FARM COMMODITY PROGRAMS: THEIR EFFECT ON PLANTINGS OF FEED GRAINS AND SOYBEANS

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ABSTRACT

FARM COMMODITY PROGRAMS: THEIR EFFECT ON PLANTINGS OF FEED GRAINS AND SOYBEANS

By

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The objectives of this study were: (1) estimate the direct and indirect effects of farm commodity programs on plantings of feed grains and soybeans; and (2) evaluate whether these programs caused major misallocations of land among field crops.

Individual equations, designed to explain changes in planted acreage due to economic, technical and institutional forces, including farm programs, were specified for corn, oats, barley, sorghum and soybeans. These equations were estimated at the national and regional level using ordinary least squares. Specially constructed policy variables were included in all equations to capture the effect of commodity programs on plantings.

Three important sets of results were found in this study: (1) commodity programs have significantly influenced crop plantings, directly and indirectly; (2) program effects on plantings have differed among regions; and (3) with few exceptions programs have not prevented the efficient allocation of land among crops and regions.

Plantings of corn, the ranking crop in the U.S., have been substantially influenced by corn programs. Increases in the level of corn price supports have increased plantings while increases in diversion payments have reduced plantings. The percentage response to diversion payments was significant and of similar magnitude in most regions. The percentage response to price supports, however, has differed substantially among regions, being greatest in regions were corn does not dominate in production and least in regions where corn is the dominant crop.

Various competitive relationships were identified between corn and other crops regionally. Corn and sorghums were shown to be highly substitutable in the Southern Plains. In the Northern Plains a strong competitive relationship was identified between corn and soybeans; and in the Corn Belt some competition between corn and wheat was evident.

The results of the national corn equation reflect responses in all regions but are heavily influenced by responses in the major corn producing regions.

Barley and sorghum have also been subject to price support and acreage diversion programs. Plantings of either crop have not been greatly influenced by their individual price support programs. This was due, in part, to the fact that both crops were produced in dry areas where wheat is the only other major competitor for cropland, and wheat plantings have been restricted. So in these regions small changes in price support levels, of either barley or sorghum, have little effect on plantings.

Although barley and sorghum price support programs had little effect on the plantings of either crop, the diversion programs, in operation for each crop, had. When in effect, they substantially reduced plantings of their respective crops.

The significant response to diversion programs in corn, barley and sorghum reflects the fact that producers, throughout the U.S., were willing to remove from production poorer quality cropland in return for diversion payments. As better land is bid out of production, however, the response to diversion payments would decline.

Neither oats nor soybeans were subject to diversion programs but both received guaranteed price support. Own price supports had little effect on the plantings of either crop. With oats major structural changes occurred, on both the supply and demand sides of the market, so that oats production was no longer very profitable. Plantings declined rapidly in the past 20 years and small changes in support levels had little impact on the rate of decline.

The lack of response in soybean plantings to own support programs resulted from support levels being low vis-a-vis market prices so that the former were discounted in planting decisions. The net result of this was that producers were uncertain about future prices and so were slow to make adjustments in planting. Demand for soybeans has increased rapidly in recent years and the slow rates of adjustment in planting coupled with this has led to continuous upward pressure on soybean prices.

While soybean plantings were not influenced by own support programs, they were influenced by soybean market prices, by corn programs, and in southern regions of the U.S. by cotton prices.

Both corn price support and diversion programs inversely affected soybean plantings in all regions. An interesting aspect of this result is that as a result of corn diversion programs, which were introduced to control corn production, soybean production was also reduced, a response hardly desired by policy makers.

Although the farm commodity programs have influenced year to year plantings, regional land allocation among feed grain and soybean crops has, with few exceptions, been in accordance with comparative advantage in production. This is important since it indicates that the farm programs generally did not foster a major misallocation of land among crops and regions. Not alone has adjustments in land allocation been in the direction of comparative advantage, but the rate of adjustment also seems efficient. This latter conclusion is based on the fact that following farm program changes in 1971, which offered definite incentives to producers to base their planting decision on market conditions, no significant acreage shifts among crops and/or regions took place.

FARM COMMODITY PROGRAMS: THEIR EFFECT ON PLANTINGS OF FEED GRAINS AND SOYBEANS

By

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CHAPTER I

INTRODUCTION

Farm commodity programs have been in operation since the 1930s and have remained largely unchanged since then. Their affects on the structure, growth, resource allocation and income distribution in agriculture have been the subject of much research, but few definite conclusions. This research is designed to provide additional information on one of these issues, namely, the influence commodity programs have had on land allocation to the feed grains[1] and to soybeans.

Feed grain policy is a major component of the farm commodity programs and of U.S. commercial farm policy. Feed grains and soybeans form the link between the crop and livestock sectors of U.S. agriculture. Major advances in technology have substantially increased per acre yields of feed grains since World War II and the resulting increases in supply have typically not been fully matched with growth in demand. The result has been downward pressure on feed grain prices and farm incomes and increasing efforts through

[1]The feed grains include corn, sorghum, oats and barley.

government programs to restrict supplies. Government programs have sought to adjust production to utilization on a year to year basis by offering incentives to producers to expand or contract their plantings of major crops.[2]

The policy instruments used in production control have included support for farm product prices, acreage allotments on major crops, and cropland retirement. These instruments have been supplemented with commodity storage programs and demand expansion programs.

The objectives of this research are: (1) estimate the direct and cross-impacts of commodity programs on land allocation among the feed grain and soybean crops, and (2) evaluate whether a major misallocation of land among these crops occurred as a result of the commodity programs.

To meet these objectives it is necessary to isolate and measure the effects program changes have had on land allocation from the complex of interacting forces which influence land allocation decisions. This is done by formulating an economic model of firm allocative decisions and using this general framework as a guide in constructing equations intended to explain changes in planted acreage due to economic, technical, and institutional forces including the farm programs. These equations are estimated using

[2]Major crops include wheat and cotton in addition to feed grains and soybeans.

ordinary least squares regression techniques. The effects of commodity programs on land allocation decisions are captured by the inclusion of specially constructed policy variables in the estimated equations.

In 1971 program requirements were altered to allow producers flexibility in their planting decisions that did not exist in earlier programs. If previous programs had effectuated an inefficient allocation of land among crops, detectable and significant shifts in plantings would be expected under the 1971 program. That such a shift actually resulted from the change in programs is supported by farm productivity measures. For example, the USDA 1973 Summary Report on <u>Changes in Farm Production and Efficiency</u> shows that; (a) farm output increased by 8 percent between 1970 and 1971 as compared with a total of 5 percent increase between 1965 and 1970 [p. 5], (b) in 1971 crop output increased by 12 percent [p. 5], (c) input use in farming has remained without significant change for several years [p. 30], and (d) farm productivity increased by 7 percent between 1970 and 1971 as a result of the output increase while input use remained relatively constant[p. 31].[3] This research will seek to determine whether this productivity

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[3]In 1970 farm productivity actually declined due in part to the crop failures in that year. This partially explains the productivity increase in 1971 over 1970, but the extent of the 1971 increase is such as to require additional explanation.

increase can be attributed to acreage shifts among crops; in so doing this research will also seek to determine whether commodity programs have resulted in major misallocation of cropland in the past.

Regression analyses will be relied on heavily to fulfill the objectives of this research. Additionally use will be made of graphic and tabular analyses and the research findings of others who have worked on related issues.

Because of climatic and edaphic conditions, production patterns vary by region throughout the U.S. It seems likely that the responses to program changes will also vary by region. Therefore the analyses are conducted at the national level, and for six major crop producing regions of the U.S.

In Chapter II the theoretical foundations of the research are presented. Chapter III discusses the variables used in later empirical analyses including the constructed policy variables, and identifies the geographic regions selected. A brief summary of the farm commodity programs is given in Chapter IV, followed by a description of trends in production, yields, and acreage planted of the major field crops. In Chapter V the results of the national equations are presented; the results of the regional equations are given in Chapter VI. Chapter VII summarizes the principle conclusions of the study.

CHAPTER II

THEORETICAL CONSIDERATIONS FOR EQUATION CONSTRUCTION

Introduction

Farm commodity programs have sought to maintain stable food supplies and reasonable income for farmers by means of product price supports and at the same time reduce the possibility of excess production by restricting acreage planted. Year to year changes have been made in the levels of guaranteed price supports and acreage restrictions in attempts to balance production and utilization. The intended result of these policy actions was to change the pattern of land allocation in accordance with year to year needs. This chapter examines how economic and statistical theory can be used to guide in the construction of estimable equations capable of measuring the effects farm commodity programs have had on acreage planted to various crops.

Economic Model

The United States has nearly 2.3 billion acres of land of which 438 million acres is classified as cropland. In 1973 the acreage planted of the principle crops was 320 million acres.[1] While it is theoretically possible that all cropland in the U.S. could be planted to a single crop, such an outcome is entirely improbable. Corn, for example, which is the ranking crop in the U.S., in terms of area, had a planted acreage of only 71 million acres in 1973. Consequently acreage availability is not a constraint for any particular crop and is important only when the simultaneous expansion of plantings to all major crops is considered. Even then cropland acreage can be increased qualitatively with more intensive land use.

