, additional wheat planted in year one would prohibit planting of additional spring crops until the spring of year three. Similarly, an increase above normal rotation of spring crops, assuming fallow ground was not used, would decrease land available for planting that fall.

Land diverted from other crops or fallow would decrease the land available for planting at least twelve months: switching grain sorghum to corn, and in the case of using grain sorghum ground for wheat production, at least eighteen months. This causes a lag in the change of

[27]Ibid.

price and the acreage adjustment. Normal crop rotation patterns will then also be disrupted, thus causing more adjustments after the planting of additional acres.

With this information on Kansas Farm Management Association three and four, a statistical analysis was performed. A Statistical Analysis System (SAS) program was designed to analyze farms by association. Each farm, with a few exceptions, contained six years of data, 1973 through 1978. The exceptions are gaps in the K-MAR-105 data; in these years the farmers did not report their current year production to K-MAR-105.

A SAS program, the backward elimination procedure, was used in analyzing the data. This technique has these basic steps:

1. A regression equation containing all variables is computed.
2. The partial F-test value is calculated for every variable treated as though it were the last variable to enter the regression equation.
3. The lowest partial F-test value, F_L say, is compared with a pre-selected significance level, say F_O.
    (a) If $F_L < F_O$ remove the variable X_L, which gave rise to F_L, from consideration and recompute the regression equation with the remaining variables; re-enter stage 2.
4. If $F_L > F_O$, adopt the regression equation as calculated.[28]

With this procedure, the first step considers all variables; if the variables are insignificant, they are omitted starting with the least significant first. By further steps, if necessary, this procedure deletes from the model any variables not significant. The

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[28]Norman Drapper and Harry Smith, Applied Regression Analysis, (New York: John Wiley and Son, Inc., 1966), p. 168.

remaining variables all produce F-values significant at the level specified in the program. At each step, the backward elimination procedure calculates the sources of variation regression, variation error and variation total. Source of variation regression is the variation attributed to the independent variables of the model. Source of error variation is the residual variation not accounted for by the model and its variables. Source of variation total regression, which is corrected for $\overline{Y}$ if an intercept is included in the model, or uncorrected if an intercept is not included, is the sum of the regression and residual variance. For each source of variation, degrees of freedom, sum of swuares, and F-value, the significance probability of the F-value and R^2 are calculated. The calculated F-value is the ratio of the regression mean swuare to the error mean square.

For each step in the backward elimination procedure, an analysis of variance is calculated and printed. For each independent variable, an estimated regression coefficient (or beta value) and its standard error are calculated. Additionally, an F-value and the significance probability associated with the Type II sum of square is calculated: a Type II sum of square is calculated for each independent variable. The Type II sum of squares is that sum of squares that would be added to the error sum of squares if that one variable were removed from the model. The F-value is calculated by dividing the mean square due to the independent variable, or Type II sum of squares, by the error term's mean square. The critical value, used to compare the calculated value, is determined by the level of significance specified in the model. When the calculated F-value is smaller than the critical value, the backward regression model rejects as significant beta's associated variable.

With this statistical procedure and the data set created from K-MAR-105 data on Kansas Farm Management Associations three and four's sample, regressions were run to determine the effects that deflated prices, current prices, and the last year's acres of the crop and its competitive crops have on current production. For testing these variables, the following regression form was used.

$$X_t = B_0 + B_1 X_{t-1} + B_2 P_{t-1} + B_3 XX_{t-1} + B_4 PP_{t-1} + \ldots\ldots + B_n XX_{t-1} + B_n PP_{t-1} + E_t \quad (9)$$

where: X_t = current production

X_{t-1} = last year's acres of the crop

P_{t-1} = last year's crop price in dollars

XX_{t-1} = last year's acres of alternative crop or livestock needs

PP_{t-1} = last year's alternative crop price in dollars

With this general equation form, prices and acres were lagged one year. Lagging the prices one year implies that cropping decisions are made at least one year in advance of planting. Decisions on production can be changed at any time before the actual seeding of the crop. For example, in the spring of year one, a farmer has three basic alternatives: plant spring crop at the normal level, increase fallow ground or intended wheat ground thus decreasing spring crop ground, or decrease fallow ground or intended wheat ground thus increasing spring crop ground. Following this, a farmer who changes his land allocation in response to a price change would have only one time each year to adjust. Adjustments could only be made at planting, unless after the crop is sprouted the farmer tills under or grazes off the crop before harvest.

This equation and the various adaptations of it that were used has the same general format as Nerlove used in his equations, with a few very important changes. Nerlove used lags of prices and acres, but his model did not include *all the alternative* uses of the land, but only corn, cotton and wheat. With only corn, cotton and wheat data it would be impossible to test all the alternatives to wheat production. In this model, variables were added or deleted to fit the exact situation. In the presentation of results that follows only the significant variables to the equation are listed. In all cases, other variables were in the model originally but were statistically insignificant, so they were rejected. Examples include the rejection of the crop's own price, alternative crops and its lagged production and price, and other variables to indicate the disposal of the crop. For example, the production of corn, grain sorghum, soybeans, alfalfa, silage and other feeds may depend on the needs of the individual's livestock.

Lagging the prices and acres more than one year, which is possible, creates a special problem for this study. For each farm there are six observations; lagging this set one year creates five observations for analysis. Although lagging two or more years is sound from an economic theory point of view, statistically you have a weaker sample from which to draw inferences. A longer series of data on each farm would correct this problem.

CHAPTER IV

RESULTS

Analysis of Farms with Irrigated Acres

Farmers in Kansas Farm Management Association three have six alternative crops which they produce on irrigated ground: wheat, corn, grain sorghum, soybeans, alfalfa and silage. Alfalfa and silage may be considered an input for the livestock enterprises, and hence were not considered a cash crop. These two crops were not considered alternatives to wheat, corn, grain sorghum and soybeans.

Irrigated wheat acres, as shown in Table 8, regression 2, indicate a negative response of current wheat acres with respect to last year's corn price. Regression 1 indicates a positive response of wheat acres with respect to the previous year's grain sorghum price. Grain sorghum and corn are both competitive with wheat, but it is possible to double crop grain sorghum on wheat ground, after the harvest.

Economic theory would provide that as corn price increases relative to wheat, then more corn would be produced and less wheat. The positive relationship between milo price and wheat would seem to be wrong in theory. On both the equations the previous year's acres

TABLE 8

ALTERNATIVE REGRESSION EQUATIONS EXPLAINING THE KANSAS FARM MANAGEMENT ASSOCIATION 3 IRRIGATED WHEAT ACREAGE FOR THE YEARS 1973-1978

Independent Variables	Regression 1 Current Prices	Regression 2 Deflated Prices
Wheat acres lagged 1 year	.686[a] (.047)[b]	.691 (.047)
Corn acres lagged 1 year	.112 (.035)	.117 (.035)
Corn price lagged 1 year		-56.993 (27.943)
Grain sorghum acres lagged 1 year	.048 (.021)	.045 (.021)
Grain sorghum price lagged 1 year	9.769 (4.066)	
Intercept	-27.127	68.236
R^2	.696	.694

[a]For each independent variable, the number given is the estimated regression coefficient or beta value.

[b]For each estimated regression coefficient calculated, the number given is the standard error of the estimated regression coefficient.

of wheat is the most important variable, with corn and grain sorghum acres explaining less of the current production.

One possible explanation for the positive response of wheat acres to the previous year's grain sorghum price is that wheat production can be increased with double cropping of grain sorghum directly after wheat, without an associated reduction in the land available for wheat production. Although the estimated regression coefficients for grain sorghum and corn were statistically significant, they did have larger standard errors than the other variables coefficients.

Analyzing both irrigated wheat regressions in Table 8, last year's acres planted are more important than wheat price in determining current production. Last year's acres of wheat, corn and grain sorghum explain an important part of current wheat acreage. Wheat acreage last year, with a coefficient of .686, corn with a coefficient of .112, and grain sorghum with a coefficient of .048 suggest that normal crop rotation patterns and other factors play an important part in planting decisions. Regressions 1 and 2 produce differing intercepts; while regression 1 has an intercept of -27.127, regression 2 has an intercept of 68.236. Indications from this seem to point to a rather small wheat production when previous acres of wheat are not considered in the production decisions.

Current irrigated corn acreage, explained by regression 1 of Table 9, suggests three variables contribute to current corn production. Previous wheat acres, corn acres and wheat price are all significant in explaining current corn production. The previous year's wheat acres, with a coefficient of .199 and corn with a

TABLE 9

ALTERNATIVE REGRESSION EQUATIONS EXPLAINING THE KANSAS FARM MANAGEMENT ASSOCIATION 3 IRRIGATED CORN ACREAGE FOR THE YEARS 1973-1978

Independent Variables	Regression 1 Current Prices	Regression 2 Deflated Prices
Wheat acres lagged 1 year	.199 (.051)	.208 (.051)
Wheat price lagged 1 year	19.803 (6.582)	
Corn acres lagged 1 year	.701 (.043)	.698 (.042)
Corn price lagged 1 year		-111.390 (33.872)
Intercept	-48.152	132.459
R^2	.686	.687

coefficient of .701 seem to show that most of the current year's acreage is explained by last year's production. Of these two variables, corn acreage is the most important factor. Normal crop rotation principles and fallow ground may be an explanation of this part of the regression equation.