In the absence of significant supply constraints land allocation among field crops will depend on the marginal productivity of land in each use. An individual producer seeking to maximize his profits will allocate his land in such a way that the marginal returns from one use equal those from other uses. Most U.S. crop producers have the land and the complementary resources to produce a variety of field crops as is evidenced by rotational practices, and prior to each growing season must decide how to allocate land among different crops. Economic theory clearly indicates the variables which must be considered in making this decision if the objective is to maximize profits. Dillion

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[1]Crop acreages included are plantings of corn, sorghum, oats, barley, durem and other spring wheat, rice, soybeans, flaxseed, peanuts, popcorn, cotton, dry edible beans, dry edible peas, potatoes, sweet potatoes, and sugar beets; harvested acreage for winter wheat, rye, all hay, tobacco, and sugarcane.

1968 [p. 44-62] shows the derivation of the best operating conditions where multiple output responses are possible for each of which control can be exercised over the level of inputs used and where total response is subject to an overall outlay constraint. If r crops can be produced according to r response functions

2.1 $$Y_h = f_h(X_{1h}, X_{2h}, . . ., X_{nh}) \quad (h = 1,2, . . ., r),$$

subject to the single outlay restriction

2.2 $$\Sigma_h \Sigma_i p_i X_{ih} \leq C \quad (i = 1,2, . . ., n),$$

where X_{ih} is the quantity of X_i allocated to the h^{th} response process (and may be zero for some Y_h's), p_i is the price of input X_i, and C is the level of the overall outlay constraint.

The constrained objective function for the producer is

2.3 $$\pi = \Sigma_h(f_h(X_{1h}, X_{2h}, . . ., X_{nh})p_h) - \Sigma_h \Sigma_i p_i X_{ih} + \lambda\ (\Sigma_h \Sigma_i p_i X_{ih} - C),$$

where π is total profit, p_h is the price of product Y_h, and λ is an undetermined Lagrange multiplier. Profit is a function of the variables $(X_{1h}, X_{2h}, . . ., X_{nh})$ and λ, with the values of p_h, p_i and C exogenously determined. Profit is maximized with respect to the variables X_{ih} and λ by setting the partial derivatives of π with respect to these variables equal to zero. Setting $\delta\pi/\delta X_{ih}$ and $\delta\pi/\delta\lambda$ equal to zero yields (rn + 1) equations as follows:

2.4 $\quad p_h f_{ih} - p_i + \lambda p_i = 0$ (for which there are n such expressions) and,

2.5 $\quad \Sigma_h \Sigma_i p_i X_{ih} - C = 0.$

To obtain the best operating conditions, i.e., the amount of each of n inputs used in each of the r responses, it is necessary to rearrange and simultaneously solve the n equations of the form expressed in Equations 2.4 and 2.5. The reduced form equations obtained by simultaneously solving Equations 2.4 and 2.5 are the input demand equations for each input used in producing each output. The input demand (factor demand) equations for each X_{ih} are functions of p_h, p_i and C.

The required second order condition for a maximum (that the differential $d^2\pi$ be negative) is satisfied by the assumption of diminishing returns in production.

If corn production is one of the options open to a producer the amount of land used in producing corn is given by

2.6 $\quad X_{11} = f(p_c, p_k, p_i, C),$

where X_{11} is land used in corn production, p_c is the price of corn, p_k is the price of competitive products. Prices, p_i, of variable resources are included in the demand function. Rather than expressing the fixed input C in value terms, the level (quantity) is included.

The input demand curve for X_{11} is obtained by graphing the input demand function, Equation 2.6, as function of p_1 (price of land) alone, on the assumption that other product and input prices are given at some predetermined level Henderson and Quandt, 1958, p. 69 . Figure 2.1 shows the input demand curve, D, for land in corn production where p_1, price of land is given on the vertical axis, and q, the quantity of land used in corn, on the horizontal axis.

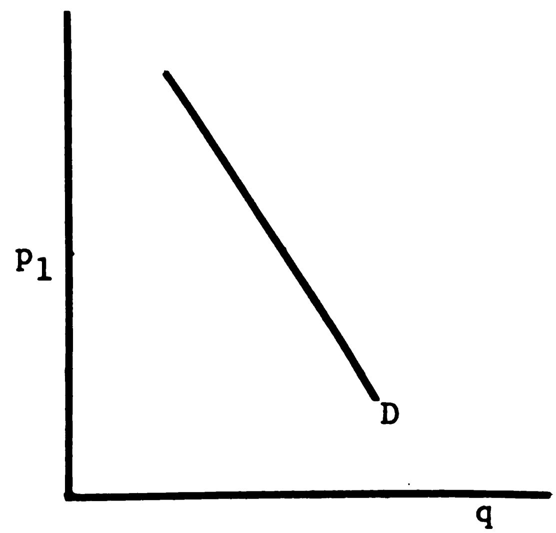

Figure 2.1. Factor-demand curve for land in corn production.

In Equation 2.6 prices are assumed to be exogenous to the firm, or producer, a condition which is consistent with the assumption of perfect competition. But when the factor demand of representative firms are horizontally summed over all firms, to obtain an aggregate factor demand, prices received cannot be assumed exogenous to the industry. It is reasonable to assume, however, that producers base their planting decisions on expected product prices and not on known prices. (Most input prices are known at planting time.) Consequently, in estimating industrial demand for a factor of production, expected prices replace the assumed known prices of Equation 2.6.

Equation 2.6 also omits important variables which influence land allocation over time. Such variables include the influence of government commodity programs, changing technical or institutional conditions, and weather. On the other hand, capital constraints which are important for the individual farm at a particular time are of lesser importance to industrial response over time.

Statistical Model

A modified version of Equation 2.6 can now be expressed in the general statistical form as follows:

2.7 $$AP_{it} = \beta_o + \beta_1 P^*_{it} + \beta_2 P^*_{jt} + \beta_3 IP_{kt} + \beta_4 Z + \varepsilon_t,$$

where AP_{it} is the acreage planted to crop i in year t, P^*_{it} and P^*_{jt} are the expected prices of crop i and competing crop j, respectively, in year t, IP_{kt} is the price of input k in t, Z includes such factors as government programs, technical change and weather, the β_i's are the coefficients associated with the explanatory variables, and ε_t is a random mean-zero disturbance with finite variance. A detailed description of each of the variables of Equation 2.7 will be discussed in the next chapter.

Since Equation 2.7 is a reduced form equation derived from a system of simultaneous equations, with all explanatory variables predetermined, ordinary least squares estimation techniques give consistent coefficient estimates [Kmenta, 1971, p. 539].[2] Ordinary least squares techniques will be used in this study as all estimated equations are of the form of Equation 2.7. Furthermore, since the emphasis of the research is on measuring the acreage response to farm commodity programs which change annually, all equations will be fitted to annual time series data.

The period 1950 to 1973 was selected for analysis as no dramatic change in U.S. farm programs has occurred since then. Most of the changes which have occurred, have been gradual in nature. In the case of grain sorghum, it was felt that the period 1956 to 1973 would provide a better base for analysis than the longer period because of the large yield increases which followed the introduction of hybrid sorghum varieties in the mid-fifties [Ross, 1970, p. 28-32].

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[2]The product price expectations models which are developed in Chapter III contain predetermined variables only. Input prices are regarded as exogenous to the planting decision.

CHAPTER III

DESCRIPTION OF VARIABLES AND UNITS OF ANALYSIS

Introduction

While Equation 2.7 offers a guide to constructing estimable equations, the form of the price expectations must be presented in observable terms as must the variables on government policy, technological change, weather and input prices. This chapter briefly describes the categories of variables used. Later sections present a discussion of the regions selected and the regional data used in the analyses.[1]

Acreage Planted

Acreage planted is the dependent variable in all equations. As the details of the commodity support programs are typically announced well in advance of planting time, data on intended rather than actual plantings would more accurately reflect producers response to program changes. Data on planting intentions, however, are not available for all crops over the period of analysis. Consequently data on actual plantings by crop were selected as the dependent variable.

[1]Data sources are indicated in Appendix A.

Expected Price and Policy Variables

Expected prices cannot be observed and must be approximated by observable prices. A possible expectations model is where expected prices are a function of the previous period prices only. Expectation models based on more elaborate distributed lags have been developed and are in common use in econometric work. The two distributed lag models which seem to be most useful for this study are, (a) the adaptive expectations model and (b) the partial adjustment model. The adaptive expectations model attributes the lags to uncertainty and the discounting of current information. The partial adjustment model attributes the lags to technological and psychological inertia and to the rising cost of rapid change [Griliches, 1967, p. 135].

All crops considered in this study were eligible for product price support and the guaranteed support prices have typically exceeded lagged market prices. Therefore, there existed little uncertainty about produce prices. With rather complete certainty of product prices, there is no basis for an argument supporting the use of adaptive price expectations models. The appropriateness of partial adjustment models cannot be so easily dismissed. This is particularly evident in the case of soybeans. The growth in demand for soybeans has exceeded growth in supply in the period since the 1950s, indicating a psychological inertia on the part of producers to change production patterns too rapidly.