Wheat price from the previous year has an estimated regression coefficient of 19.083. Economic theory suggests the opposite; normally corn would compete with wheat production for inputs, so a negative relationship between the two variables would be expected. The wheat price coefficient's standard error is rather high; however, the coefficient is statistically significant.

Regression of deflated prices, Table 9, regression 2, produces about the same statistical results as in the regression using current prices. The estimated regression coefficients of the previous year's corn and wheat price are approximately the same as for current price's regression. Apparently, both the variables contribute the same explanation to both equations. The previous year's corn price, with its -119.390 coefficient, indicates that as the price of corn rises, production would decrease. Economic theory would indicate this is incorrect, suggesting exactly the opposite relationship. The standard error associated with the corn price variable is extremely high, but is statistically significant.

TABLE 10

ALTERNATIVE REGRESSION EQUATIONS EXPLAINING THE KANSAS FARM MANAGEMENT ASSOCIATION 3 IRRIGATED GRAIN SORGHUM ACREAGE FOR THE YEARS 1973-1978

Independent Variables	Regression 1 Current Prices	Regression 2 Deflated Prices
Corn acres lagged 1 year	.086 (.051)	.086 (.051)
Grain sorghum acres lagged 1 year	.757 (.036)	.757 (.036)
Intercept	12.098	12.098
R^2	.604	.604

Both regressions explaining grain sorghum acres planted provide almost identical results, as shown in Table 10, regressions 1 and 2. Statistically, of all the independent variables presented in the regression equation originally, only previous year's corn and grain sorghum acre contribute to the explanation of current grain sorghum acres. According to both equations, previous year's grain sorghum acres contribute relatively more to the explanation of current grain sorghum production than do previous year's corn acres. These coefficients may be taken to mean that for grain sorghum, rotation and crop patterns affect production more than does the price of grain sorghum. Each regression produced the same results so that in this case farmers respond equally to either deflated or current price.

Summary of the Irrigated Crop Response

Each of the alternative regressions explaining irrigated corn, grain sorghum and wheat seem to point out that farmers respond more to last year's production than they do to the price of the commodity. While some price response can be seen with both current and deflated price series, many of the responses to deflated prices produced signs that are wrong from the view of economic theory. The three regression equations using current prices fit the explanation of current acres better than do the regressions produced using deflated prices.

Analysis of Farms with Dryland Acres in a Semi-Arid Region

Most dryland producers in Kansas Farm Management Association three have two major crop alternatives, wheat and grain sorghum. In this study less than 20 percent of the farmers chose the other alternatives including corn, soybeans, alfalfa and silage. Collectively, only wheat and grain sorghum production will be analyzed. The general regression equation used included these independent variables: wheat price and acres, corn price and acres, grain sorghum price and acres, and soybean price and acres. Corn and soybeans are alternatives to wheat and grain sorghum utilized by many producers. No farmers in the study produced corn or soybeans continually each year of the study. Several did, however, produce them occasionally, presumably as an alternative to wheat and grain sorghum.

TABLE 11

ALTERNATIVE REGRESSION EQUATIONS EXPLAINING THE KANSAS FARM MANAGEMENT ASSOCIATION 3 DRYLAND WHEAT ACREAGE FOR THE YEARS 1973-1978

Independent Variables	Regression 1 Current Prices	Regression 2 Deflated Prices
Wheat acres lagged 1 year	.739 (.037)	.740 (.037)
Wheat price lagged 1 year		751.752 (288.853)
Soybean price lagged 1 year	-16.840 (8.995)	
Intercept	187.701	-973.890
R^2	.545	.549

Statistically, only last year's wheat acres and the soybean price lagged one year explain the current wheat production in Table 11, regression 1. The soybean price coefficient has a rather large standard error. As the price of soybeans increases, according to this model, less acres of wheat are produced. From 1973-1978, the soybean price increased from $3.24 a bushel to a high of $6.61 in 1976. While during the same period wheat sold for $1.55 in 1973 and for a high of $4.23 in 1974. This period of time and the changing prices apparently caused farmers to change cropping patterns in response to price. Wheat acres lagged one year also had an impact on current wheat acres. The R^2 produced by both equations in Table 11 is small, explaining 55% of the variation in current wheat production.

The deflated price series used in regression 2 produced almost an identical estimated regression coefficient for wheat acres as did the current prices. This equation, however, had a large coefficient for wheat price and an even larger coefficient for the intercept. These two factors, combined with the low R^2, indicate that variables other than those regressed have a relatively large impact on current wheat production.