No major or rapid market changes have occurred in the other crops and there are no strong a priori arguments supporting a partial adjustment hypothesis for these commodities.[2]

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[2]The general form of the partial adjustment model can be expressed as in Kmenta [1971, p. 476-477]. Suppose the desired level of Y at time t is Y^*_t which is a linear function of an explanatory variable X_{t-1} plus an error term ε_t; i.e.,

1. $$Y^*_t = \alpha + \beta X_{t-1} + \varepsilon_t$$

The values of Y^*_t are not observable, but we assume that an attempt is being made to bring the actual level of Y to the desired level, and that such an attempt is only partially successful during any one period due to various rigidifying forces. The relationship between the actual and the desired level of Y may be expressed as follows:

2. $$Y_t - Y_{t-1} = \gamma(Y^*_t - Y_{t-1})$$

Where γ is the adjustment coefficient and has values $0 \leq \gamma \leq 1$. Substituting for Y^*_t from (2) into (1) gives

3. $$Y_t = \alpha\gamma + \beta\gamma X_{t-1} + (1 - \gamma)\, Y_{t-1} + \gamma\, \varepsilon_t,$$

which is the general form of the partial adjustment model. When γ has a value close to zero this indicates that no adjustment in Y_t occurred from one period to the next and so the industry is in long run equilibrium. Other included explanatory variables then show no statistical influence on Y_t. On the other hand, when γ has a value close to unity this means that historically Y_t completely adjusted to its desired level from one period to the next. The coefficient values estimated for the explanatory variables other than the lagged dependent variable would show their individual effects on Y_t. When γ has an estimated value between zero and unity this indicates that historically Y_t only partially adjusted to desired levels. The coefficient values estimated for the other explanatory variables show their short run influence on Y_t. Their long run influence can be obtained by dividing the estimated coefficient values by the estimated value of γ.

Guaranteed price supports where offered each year for all feed grains and for soybeans. Producers had the option of availing themselves of the guaranteed price support (with its restrictions) or of taking their chances on market prices. These producer options for reaction to price stimuli would support the testable hypothesis, as presented by Houck, Ryan, and Subotnik [1972, p. 90], that the expected prices of corn, oats, barley, sorghums and soybeans can be expressed by a linear function:

$$3.1 \quad P^*_{it} = a_{11}P_{it-1} + a_{12}PV1_{it}$$

where P^*_{it} is the expected price of crop i in year t, P_{it-1} is the actual price received by farmers for crop i in year t-1, and $PV1_{it}$ is the price support policy variable for crop i in year t.

Actual price support operations have differed slightly among all the crops. Soybeans and oats both received guaranteed support prices but with no acreage restrictions. Measuring the effects of own policy programs on plantings of these two crops present few difficulties.

Price support operations for corn, sorghum and barley have consisted of guaranteed support prices and acreage restrictions. In addition, diversion payments were made to participants of the latter programs in return for the voluntary diversion of cropland. The guaranteed support prices often included several elements--a nonrecourse loan, and a direct payment which varied by participation level and by production history. Diversion payments, when in operation, also varied by participation level and by production history. Because of these various elements of the price support and diversion payments operations for corn, sorghum and barley, it is difficult to measure the impact of these commodity programs on plantings. Houck and Ryan [1972] suggested a means of weighting the announced price support by the acreage restrictions imposed, to obtain the "effective price support." Similarly, they obtained an "effective diversion payment" by weighting the announced diversion rate by the eligible diversion acreage. This procedure condenses four real variables; price supports, planting restrictions, diversion payments, and diversion payment restrictions, into two policy variables which have the disadvantage of any composite variables in that they mask the individual effects of each of their component parts, but have the advantage of simplicity.

This weighting procedure can easily be illustrated in the framework of the theoretical discussion of Chapter II. Consider again the hypothetical factor demand curve, (Figure 3.1), of land in producing any crop. Land prices are given on the vertical axis, acreage planted is given on the horizontal axis, and the factor demand curve D_o shows that at a land price P_o, A_o acres will be planted.

If the product price is increased, _ceteris paribus_, (e.g., by an increase in government support levels) the

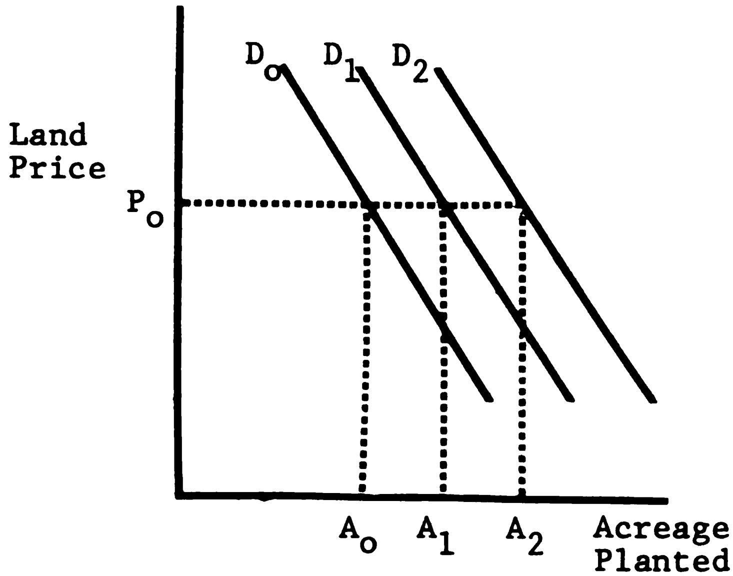

Figure 3.1. Factor demand curve for land.

factor demand curve will shift to D_1 and A_1 acres will be planted at a land price P_o. Further increases in product price will shift the factor demand curve to D_2, and A_2 acres will be planted at a land price P_o. Clearly the amount of land demanded for a particular use is a function of product price. This factor-product functional relationship is illustrated in Figure 3.2. The product support price is measured on the vertical scale and the acres planted are on the horizontal scale.

As the product support price increases for a particular crop, ceteris paribus, the acreage planted to that crop increases as indicated by S_1. If policy makers wish to have A_1 acres planted then setting the support price at PA would accomplish this objective. But if policy makers wish to have only A_o planted, they could reduce the support price to PV, or attach acreage restrictions to obtaining PA so that, on balance, acreage planted falls to A_o. Alternatively policy makers could make diversion payments to producers, which effectively raise the price of land in crop use and reduce plantings at all levels of product price, thereby shifting the acreage-product price response to S_2, where A_o acres would be planted for a support price of PA. In practice policy makers have used all three options in production control programs.

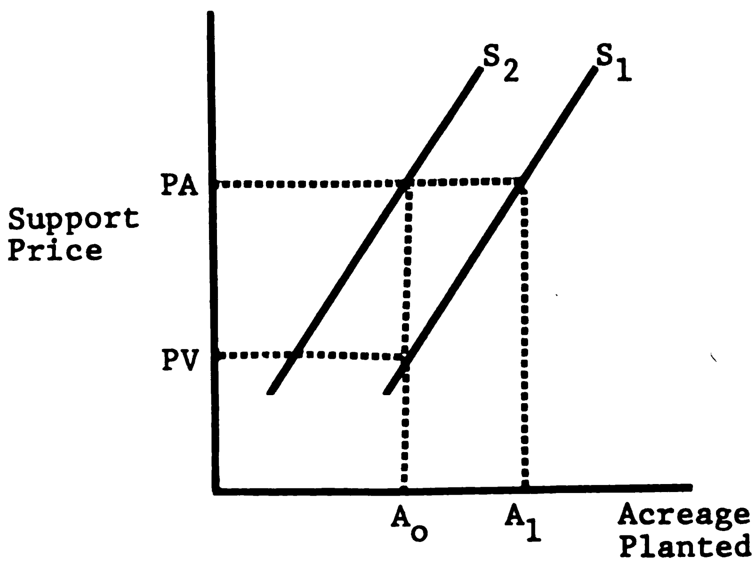

Figure 3.2. Acreage "supply" relationship.

Having illustrated how policy makers can adjust plantings by varying the level of price supports or diversion payments or by attaching restrictions to these policy instruments, the questions remain as to how can these various elements be combined in the weighted policy variables, "effective price supports" and "effective diversion payments."[3]

[3]More complete information on the calculation of the "effective price supports" and the "effective diversion payments" for all crops is given in Appendix B.

3.2 Let $PV1 = rPA$,

3.3 and $PV2 = wPR$

where PA is the announced support price, r is the adjustment factor reflecting planting restrictions, PR is the payment rate for diversion, w is the proportion of acreage eligible for diversion payments, PV1 and PV2 are the two weighted policy variables, the "effective price support" and the "effective diversion payment," respectively.

Both r and w can range from 0 to 1.0. If no planting restrictions are imposed on PA, r equals 1.0, and PV1 = PA. Similarly, if all land can be diverted for payment, w equals 1.0 and PV2 = PR. The tighter the planting restrictions imposed, the closer r will be to zero. The smaller the proportion of diverted acreage for which payments are made, the closer w will be to zero. So the values of PV1 and PV2 depend both on payment levels (PA support and PR diversion) and on the acreage eligible for payments (r and w).