Corn price of the previous year has a positive influence on current grain sorghum production, as shown in Table 12. Economic theory would suggest that for competitive outputs such as corn and grain sorghum, the relationship between corn price and grain sorghum output would be negative. Although corn is an alternative to grain sorghum on dryland ground, low rainfall tends to limit the production of corn. Corn and grain sorghum are alternative livestock feeds, so there may be some correlation between the two. Current soybean prices lagged one year produce a negative relationship between their price and the acres of wheat produced. Although the standard error is rather high, it does show statistical significance. According to this, as the soybean price increases, the acres of grain sorghum produced decrease. Soybeans and grain sorghum then may be considered to be competing for available inputs.

TABLE 12

ALTERNATIVE REGRESSION EQUATIONS EXPLAINING THE KANSAS FARM MANAGEMENT ASSOCIATION 3 DRYLAND GRAIN SORGHUM ACREAGE FOR THE YEARS 1973-1978

Independent Variables	Regression 1 Current Prices	Regression 2 Deflated Prices
Wheat price lagged 1 year		264.212 (158.682)
Corn price lagged 1 year	22.478 (9.720)	
Grain sorghum acres lagged 1 year	.741 (.037)	.748 (.040)
Grain sorghum price lagged 1 year		113.063 (68.200)
Soybean price lagged 1 year	-10.667 (4.517)	-25.802 (8.791)
Intercept	20.896	259.562
R^2	.559	.561

Grain sorghum explained by the regression of deflated prices, Table 12, regression 2, is determined by four variables: the previous year's wheat, grain sorghum, and soybean prices, plus the previous year's acres of grain sorghum. A negative relationship between wheat prices and acres of grain sorghum was found, and the same relationship was found between soybean price and grain sorghum acres. These two negative relationships indicate that there is some response in dryland grain sorghum production to changes in price. A positive relationship between grain sorghum prices and acres exists, indicating there is further price response in planting decisions. Although each of these coefficients has a rather large standard error, it does reinforce the theory that farmers account for price changes in determining production.

Summary of Farms with Dryland Acres in a Semi-Arid Region

Neither deflated nor current prices and their regressions on current production contribute much over 50% to the explanation of the variance in current production. In the semi-arid region of the state farmers respond about equally to current or deflated price in determining production goals. Current prices produced equations that were better fitted to the explanation of crop production from a theory standpoint. Both the grain sorghum and the wheat equations indicate that during this period farmers looked at the price of soybeans when determining what to plant. Although there is strong evidence presented in these equations to support the view that farmers respond to prices, a lot of the response in the equations was due to the previous year's acres. Normal crop rotation and summer fallow patterns seem to dictate more than do prices the current production of grain sorghum and wheat. The regression equations used for grain sorghum and wheat did not seem to fit this agricultural situation as well as they did in the irrigated region.

Analysis of Farms with Dryland Acres in Eastern Kansas

Kansas Farm Management Association four farmers studied by this report have these dryland alternatives: wheat, corn, grain sorghum, soybeans, alfalfa and silage. Alfalfa and silage may be considered primary inputs for livestock instead of cash crops. Wheat, corn, grain sorghum and soybeans are the major cash crops.

Dryland wheat acres in Kansas Farm Management Association four are explained in Table 13. Current price series used in regression 2 produces a negative response between previous year's soybean price and wheat acres. Previous year's wheat price produces a positive relationship between it and the wheat acres. Although the standard error of both lagged soybean and wheat price is large, it does indicate statistical significance. As shown by this equation, changes in the price of soybeans and wheat contribute to the explanation of wheat production.

TABLE 13

ALTERNATIVE REGRESSION EQUATIONS EXPLAINING THE KANSAS FARM MANAGEMENT ASSOCIATION 4 DRYLAND WHEAT ACREAGE FOR THE YEARS 1973-1978

Independent Variables	Regression 1 Current Prices	Regression 2 Deflated Prices
Wheat acres lagged 1 year	.624 (.041)	.543 (.039)
Wheat price lagged 1 year	25.277 (3.760)	130.382 (76.734)
Corn acres lagged 1 year	.036 (.013)	.046 (.013)
Corn price lagged 1 year		-94.320 (21.000)
Soybean price lagged 1 year	-13.510 (2.830)	-19.060 (4.766)
Silage acres lagged 1 year		.192 (.053)
Intercept	23.851	-5.263
R^2	.487	.477

Lagged acres of wheat and corn contribute to the regression equation explaining wheat acres. These regression coefficients may be associated with normal crop rotation practices. An R^2 of .487 indicates several other variables not in the equation contribute to the explanation of current wheat acres.