In calculating PV1, r is assumed to be the proportion of the base acreage permitted for crop planting by program participants. In most years a range of plantings were permitted and to account for this, the minimum and maximum shares allowed were averaged. For example, in 1963 participants in the corn program could qualify for $1.25 support per bushel ($1.07 loan and 18 cents support payment) if they planted between 0.6 and 0.8 of their base acreage. Consequently, for corn in 1963, $r = 1/2\ (0.6 + 0.8) = 0.7$ and $PV1 = 0.7\ (1.25) = \$0.875$.

The values for PV2 were computed according to Equation 3.3. When the payment rate differed for various levels of diversion, Equation 3.3 was disaggregated, i.e., $PV2 = w_1PR_1 + w_2PR_2$ where the subscripts 1 and 2 refer to different payment rates for different portions of the diverted acreage. Furthermore, since a range of diversion was allowed for most years, minimum and maximum provisions were averaged as was done in calculating PV1. For instance, for corn in 1966 a minimum of 20 percent and a maximum of 50 percent of the base acreage could be diverted for payment. The payment rate was 75 cents per bushel for the estimated production on the first 20 percent of the base diverted and 65 cents per bushel on the next 30 percent of base acreage diverted. So, $w_1 = 0.2$, $w_2 = 0.3$, $PR_1 = 0.75$, $PR_2 = 0.65$, and $PV2 = 1/2 [(0.2 \times 0.75) + (0.2 \times 0.75 + 0.3 \times 0.65)] = 0.248$.

The averaging procedure used in calculating r and w was chosen because it closely corresponded to the actions of participants. For example, in most years between 1961 and 1970, participants in the feed grain program (which covered the crops of corn, sorghum and barley) were required to divert 20 percent of their feed grain base as a minimum with the option to divert for payment up to a maximum of 50 percent. The averaging procedure assumes that as a result of some producers complying at the minimum level, some at the maximum level and some at levels in between, the overall level of diversion would be 35 percent. Thus r would equal 0.65 and w would equal 0.35. The 1973 ASCS annual report [p. 167-169] shows that the actual amount of land diverted in the years 1961 through 1970 exceeded the simple average of the maximum and minimum rates in all years in which those options were available. Feed grain programs throughout this period, however, included a provision whereby small farmers (those with, or willing to reduce their feed grain base to 25 acres) could divert their entire acreage for payment. When the actual acreage diverted is corrected for the small farm component the result indicates that the averaging procedure gives a fairly accurate estimate of reality.

Oats producers have never been subject to acreage restrictions, nor have they received diversion payments. Therefore, for oats, PV1 = PA and PV2 = 0. Similarly, for soybeans PV1 = PA and PV2 = 0.

To summarize Equation 3.1 reflects the hypothesized price expectations of the feed grain and soybean crops. In the case of corn, sorghum and barley, however, the effective diversion payments (PV2), which shift this linear relationship, are part of the overall price expectation model. The effective price support (PV1) for soybeans has been low relative to market prices and has probably been viewed by producers as the lower bound of expected prices. Given the rapid growth that has occurred in the soybean industry there has been an excess demand for soybeans. This indication of only partial adjustment to the new market conditions suggests that it is appropriate to superimpose a partial adjustment model on the soybean price expectation model which is employed to estimate soybean acreage equations.

One comment remains on the price and policy variables included in the estimated equations. Because price support levels of other feed grains are established in accordance with the relative feed value of the particular commodity as compared to the feed value of corn, policy variables for two or more feed grains are not included in any single equation. Policy variables for the crop deemed to be the more important in explaining variation in the dependent variable are included. Lagged market prices replace the policy variables of the remaining crop(s). As policy makers adjust program provisions for a given year on the basis of the experience of the previous year and since policy control action influences market behavior, lagged market prices should reflect both current and past policy action.

No attempt was made to calculate policy variables for wheat or cotton even though it is obvious that these crops are major competitors for cropland. It is assumed that their lagged market prices accurately reflect both the results of production control programs for these crops and current price expectations.

Technological Change

A precise definition and measurement of technological change has baffled economists for years. Typically a trend variable is included in regression equations to capture the effect of this amorphous variable. In field crops, however, yields indicate changes in productivity per acre due to technological change. But yields include more than the impact of technological change as they are also influenced by input use and weather. Nevertheless they indicate to the producer the likely outcome of his production process and the expected per acre productivity.

Lagged yields are included in this study to capture the effect of technological change.

Weather

Weather is a very important variable in agricultural production. Different climatic features influence production differently at different stages of growth; winds, for example, may do little damage in early growth while doing extensive damage later in the season. When disease or insect attacks coincide with weather conducive to their growth the results can be damaging. Due to the variety of climatic elements which influence crop production, suitable weather variables are difficult to obtain for econometric work.

In this study, where the emphasis is on factors influencing plantings to various crops, precipitation at and immediately prior to planting time is viewed as the crucial weather variable. Most feed grains and soybeans are planted in late April through May in the U.S. [USDA Handbook, No. 283]. The average precipitation in April and May over all major crop producing states was calculated annually. To do this the total precipitation, in these months, was recorded for a selected climatic division within each state of the six included regions; each climatic division was selected to correspond with an important crop producing area within each state. The recorded precipitation of each climatic division was taken as a proxy of the precipitation in its respective state. Regional precipitation in April and May was taken as the simple average of its member states. National precipitation in April and May was taken as the simple average of that calculated for each of the six regions considered.

Input Prices

Because of the limited degrees of freedom available for estimation, a large variety of individual input price variables were not included. Price series were used for the primary inputs of land, labor and capital and for fertilizer a widely used intermediate input. The input price series used were: for land,[4] the per acre value of land and buildings; for labor, the hourly farm wage rate without room or board; for capital, the annual interest rate on prime commerical paper (4 to 6 months); and for fertilizer, the index of prices paid by farmers for fertilizer.

[4]The per acre rental value of cropland would be more desirable but such data were not available for the U.S. for the entire period of analysis. The per acre rental data that were available showed a strong positive correlation with the per acre value of land and buildings series used.

As an alternative to these individual input price series the index of prices paid by farmers for all commodities bought including interest, taxes and wage rates, was tried in many equations.

Other Shift Factors

Some changes in government programs are not readily expressed by the two policy variables already discussed. Examples of such changes include alternations in the method of making support payments which occurred in 1963 and 1966; the provision allowing substitution of wheat and feed grains from 1965 onward; and the further relaxing of program restrictions in 1971. These all represent factors which could alter plantings to various crops but which are not incorporated in the calculation of the policy variables. To account for these shifting factors binary (dummy) variables are used whenever they appear justified.

A Typical Equation

Having discussed the form of the variables which are used in estimation work a typical equation can now be presented as follows:

3.7 $$APC_t = \beta_o + \beta_1\ PV1C_t + \beta_2\ PV2C_t + \beta_3 PC_{t-1} + \beta_4 P_{kt-1} + \beta_5\ YC_{t-1} + \beta_6 W_t + \beta_7\ IP_t + \beta_8\ DV + \varepsilon_t,$$

where APC_t is the acreage planted to corn in time t, $PV1C_t$ and $PV2C_t$ are the calculated effective price support and effective diversion payment, respectively, for corn in time t, PC_{t-1} is the average market price of corn in time t-1, $P_{k,t-1}$ is the average market price of the competing crop k in time t-1, YC_{t-1} is the average yield of corn in time t-1, W_t is the average precipitation in April and May, IP_t reflects input prices in time t, DV represents other identifiable shift factors, and ε_t is a random, mean-zero disturbance with finite variance.

Regions Selected

As mentioned earlier regional as well as national equations are fitted to measure the response of government programs under different competitive structures. Figure 3.3 shows the regional selection made, where Region 1, includes the Corn Belt States; Region 2, the Lake States; Region 3, the Northern Plains States; Region 4, the Southern Plains States; Region 5, the Delta States; and Region 6, the South-Eastern States.

These regions, all of which are important in crop production, have somewhat different cropping systems. Corn is an important crop in the Corn Belt, the Lake States, the Northern Plains and to a lesser degree in the South East. Soybean production is concentrated in the Corn Belt, the Lake States, the Delta and the South East. Production of sorghums is confined almost exclusively to the drier Northern and Southern Plains Regions. Oat production, which alone among the crops is declining, is somewhat

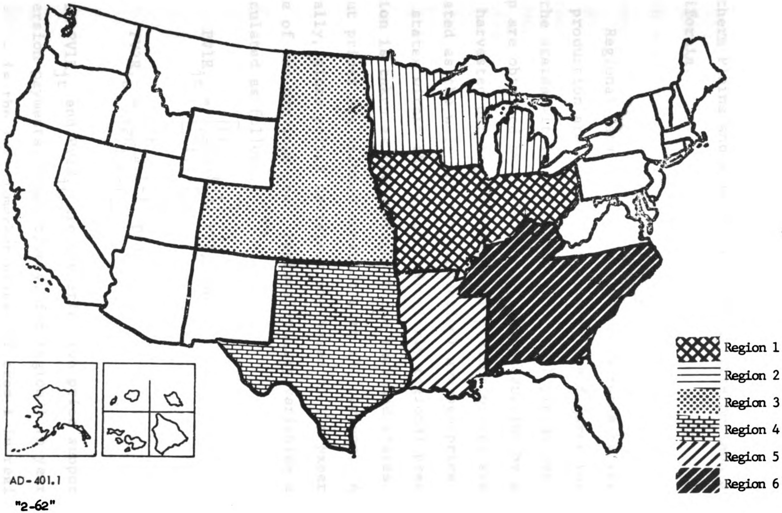

Figure 3.3. Regional map.

concentrated in the Corn Belt, the Lake States and the Northern Plains. Barley production is greatest in the Northern Plains and some Western states like Montana and California.

Regional Data

Regional data on acreage planted, acreage harvested and production are obtained by summing the figures for each of the states within the region. Regional yields for each crop are obtained by dividing regional production by acreage harvested per region. Regional product prices are calculated as the weighted (by production) average price of all states within the region. Similarly regional precipitation is taken as the average of the included states. Input prices are assumed constant over all regions. And finally, since policy decisions are based on the experience of the previous year, regional policy variables are calculated as follows:

3.5 $$PV1R_{jt} = \left[\frac{PR_{ij,t-1}}{PN_{i,t-1}}\right] PV1_t, \text{ and}$$

3.6 $$PV2R_{jt} = \left[\frac{PR_{ij,t-1}}{PN_{i,t-1}}\right] PV2_t$$

where $PV1R_{jt}$ and $PV2R_{jt}$ are the effective price support and diversion payments, respectively, for region j in year t, $PR_{ij,t-1}$ is the lagged market price for crop i in region j, $PN_{i,t-1}$ is the national market price for crop i in year t-1,

$PV1_t$ is the national effective price support in year t, and
$PV2_t$ is the national effective diversion payment in year t.

In this chapter the unobservable explanatory variables of Equation 2.7 have been replaced by observable variables which represent aspects of government policy action, producers price expectations, technological change, weather and prices paid by producers for inputs. In addition, six regions have been identified on which analysis will be conducted to supplement the results from the national equations.

CHAPTER IV

TRENDS IN PRODUCTION, YIELDS AND PLANTING OF MAJOR FIELD CROPS

Introduction

This chapter reviews the major production control legislation of the last few decades followed by a discussion of the trends in production, yields, and plantings of not only the feed grains and soybeans, but also of wheat and cotton (upland), both of which are major crops competing for land with feed grains and soybeans.

A Review of Commodity Programs

National farm programs, which have sought to assure adequate food supplies and stable prices while concurrently supporting farmers' incomes, have continued in essentially the same form since the 1930s when they were initiated. The same basic instruments of land retirement for supply control, commodity storage for price support, and food distribution and export promotion for demand expansion have appeared and reappeared under different names over the last four decades.

This review concentrates on price support and production control programs for the period 1950 to 1973. More complete reviews of commodity programs are given by Tweeten

[1970, p. 300-321] and by Rasmussen and Baker [1966, p. 68-79]. More complete program details are presented in USDA Agricultural Handbooks, Nos. 345 and 408.

The genesis of price and market stabilization programs dates back to the emergency credit and loan programs of the mid-twenties, but the basic price support and production control legislation started with the Agricultural Adjustment Act (AAA) of 1933.

The Triple-A Act of 1933 made price supports mandatory for the "basic" (storable) commodities--corn, wheat and cotton (upland). Provisions were also made for contractual production control agreements, in specified crops, between farmers and the Secretary of Agriculture.

In 1936 the Supreme Court declared the production control programs of the Triple-A Act unconstitutional. In that same year, however, the Soil Conservation and Domestic Allotment Act, which shifted the emphasis from acreage control toward soil conservation and upbuilding, was passed. This Act permitted acreage limitations on soil-depleting crops.

The Agricultural Act of 1938 strengthened and expanded the provisions of the Soil Conservation and Domestic Allotment Act of 1936. It provided for mandatory price support loans, acreage allotments, and marketing quotas for the "basic" commodities. Nonrecourse loans were established as the key price support instrument. Nonrecourse loans were loans made available to farmers at low interest rates which could be repaid at any time prior to maturity (usually less than one year). If a farmer chose not to repay, then the Commodity Credit Corporation (CCC) took title to the commodity, and the loan, including interest, was satisfied. The level of all price support loans was set in relation to parity. Parity was a concept which attempted to provide a standard on which to base the level of assistance given farmers. A historical period (1910-1914 or 1919-1929 for most crops), when farmers' returns provided them "fair" purchasing power, was established as the parity base. The 1938 Act, with many amendments, has provided the basic farm commodity legislation since then.

In 1941 the list of basic commodities was expanded to include rice, tobacco and peanuts. Later in 1941 the "Steagall Amendment" authorized price support loans for certain "nonbasic" commodities for the duration of the war and for the two years after the end of hostilities. Under This amendment the Secretary had discretionary power to offer support on a long list of commodities including milk, hogs, soybeans and potatoes.

High support prices (90 percent parity) and limited inventories characterized the war and post-war years. By 1949 inventories had begun to accumulate and efforts began to reduce the level of price support by introducing a flexible support system where commodities, instead of receiving fixed support at 90 percent parity, would be supported within a range of, say, 75 to 90 percent parity.

The Brannan Plan, which was essentially a deficiency payment support system, was introduced and was rejected in 1949. High price supports with few production restrictions continued through 1953. Beginning in 1950 parity prices were computed according to an updated formula. Under the new formula the relationship of individual commodities was changed to reflect average prices during the most recent 10 year period. This had the effect of increasing parity prices of beef cattle and hogs, and reducing parity prices for cotton, corn and wheat.

With high support prices and limited production restrictions, huge inventories developed and became so burdensome that new production control and demand expansion actions were sought. In response to the growing surpluses, a flexible system of price supports was adopted in 1954. Also acreage allotments for corn were reintroduced in 1954, which excepting 1950, was the first time corn allotments were used since 1942. The corn allotments remained in effect through 1958 when they were voted out by a producer referendum. These allotments applied only to the commerical area, a region normally regarded as the Corn Belt. Public Law 480, also enacted in 1954, provided broad authority for disposal of surplus commodities on foreign markets.

The Agricultural Act of 1956 established the Soil Bank, the first large scale effort since the 1930s to bring production in line with utilization. Under one provision, The Acreage Reserve, farmers were paid to reduce plantings of "basic" crops below allotment levels. Under a second feature, the Conservation Reserve, farmers were paid to divert all or part of their cropland to soil-conserving uses under long-term contracts. The Conservation Reserve was a general cropland retirement program and was not directed at specific crops.

Following the adoption of the Soil Bank Act, corn allotments were suspended and replaced by a larger (51 million acre) "base acreage." No acreage restrictions were in effect for corn in 1959 and 1960 and as a result plantings increased substantially.

The Agricultural Act of 1958 made price support for oats, barley and grain sorghum mandatory for the first time, with the level of support set at levels determined fair and reasonable in relation to the support price of corn. Prior to then support for these commodities was at the discretion of the Secretary of Agriculture.

Huge commodity inventories continued to develop throughout the 1950s and feed grains were an important component. Of a total investment in commodity operations of about $8 billion in 1960, over $3 billion was in corn and grain sorghum [USDA, CCC Charts, 1973]. A contributing factor to the surpluses of feed grains was that throughout the 1950s, land retired under allotment programs could be planted to other crops. For example, a clear inverse relationship exists between sorghum plantings (a nonallotment crop) and wheat and cotton plantings throughout this period.

While the 1950s saw a period of high support prices and ineffective controls, the 1960s saw high support prices but effective controls. In 1961 the emergency Feed Grain Act was approved. It was designed to divert corn and sorghum acreage to soil conserving uses. Producers were eligible for price supports if they diverted 20 percent of their feed grain base, i.e., the average acreage they had planted to corn and sorghum in 1959 and 1960. In addition to the price supports, diversion payments were made for the minimum 20 percent acreage diversion. For additional voluntary diversion up to a maximum of 40 percent of the base, extra diversion payments were made. The program was popular and the compliance rate among producers was high. The program was also expensive to the government, but it did restrain production and reduced high cost inventories.

Although the 1961 Feed Grain legislation was introduced as an emergency measure in 1961, it remained the basic feed grain legislation through 1970 with a few minor alterations. Barley, for example, was included in the program from 1962 through 1966 and again in 1969 and 1970. A 1963 amendment divided the high price supports into two parts; a nonrecourse loan and a direct support payment.

Between 1961 and 1963 feed grain producers who fed rather than sold their grain could not benefit from the high support payment which was granted as a nonrecourse loan exclusively. If they availed of the loan they had to repay in cash. The 1963 change guaranteed all compliers a direct support payment in addition to the diversion payments thereby making the program more attractive to feed grain producers who fed rather than sold their grain.

In 1965 another important modification was added where wheat allotment could become part of the feed grain base and vice versa. The main results of this change were the growing of wheat on barley acreage in the Northern Plains and wheat on sorghum acreage in the Midwest and Southern Plains [USDA Feed Situation, Ap. 1966].

Finally, from 1966 onward diversion payments ceased for the minimum 20 percent diversion, they were only made for additional voluntary diversion. The direct price support payments became in effect payments for minimum diversion.

For wheat and cotton the 1960s marked the beginning of the two tier pricing system. Major reductions in the wheat allotment also took place.