Regression 2, Table 13, explains the deflated price series' effect on current production of wheat. This equation differs from the current price equation in several ways. According to the estimated regression coefficients produced by the previous year's corn and soybean prices, there is a negative relationship between current production and previous year's prices of these two crops. There is a positive relationship between previous year's wheat price and current production of wheat. Soybeans, and especially corn and wheat price's standard error associated with their respective regression coefficients are rather high. All three were statistically significant in explaining current wheat production.

Wheat, all silage and corn acres lagged one year contribute to the explanation of current wheat production. This contribution may be taken as an indication of normal crop rotation methods. As with the current price explanation, this equation produced a relatively low R^2 of .477. This may be interpreted to mean that other variables not contained in either equation have a definite influence on production.

Grain sorghum production is explained by two variables according to Table 14, regression 2; acres of grain sorghum lagged one year and the deflated price of soybeans. A negative relationship exists between soybean price and acres of grain sorghum. Although the standard error of the estimate is rather high, soybeans price does statistically contribute to the explanation of grain sorghum production. The intercept, 70.81, explains that on the average farmers plant 70.81 acres of grain sorghum regardless of last year's production or price.

TABLE 14

ALTERNATIVE REGRESSION EQUATIONS EXPLAINING THE KANSAS FARM MANAGEMENT ASSOCIATION 4 DRYLAND GRAIN SORGHUM ACREAGE FOR THE YEARS 1973-1978

Independent Variables	Regression 1 Current Prices	Regression 2 Deflated Prices
Wheat acres lagged 1 year	.089 (.054)	
Corn acres lagged 1 year	-.027 (.017)	
Grain sorghum acres lagged 1 year	.699 (.041)	.733 (.036)
Grain sorghum price lagged 1 year	12.768 (5.085)	
Soybean price lagged 1 year	-10.971 (3.659)	-15.952 (5.121)
Intercept	41.605	70.810
R^2	.534	.540

Current prices as explained in Table 14, regression 1, also produce a large constant acreage of 41.6 acres. According to this explanation, grain sorghum and soybean prices also help explain current grain sorghum production. The relationship between grain sorghum production and soybean price is negative, suggesting that an increase in the price of soybeans causes a reduction in current grain sorghum plantings. A normal or positive relationship between grain sorghum price and grain sorghum acres produced exists, so that as grain sorghum price increases the production should increase, all other things being constant. There is a positive relationship between grain sorghum production and last year's wheat acres. Grain sorghum production is also positively related to last year's wheat acres. Grain sorghum production and last year's corn production have a negative relationship.

TABLE 15

ALTERNATIVE REGRESSION EQUATIONS EXPLAINING THE KANSAS FARM MANAGEMENT ASSOCIATION 4 DRYLAND CORN ACREAGE FOR THE YEARS 1973-1978

Independent Variables	Regression 1 Current Prices	Regression 2 Deflated Prices
Corn acres lagged 1 year	.865 (.027)	.864 (.025)
Soybean acres lagged 1 year	.220 (.074)	.212 (.069)
Intercept	.138	.643
R^2	.775	.774

The regressions explaining dryland corn production are almost identical, as shown in Table 15, regressions 1 and 2. Corn acres lagged one year and soybean acres lagged one year explain a large part of the current corn production. R^2 for both is .77, the highest calculated for any of the crops analyzed in this study. Crop rotations and normal planting with no response to price changes seem to explain the variation of corn production better than any other variables in the equation. Corn production does not seem to be adjusted for changes in price of corn or other grains as explained by these alternative regression equations.

TABLE 16

ALTERNATIVE REGRESSION EQUATIONS EXPLAINING THE KANSAS FARM MANAGEMENT ASSOCIATION 4 DRYLAND SOYBEAN ACREAGE FOR THE YEARS 1973-1978

Independent Variables	Regression 1 Current Prices	Regression 2 Deflated Prices
Wheat acres lagged 1 year	.205 (.040)	.196 (.039)
Wheat price lagged 1 year	-14.045 (3.931)	
Grain sorghum price lagged 1 year		-115.280 (33.241)
Soybean acres lagged 1 year	.644 (.039)	.645 (.038)
Soybean price lagged 1 year	12.473 (2.937)	14.432 (4.375)
All silage acres lagged 1 year	-.158 (.058)	-.155 (.054)
Alfalfa acres lagged 1 year	-.258 (.119)	-.205 (.104)
Intercept	-14.895	177.332
R^2	.554	.551

Soybean production under dryland conditions in Kansas Farm Management Association 4, as explained by regression 1 of Table 16, depends on several variables. Lagged wheat and soybeans acres have a positive relationship with current production of soybeans. A negative relationship between current acres and the lagged acres of all silage and alfalfa exists in this model. Apparently, production of silage or alfalfa in amounts more than needed for livestock usage competes with soybeans for resources. This competitive relationship may not only be for inputs of labor, management and capital, but for land and its normal crop rotation patterns. A negative relationship exists between lagged wheat price and current soybean acres planted. An increase in wheat acres would be associated with a decrease in soybean production. Current soybean plantings are positively related to lagged soybean price, with an increase in price causing an increase in planting. Standard errors and their coefficients seem to be larger than would be expected, but the coefficients are significant.