The Agricultural Act of 1970 marked a substantial departure from the 1961 legislation. Price supports were again exclusively paid as nonrecourse loans. Acreage diversion programs were labeled set-aside programs for which set-aside payments were made. The important distinction between the two programs was that after meeting minimum set-aside requirements and maintaining conserving base, producers could plant their remaining acreage without limitation to any feed grain crop or to wheat. In 1972 soybeans was included as a substitutable crop for feed grains or for wheat. A simple example will illustrate the potential effect of this change.

Assume a hypothetical producer with 300 acres of land, 100 acres of which is corn base. Under the 1961 program this producer could comply with the program by planting 80 acres of corn, diverting 20 acres and planting the remaining 200 acres to a crop of his choice. In 1971 this same producer could comply with the program and plant 280 acres of corn while placing 20 acres in set-aside. Alternatively he could plant 280 acres of any other feed grain crop, or of wheat. Nonrecourse loans were available for the total production of the crop planted.

The Agricultural Act of 1970 covered the years 1971, 1972 and 1973. The principle differences between these three programs were in the level of price support loans, the level of set-aside payments, and voluntary options on additional set-aside.

In 1973 the Agriculture and Consumer Protection Act was passed establishing a new mechanism of price supports which would be applicable through the 1977 crop year.

Under this new system minimum guaranteed prices, which were labeled "target prices," become effective only when market prices drop below the target rates. In the event of such an occurence, producers receive a direct payment of the amount of this difference on their base production.

To summarize then, the 1950s were a period of high price supports with limited acreage restrictions. Individual feed grains were treated separately and only corn was subject to any acreage restrictions. Land retired under allotment programs could be planted to "nonbasic" crops. The final outcome of these programs was burdensome inventory build-ups. From 1961 through 1973 price supports were accompanied by acreage diversion programs. Land retired under these programs could not be planted to any other major field crops. The feed grain crops were no longer treated separately. Rather, the feed grain program included corn and sorghum every year and barley most years. Utilization of feed grains exceeded production in most years and inventories decreased annually.

Neither oats or soybeans were ever subject to production controls.

Government Costs

Since large scale diversion programs were introduced in 1961, feed grain inventory fell from 85 million tons in 1961 to 34 million tons in 1973. Corn production, for example, exceeded utilization in only three years, 1963,

Table 4.1. Price Support, Diversion and Set-Aside Payments: Feed Grain, Cotton and Wheat, June 30, 1961 Through June 30, 1973.

Fiscal Year	Feed Grain	Cotton	Wheat	Excess of Sales Over Purchases*	Total
1961	333.2	-	-	-	333.2
1962	803.0	-	65.1	-	868.1
1963	677.3	-	268.6	-	945.9
1964	1,028.5	62.6	193.8	-	1,284.9
1965	1,196.2	486.2	32.5	106.6**	1,608.3
1966	1,272.4	506.0	38.1	160.0**	1,656.5
1967	1,340.4	812.9	302.8	1.7	2,457.8
1968	832.2	855.0	345.8	NS	2,033.0
1969	1,051.8	730.9	362.7	NS	2,145.4
1970	1,643.5	827.6	473.8	NS	2,944.9
1971	1,503.6	917.5	488.2	NS	2,909.3
1972	1,053.3	823.9	492.0	NS	2,369.2
1973	1,846.3	813.5	462.6	NS	3,122.4

*Represents excess of wheat marketing certificates sold by CCC over certificates purchased or to be purchased. This amount of net receipts is more than offset by refunds and subsidy payments to exporters on wheat and wheat products exported, and the value of marketing certificates included in the price paid by the corporation for wheat products purchased.

**Denotes gain.

NS = less than 50,000.

Source: USDA Commodity Credit Corporation Charts, 1973, p. 19.

1967 and 1971 [USDA Agricultural Handbook No. 455, p. 108]. While inventory of feed grains fell, these programs have been very expensive to the government. Table 4.1 shows the annual government costs of the feed grain, wheat and cotton programs between 1961 and 1973, inclusive. The overall total government cost was $24.7 billion, of which $14.6 billion went to feed grain producers.

The Production Changes in 20 Years

National Overview

In this section production in the early 1950s is compared with that in the early 1970s for each of the seven major field crops (corn, oats, barley, sorghum, soybeans, wheat and upland cotton). As production is the product of plantings and yields, it is useful to compare these also, to identify the source of the production shifts (Table 4.2).

Production of corn, barley, sorghum, soybeans and wheat have increased, that of upland cotton has remained fairly constant, while oats production has declined by 42 percent. The major increases in production have been in sorghums and soybeans.

Although production has generally increased, overall plantings to the seven crops have declined by 11 percent, from 268 million acres in 1950-52 to 239 million acres in 1971-73. Plantings of corn, oats, wheat and cotton declined by a total of 67 million acres, while sorghum and soybean plantings increased by 38 million acres.

Table 4.2. Changes in U.S. Production, Acreage and Yields of Selected Crops, Averages 1950-1952 and 1971-1973.

Crop	Production			Acreage Planted			Yields		
	1950-51	1971-73	Percent Change	1950-51	1971-73	Percent Change	1950-52	1971-73	Percent Change
	(Million Bushels)			(Million Acres)			Bushels/Acre		
Corn	3098[1]	5612[2]	+ 81	83	71	- 14	38.2	91.6	+140
Oats	1288	747	- 42	43	20	- 53	34.7	51.3	+ 48
Barley	263	437	+ 66	11	11	--	27.4	43.2	+ 58
Sorghum	163[1]	878[2]	+439	14	19	+ 36	19.6	57.7	+194
Soybeans	294	1340	+356	16	49	+206	21.1	27.7	+ 31
Wheat	1104	1625	+ 47	76	56	- 26	17.0	32.8	+ 93
Cotton (Upland)	13.4[3]	12.3[4]	NC	25	13	- 48	273[5]	484[5]	+ 77

[1]Refers to total production.

[2]Refers to grain production only.

[3]Millions of 500 pound gross weight bales.

[4]Millions of 480 pound net weight bales.

[5]Pounds per acre.

NC = Not comparable.

Yields of all seven crops increased. Rates of increase varied from 31 percent increase in soybean yields to an increase of 194 percent in sorghum yields. Except from some variations due to weather, yeilds have increased at fairly constant rates throughout this period. (Sorghum yields remained constant until 1956 after which they increased rapidly.) Yield increases have been due primarily to increased use of fertilizers, pesticides, mechanization and in the case of both corn and sorghums, to hybridization. Increased use of irrigation in recent years has also increased yields particularly in the plains states.

Of the two crops with greatest production increases, soybeans and sorghums, soybean production has increased mostly from increased plantings, whereas sorghum production has increased mostly from yield increases. Production increases in the other crops were entirely due to yield increases.

Region Overview

The production shifts, which occurred nationally, have not been uniformly distributed by region (Table 4.3). Corn production has declined both absolutely and relatively across the southern part of the country (Regions 4, 5 and 6), and increased in Region 1. On the other hand, the relative position of soybeans has increased in Regions 5 and 6, and decreased in Region 1. The production of both oats and barley has increased relatively in Region 3 and

Table 4.3. Percentage of U.S. Production by Region 1950-52 and 1971-73.

	Corn	Oats	Barley	Sorghums	Soybeans	Wheat	Cotton
Region 1							
1950-52	51	37	2	NS	75	13	2
1971-73	58	20	NS	6	60	9	3
Region 2							
1950-52	14	30	17	NS	7	5	NS
1971-73	15	32	9	NS	8	5	NS
Region 3							
1950-52	14	18	29	28	3	45	NS
1971-73	15	32	32	43	4	49	NS
Region 4							
1950-52	2	2	NS	64	NS	8	29
1971-73	NS	3	3	43	NS	10	33
Region 5							
1950-52	3	NS	NS	NS	7	NS	26
1971-73	NS	NS	NS	2	14	NS	30
Region 6							
1950-52	10	3	2	NS	5	2	23
1971-73	6	2	2	1	11	2	15
Total[1] 50-52	94	90	50	92	97	73	80
Total[1] 71-73	94	89	46	95	97	75	81
Other[2] 50-52	6	10	50	8	3	27	20
Other[2] 71-73	6	11	54	5	3	25	19

[1]Total of the six included regions.

[2]Percentage of production in states other than those included in the six regions mentioned.

NS indicates less than 1 percent.

has declined or remained fairly constant elsewhere. Sorghum production has shifted from Region 4 to Region 3, primarily to Kansas and Nebraska. (The production of sorghum in Region 4 doubled between 1950-52 and 1971-73, as production in Region 3 increased more than sixfold.) Wheat production declined relatively in Region 1 and has increased in both Regions 3 and 4. Cotton production has continued an earlier trend of moving west; production has increased in Regions 4 and 5 and about 20 percent is now produced in such western states as California, Arizona and New Mexico.

Overall production of all seven crops within the six regions has remained relatively constant between both time periods.

Table 4.4 shows the acreage planted by crop and by region in both time periods. Corn plantings which showed an overall decline nationally actually increased in both Regions 1 and 2. Plantings of oats, barley, wheat and cotton declined in most regions while sorghum and soybean plantings increased in all regions. The rates of decline and of increase have differed, however, in the different regions.