Lagged deflated prices and lagged acreages of various crops provide an alternative explanation of current soybean production with almost identical results as current prices, with a few exceptions. There is a negative relationship between grain sorghum price and soybean production. The other independent variables produce basically the same results as regression 1. The only other difference between these equations is the intercept which seems to be quite high at 177.33 acres. An R^2 of .55 was produced by the calculation of both equations.

Summary of Dryland Acres in Eastern Kansas

The regressions using current prices explained the variance of wheat, grain sorghum, corn and soybeans production more consistently than did the deflated price regressions. Both sets of regressions showed response to prices and acres. Apparently the crop rotation principles, expressed through the previous year's acres, determine a large part of the explained crop production. The interrelationships between one crop and its competitive alternatives are more complex in this region of the state compared to the semi-arid and irrigated ground analyzed earlier in this chapter. In every regression equation except the ones explaining corn, the price of soybeans has an impact on current production of all cash crops. The corn regression, with an R^2 of .775, was the best fitting regression found in this study. Also in this regional analysis, the wheat regressions were the poorest, which produced the lowest R^2 of this study.

Crop regression equations calculated for this area explain the same amount of variation in the current production as do the equations studied in the semi-arid region. All equations produced in this analysis contained information leading to the conclusion that acreage adjustments are made in response to other things besides changes in the price of the various commodities. From these equations it is evident past cropping patterns, explained by lagged acres, help determine current production. What causes this response to crop patterns is not ascertainable through this study.

CHAPTER V

SUMMARY AND CONCLUSIONS

Summary

In farming, two things influence gross income, the amount of production sold and the price received for the commodity. Farmers, individually, have little or no control over their price received, but they can control the acreage used in production. In the short run a farmer can sell at a level which only covers his variable costs, but eventually he must be compensated for his total cost of production.

What factors do farmers consider when determining their future production, prices or cropping patterns? From past production records it is obvious that farmers vary production. This variance is generally attributed to either price or cropping pattern changes by many economists.

Three agricultural situations were selected for this study: the semi-arid region of western Kansas, irrigated land in the same region and dryland in eastern Kansas. Farms from each of these regions were selected from the Kansas Farm Management Association data bank, and their production for 1973 through 1978 was used as a basis for this study. These farms, one hundred and fifteen in total, represent farms which remained fairly constant in size during this period of time.

Selecting farms of constant size during this period eliminated the effect of changing crop acreage on production.

The current commodity price and a deflated price series were compiled for use as the variables representing the price received for agricultural output. These prices and data on current production were combined in a data set for analysis on a program designed with the help of a Statistical Analysis System program. Only cash crops were analyzed, but other crops and livestock numbers were used in the preliminary equations designed to explain crop production variance. The production of some crops, which are used as inputs for another process such as feeding cattle, were not analyzed in this study. Analysis was restricted to wheat, corn, grain sorghum and soybeans.

The equations used for this study are distributed lag equations similar in many respects to equations used by Marc Nerlove's supply response study. All of Nerlove's equations were restricted to the use of data on current and past production of corn, wheat and cotton. Both Nerlove's study and this study used distributed lags, but at this point the similarity between the equations ends. Variables used in this study's equations included lagged prices of the crops produced, lagged prices and acreage of competitive crops, and in some cases variables to indicate use of crops for use as feed for livestock. Grain and feed utilized for livestock needs may either be produced or purchased at the market place. Variables such as livestock numbers on each farm and others were originally used in this study. None of these variables produced a significant explanation to crop production and hence are not seen in any of the alternative regressions of Chapter IV.

Additionally, some of the explanations presented do not include the crop's own price or its competitive crop's price. With the backward procedure used, insignificant independent variables are deleted from the final equation. The equations produced by this analysis varied widely, with the variables explaining from 48 to 77 percent of the variance in crop production. The equations worked best in explaining total variation for irrigated crop production. Equations explaining the semi-arid and eastern Kansas regions' production of dryland crops achieved less success. Irrigated land and current prices produced the best fitting equations of the whole survey. Similarly, equations using current prices for the analysis of dryland production in both regions, the semi-arid and eastern Kansas, produced better results than did deflated prices. From this a conclusion may be drawn: farmers respond to current prices rather than deflated prices when determining production. This conclusion is in conflict with Nerlove's methodology which used deflated or real prices in all regressions explaining production.

The equations seem to fit irrigated crop production best. This may be attributed to the fact that less total acres and fewer farmers are involved compared to dryland farmers in this study. Of the fifty-four farms analyzed in the semi-arid region of Kansas, only thirty-six percent of the farms had irrigated crops. Fewer acres and less farmers contributed a data set with less variance in production. Dryland production is comprised of more farms, each having more acres in production than with irrigated farms. The semi-arid region produced equations which produced less response to price and comparatively more response to cropping patterns.

As might be expected in a region where there are limited alternatives, other variables influence the planting decisions more than does price. In this area of the state, livestock needs, debt servicing requirements, and fewer alternatives restrict the production response to crop patterns and to rotations.

Compared to the irrigated and semi-arid regions of this study, the eastern Kansas crop production explanations were quite different with respect to the independent variables affecting production. Prices of alternative crops and past production patterns contributed a different explanation to current production. These farms were smaller in size, but the number of farms was about equal to the number studied in the semi-arid region. More variables were needed to explain variance in production, as this area has more feasible alternatives than in the other two areas. From the results produced in the equations, with the exception of corn, it can be concluded that variables other than price and past production contribute to the explanation of current production.

As a whole, it may be concluded that farmers respond relatively more to cropping patterns than they do to commodity prices in the regions included in this study. Nerlove's analysis points out that farmers respond both to prices and cropping patterns. Under his study all of the coefficients produced by variables representing prices were under 1.00 and their standard error was smaller than the ones calculated in this study. Nerlove's longer data set and larger area of study may have contributed to the explanation for this difference in the two studies.

The results of the midwest farmers' survey conducted by Glenn Johnson found that farmers responded more to cropping patterns than they do price. On the basis of this survey, that hypothesis is supported and further verified. In the regions of Kansas studied, cropping patterns are more important than are commodity price changes in determining current production. Past cropping patterns influence present crop production to a large extent.

Conclusions

In determining current crop production, farmers respond in certain cases to commodity prices. When commodity prices are considered, current rather than deflated prices best explain variance in crop production. Farms in the semi-arid region of Kansas behave differently in determining production, as there are fewer alternatives. Crops produced under irrigation are determined by about the same variables as on dryland, where in both cases the alternatives are restricted.

Cropping patterns in years past are more important than commodity prices in determining present production. Although response to cropping patterns varies somewhat by the region, all regions studied had significant response to past crop patterns in determining current production. Government price support and set aside programs, when in effect, control current production.

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APPENDIX

Nerlove's Alternative Regressions

Explaining United States Wheat, Corn and Cotton Acreage

1909 through 1932

The results of Nerlove's original work may be divided into three areas: corn, wheat and cotton acreage. Although this study does not analyze cotton, Nerlove's results are presented in this appendix. For each of the commodities, there are four regressions listed. Each of these alternative regressions corresponds numerically to the equations discussed in Chapter I of this study. For example, regression 1 has the form presented on page 13, Nerlove's first equation.

APPENDIX TABLE A

NERLOVE'S ALTERNATIVE REGRESSIONS EXPLAINING UNITED STATES WHEAT ACREAGE FOR 1909 THROUGH 1932

Independent Variables	Regressions 1	2	3	4
Expected "normal" price	0.865 (.159)	------	------	------
Price lagged one year	------	0.291 (.078)	0.346 (.104)	0.255 (.113)
Price lagged two years	------	------	------	0.193 (.115)
Acreage lagged one year	------	0.478 (.135)	------	------
Trend	1.394 (.169)	0.531 (.173)	1.029 (.170)	1.098 (.169)
Constant	-23.612	2.609	20.358	10.683
R^2	.77	.77	.64	.68

APPENDIX TABLE B

NERLOVE'S ALTERNATIVE REGRESSIONS EXPLAINING UNITED STATES WHEAT ACREAGE, INCLUDING CORN PRICE, FOR 1909 THROUGH 1932

Independent Variables	Regressions 1	2	3	4
Expected "normal" wheat price	0.871 (.168)	------	------	------
Expected "normal" corn price	0.415 (.264)	------	------	------
Wheat price lagged one year	------	0.291 (.081)	0.352 (.106)	0.273 (.124)
Corn price lagged one year	------	0.024 (.093)	-.066 (.117)	0.092 (.161)
Wheat price lagged one year	------	------	------	0.235 (.137)
Corn price lagged one year	------	------	------	-.143 (.168)
Wheat acreage lagged one year	------	0.492 (.139)	------	------
Corn acreage lagged one year	------	0.228 (.242)	------	------
Trend	1.470 (.170)	0.510 (.179)	1.020 (.174)	1.127 (.181)
Constant	-48.503	-22.528	23.705	8.041
R^2	.79	.78	.64	.69