Corn plantings in Region 5 have declined to one-tenth their former level while in Region 6, they declined to about half their 1950-52 level. Oats plantings declined to one-third their 1950-52 level in Region 1 while increasing marginally in Region 4. Plantings of sorghum almost doubled in Region 3, but remained constant in Region 4. In Region 1, soybean

Table 4.4. Average Acreage Planted by Crop and by Region in 1950-53 and in 1971-73.

	Corn	Oats	Barley	Sorghums	Soybeans	Wheat	Cotton
	(Million Acres)						
Region 1							
1950-52	31.4	13.9	.2	.1	10.0	7.4	.5
1971-73	33.4	4.3	NS	.8	25.6	4.0	.3
Region 2							
1950-52	9.5	9.5	1.6	NS	1.3	2.5	NS
1971-73	11.5	4.7	.9	NS	4.3	2.3	NS
Region 3							
1950-52	15.6	9.6	4.4	4.7	.7	36.9	NS
1971-73	12.6	5.6	3.7	7.9	2.4	26.4	NS
Region 4							
1950-52	3.4	2.1	.3	8.5	.1	11.9	12.2
1971-73	.8	2.6	.6	8.7	.5	9.6	5.9
Region 5							
1950-52	3.9	.6	NS	NS	1.6	NS	5.3
1971-73	.4	.2	NS	.4	8.8	.6	3.3
Region 6							
1950-52	13.6	2.7	.3	.2	1.5	1.3	5.4
1971-73	6.5	.8	.2	.4	6.5	1.2	2.0

NS indicates less than .1 million acres.

plantings more than doubled, but increased over five times in Region 5.

Both wheat and cotton showed similar disproportionate rates of decline. Wheat plantings for example declined by almost 45 percent in Region 1, while plantings in Region 3 declined by less than 30 percent.

Table 4.5 shows the yields per acre in both time periods. As was the case with the national yields, all regions show

Table 4.5. Average Yields by Crop and by Region in 1950-52 and in 1971-73.

	Corn	Oats	Barley	Sorghums	Soybeans	Wheat	Cotton
	----------------			Bushels/Acre		----------------	Lb/Acre
Region 1							
1950-52	50.68	36.44	25.47	19.10	22.87	20.46	321
1971-73	103.07	55.09	41.98	72.39	31.44	39.86	534
Percent Change	103	51	65	279	37	95	66
Region 2							
1950-52	45.10	41.64	28.58	---	17.49	21.60	---
1971-73	87.92	54.08	45.49	---	26.06	36.68	---
Percent Change	95	30	59	---	49	70	---
Region 3							
1950-52	29.07	26.39	20.62	18.99	15.30	15.08	---
1971.73	84.83	49.27	40.40	58.34	25.34	32.08	---
Percent Change	190	87	96	207	66	113	---
Region 4							
1950-52	19.08	19.36	13.31	19.43	13.50	11.43	184
1971-73	86.83	33.50	31.17	55.32	22.79	24.18	351
Percent Change	355	73	134	185	69	112	91
Region 5							
1950-52	20.25	29.06	20.00	18.72	18.31	17.85	348
1971-73	42.72	56.59	---	43.49	22.00	30.53	560
Percent Change	111	95	---	132	20	71	61
Region 6							
1950-52	23.30	28.51	23.31	23.52	16.92	17.83	293
1971-73	63.44	45.73	43.31	50.81	23.23	31.85	475
Percent Change	172	60	86	116	37	79	62

increased yields for all crops. But the rates of increase again differ by region. The greatest percentage increase in corn yields occurred in Region 4. Most of this increase occurred in recent years with a 41 bushels/acre increase from 45 bushels per acre in 1967-69 to 86 bushels per acre in 1971-73. This major yield increase was due partly to good weather conditions, and partly to increased use of irrigation in that region in recent years. After Region 4, Region 3, another major irrigation area, showed the next largest increase in corn yields. The lowest rate of yield increase occurred in Region 2. Region 1, where the absolute level of corn yields was highest throughout this period, recorded a median rate of increase of about 100 percent.

Omitting the Southern regions where plantings to oats and barley are small, yield increases for both crops were greatest in Region 3 and least in Region 2. Sorghum yields increased more in Region 3 than in Region 4. Increases in soybean yields were greatest in regions with small plantings but of the major producing areas yields increased most in Region 2 and least in Region 5. Wheat yields registered their greatest increases in the plains where the rates of increase in both Regions 3 and 4 were equal. Finally, cotton yields increased by the greatest amount in Region 4 and by almost equal rates elsewhere.

Implications

Casual observation of these overall results indicate responsiveness to market forces. Crops for which demand has expanded have shown production increases and with the exception of soybeans the production expansion has been sufficient to keep annual average market prices relatively constant. Where demand has fallen, as in the case of oats, production has also fallen.

Additionally production patterns have generally moved according to the law of comparative advantage, i.e., regions have tended to concentrate more on the production of products, where they have a comparative advantage. This latter assertion is based on the data shown in Tables 4.3, 4.4 and 4.5 and will be discussed in the next few paragraphs. These data show that if yields are taken as representative of the technical productive capacity of land in different regions and are as such representative of the comparative advantage existing between crops and between regions, then crop production has moved in the direction of comparative advantage. Two qualifying points should be kept in mind throughout this discussion, (1) the concept of comparative advantage is a static one and must be interpreted with caution in a dynamic world, and (2) technical data, such as yield per acre, may not accurately reflect comparative advantage. That is production costs and product prices should also be taken into account.

Yields are, however, taken as indicative of comparative advantage as neither product or input prices vary greatly between crop producing regions. Data on yields were examined for both the early 1950s and early 1970s to detect any changes in comparative advantage which may have occurred between these periods. The analysis concentrates on the ranking crops produced in different regions. To illustrate the procedure followed a simple example is presented.

Table 4.6 shows corn and soybean yield in Regions 1 and 5 for 1950-52 and for 1971-73.

Table 4.6. Average Yields of Corn and Soybeans in Region 1 and Region 5.

(A) Average Yields 1950-52			(B) Average Yields 1971-73		
	Region 1	Region 5		Region 1	Region 5
Corn	50.68	20.25	Corn	103.07	42.72
Soybeans	22.87	18.31	Soybeans	31.44	22.00

If column 1, Section A, of Table 4.6 is compared with column 2, Section A, it can be observed that Region 1 has an absolute advantage in producing both corn and soybeans. But if row 1, Section A, is compared with row 2, it can be observed that Region 1 has a greater advantage, or a comparative advantage in producing corn, while Region 5 has the lesser disadvantage or has a comparative advantage in producing soybeans. Resources are allocated more efficiently if each region increases relatively the production of that commodity where it has a comparative advantage and decreases relatively the production of that commodity where is has a comparative disadvantage. Examination of the data presented in Tables 4.3, 4.4 and 4.5 shows that for the most part, this is what indeed happened.

The percentage of U.S. corn produced in Region 1 increased between 1950-52 and 1971-73, while it decreased in Region 5. Conversely, soybeans production as a percentage of U.S. total, decreased in Region 1 and increased in Region 5. More importantly, corn plantings absolutely increased in Region 1, while declining in Region 5. On the other hand, soybean acreage which increased by 33 million acres nationally increased at a faster rate in Region 5 than in Region 1.

Table 4.6, Section B shows that the direction of absolute and comparative advantage between these same crops and regions were the same in 1971-73 as they were in 1950-52.

Similar analysis indicates that between Regions 1 and 6 corn plantings should increase relatively in Region 1 over Region 6, while soybean plantings should increase relatively in Region 6 over Region 1, because of the direction of the comparative advantage between these two crops in these two regions. This is what actually occurred.

Again, the comparative advantage of corn and soybeans between Region 2 and Region 5 and between Region 2 and Region 6 indicate that the relative plantings of corn should expand in Region 2, while soybean plantings should increase relatively in both Regions 5 and 6. And again, this is what actually occurred. The comparison of yields for different crops (corn and wheat, corn and cotton, etc.) between different regions could be extended; however, the results are generally as expected. Production and plantings of crops increased absolutely or relatively in regions of comparative advantage and decreased absolutely or relatively in regions of comparative disadvantage. In most cases the direction of comparative advantage in 1971-73 has remained the same as in 1950-52 although the degree of comparative advantage sometimes decreased, e.g., between corn and wheat in Region 1 and 3 the absolute superiority of Region 1 over Region 3 in 1971-73 was about the same for both crops.

In at least one case the direction of comparative advantage was reversed in 1971-73. This was for corn and wheat between Regions 1 and 4 where recent sudden increases in corn yields in Region 4 reversed the direction of comparative advantage which existed in the 1950-52 period. This reversal illustrates the caution which must be exercised in the comparative advantage concept in a dynamic world where the adoption of a technological change uniquely suited to one region (irrigation in this case) completely changes the direction of comparative advantage over time.

Two notable exceptions to shifts in the direction of comparative advantage should be pointed out. Firstly, comparative advantage would indicate that between wheat and sorghum, wheat plantings should increase relatively more in Region 3 than in Region 4, while sorghum plantings should increase relatively more in Region 4 than in Region 3. Results show that the opposite occurred. Apart from the possible effect of commodity programs, another possible explanation of these results is that since the relative comparative advantages indicated by yields are not great, then if account were taken of differences in product prices and production costs in both regions the expected results could be changed. Second, in comparing cotton and corn yields between Regions 4 and 6, the relatively smaller decline in cotton plantings in Region 4 would not be indicated. Again, possible explanations lie in the effect of commodity programs on production patterns and on possible differences in production costs of both crops in these two regions.