APPENDIX TABLE C

NERLOVE'S ALTERNATIVE REGRESSIONS EXPLAINING UNITED STATES CORN ACREAGE FOR 1909 THROUGH 1932

Independent Variables	Regressions 1	2	3	4
Expected "normal" price	0.838 (.177)	------	------	------
Corn price lagged one year	------	0.419 (.091)	0.161 (.876)	0.047 (.102)
Corn price lagged two years	------	------	------	0.212 (.107)
Corn acres lagged one year	------	0.461 (.238)	------	------
Trend	0.380 (.105)	0.157 (.108)	0.206 (.105)	0.247 (.102)
Constant	61.603	45.050	91.702	83.331
R^2	.43	.35	.22	.34

APPENDIX TABLE D

NERLOVE'S ALTERNATIVE REGRESSIONS EXPLAINING UNITED STATES CORN ACREAGE, INCLUDING WHEAT PRICE, FOR 1909 THROUGH 1932

	Regressions			
Independent Variables	1	2	3	4
Expected "normal" wheat price	-.245 (.130)	------	------	------
Expected "normal" corn price	0.725 (.177)	------	------	------
Wheat price lagged one year	------	-.081 (.082)	-.094 (.081)	-.197 (.084)
Corn price lagged one year	------	0.159 (.094)	0.172 (.089)	0.040 (.109)
Wheat price lagged two years	------	------	------	0.043 (.093)
Wheat acres lagged one year	------	-.022 (.141)	------	------
Corn acres lagged one year	------	0.439 (.245)	------	------
Trend	0.206 (.137)	0.093 (.181)	0.113 (.133)	0.108 (.122)
Constant	79.770	55.616	98.705	94.765
R^2	.52	.39	.27	.51

APPENDIX TABLE E

NERLOVE'S ALTERNATIVE REGRESSIONS EXPLAINING UNITED STATES COTTON ACREAGE FOR 1909 THROUGH 1932

	Regressions			
Independent Variables	1	2	3	4
Expected "normal" price	14.329 (2.409)	------	------	------
Cotton price lagged one year	------	0.655 (.196)	0.603 (.238)	0.433 (.291)
Cotton price lagged two years	------	------	------	0.321 (.313)
Cotton acreage lagged one year	------	0.592 (.169)	------	------
Trend	-.188 (.129)	0.177 (.123)	0.481 (.096)	0.469 (.097)
Constant	128.219	4.994	23.560	21.788
R^2	.80	.74	.59	.61

KANSAS CROP PRODUCTION VARIATION IN
RESPONSE TO COMMODITY PRICE CHANGES

By

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B.S., Kansas State University, 1978

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In farming, two things influence the gross income of a farmer, the amount sold and the price received for that commodity. Individually, farmers have no or very little control over the price. They are then left with the other alternative, controlling their production. In 1977, 13,200,000 acres of wheat were planted and by 1979, only 9,593,000 acres of wheat were planted in Kansas. When the farmer analyzes his planting decisions, does the commodity price enter into his choice? The expansion or contraction of acres planted to any one crop is usually limited by two things: land available and the resources needed to plant those additional acres.

Prices and acres of each commodity produced in Kansas were collected and analyzed to determine if farmers respond to price in making their planting decisions. The acres used for this study came from three entirely different agricultural situations which exist within the state. Current production for the years 1973 through 1978 were collected for selected farms in these regions: the semi-arid dryland in western Kansas, irrigated ground in western Kansas, and the dryland in the eastern part of the state. Current acres was the dependent variable which was regressed on the various independent variables. The price of the crop and its competitive crops was used, along with the acres of the crop and its competitive uses, in a distributed lag equation to explain the variance of crop production in these Kansas areas.

In determining current production, farmers respond in certain cases to commodity prices. When commodity prices are considered, current rather than deflated (or real) prices best explain the variance in crop production within the state. Farmers in the semi-arid region behave differently in determining production than do the farmers in eastern Kansas. Semi-arid production is limited to a few economic alternatives, and hence less weight is given to alternative crops and their prices. Eastern Kansas farmers have more alternatives, and their production decisions reflect this, as the relationship between production and previous year's acres and prices is more complex. Crop production under irrigation is determined by about the same variables as on dryland, but in both cases the alternatives are restricted.

Cropping patterns in years past are more important than commodity prices in determining present production. Although there is response to price in some situations, all regions studied had a significant response to cropping patterns in determining current production. Farmers adjust more to the needs of their farms than they do to changes in commodity prices.