Finally it should be noted that this analysis says nothing about the rates of adjustment in plantings, i.e., whether they would have been faster or slower in the absence of farm programs, it merely indicates that the direction in which they occurred was as would be expected in most cases. To see what the rates of adjustment actually were, the annual trends in plantings must be examined; these trends are the topic of the next section.

Acreage Planted by Crops

Figure 4.1 illustrates the yearly changes in plantings for each of the seven major field crops. A few highlights

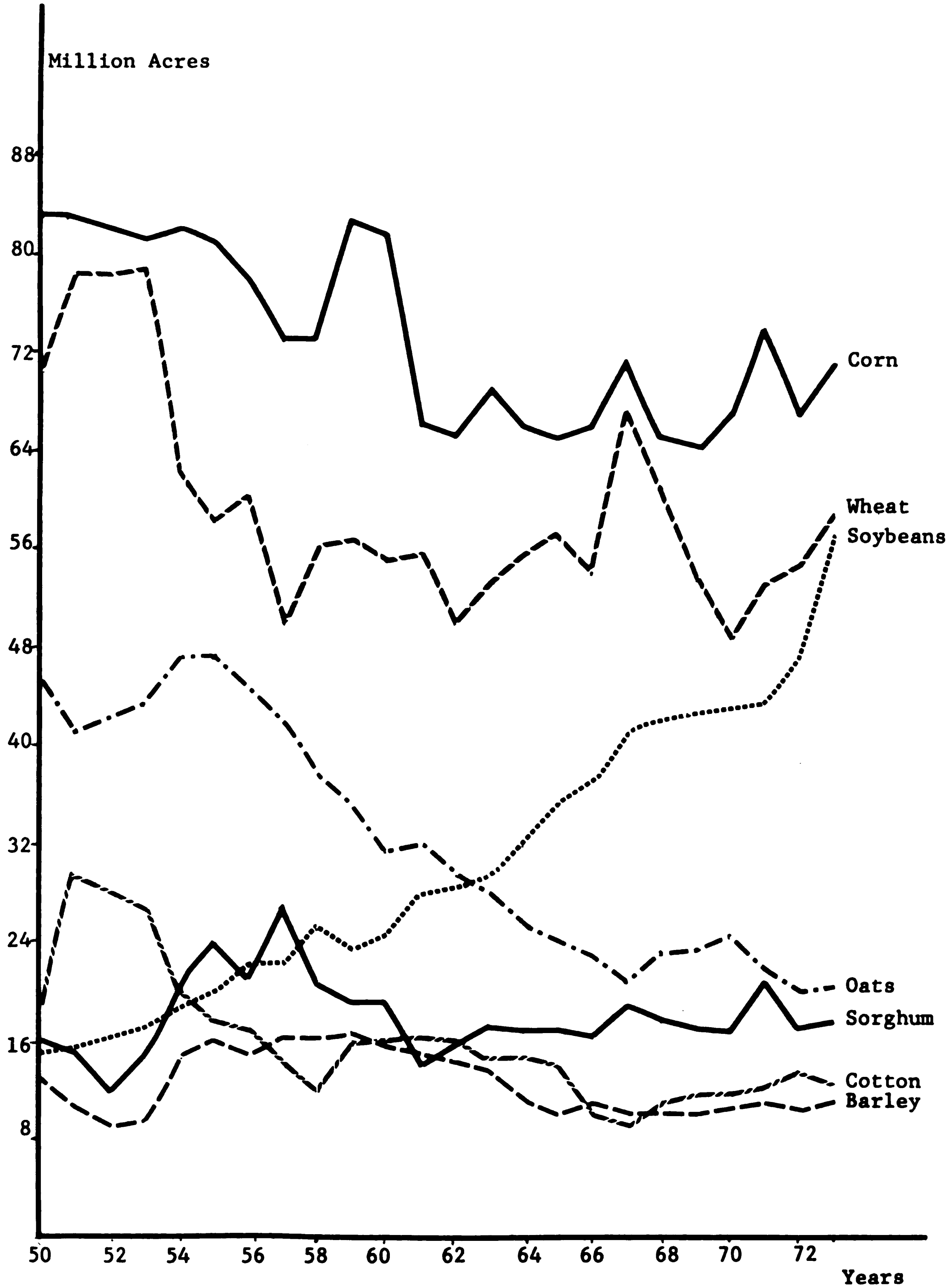

Figure 4.1. Acres planted to various crops; 1950-73.

should be noted on each of the crops particularly the effect of commodity programs, and the differences between the national and regional trends of each crop.

Corn

U.S. plantings of corn declined irregularly between 1950 and 1973 continuing a decline which began in the 1930s. Periods of rapid decline in 1956 and 1961 correspond with the introduction of acreage diversion programs; the acreage reserve program in 1956, and the feed grain legislation of 1961. Other increases and decreases in plantings closely parallel changes in commodity programs. For example, corn plantings increased by over 9 million acres between 1958 and 1959 following the removal of all acreage planting restrictions on corn. Again in 1967 and 1971, both years with no provisions for additional voluntary diversion over the 20 percent required minimum, plantings increased in response to program changes. Changes in corn plantings also corresponded to changes in the effective price support level. The effective price support of corn peaked in 1953 then declined in 1954 with the introduction of flexible supports (which reduced price support levels) and continued to decline through 1958. After a rise in 1959 and 1960, it again dropped in 1961 and has fluctuated in close correspondence with planted acreage since then.

Trends in corn plantings regionally (Figure 4.2) differ greatly by region. In Region 3 the trend closely

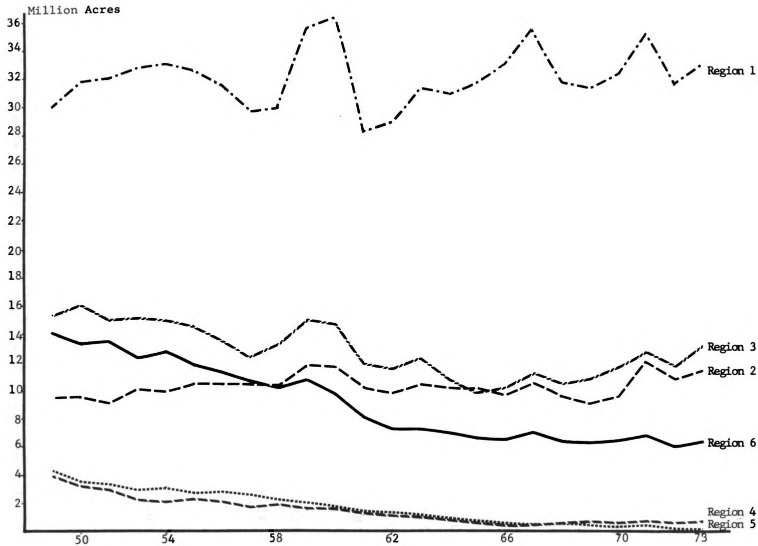

Figure 4.2. Corn plantings by region; 1950-73.

resembled the trend nationally. Annual planting changes in Region 1 were proportionately greater than nationally. They also showed an overall increase as contrasted to the decline nationally. Region 2, which also showed an overall increase in plantings, was unique in that plantings increased throughout the period 1950 to 1960; this occurred despite declining effective support rates between 1954 and 1958 and declining market prices from 1951 onward. Nor did the acreage reserve program, which clearly reduced national corn plantings, have any noticeable effect in Region 2. The rapid increase in the quantity of grain fed to dairy cows throughout the 1950s [USDA-ERS, Statistical Bulletin No. 303] probably accounts for this seemingly unusual behavior. Producers in Region 2, probably found it more profitable to produce their own feed grain than to purchase it despite rapidly falling market prices.

Corn plantings in Regions 4, 5 and 6 show a continuous downward trend throughout, with some slight changes in the rate of decline, particularly in Region 6.

Oats

Oats plantings increased to a peak of 47 million acres in 1955 and then declined rapidly to 20 million acres in 1967. As Brown [1971, p. 2] reports, this decline corresponded with the introduction of chemical weed control systems thereby reducing the need for oats in rotation. Demand for oats also declined over this period due to low numbers of horses and mules and to changes in feeding patterns toward more highly concentrated feeds. Since 1967, oats plantings have stabilized somewhat. Between 1955 and 1967 the greatest decline in oats plantings came in Region 1 (Figure 4.3), but all regions showed patterns similar to the national trend.

Barley

Barley plantings, following an initial decline in the early 1950s remained close to 16 million acres through 1961. In those years barley could be planted on retired acreage of allotment crops and a close inverse relationship can be seen between wheat and barley plantings through the 1950s. In 1962 barley was included in the feed grain program; in response to diversion payments, plantings dropped rapidly to about 10 million acres in 1965. Since then, barley plantings have remained fairly close to 10 million acres.

The major barley producing region of the six regions considered in this study is Region 3. Figure 4.4 shows that plantings in that region have followed a pattern similar to the national trend.

Sorghums

After a decline from 16 million acres in 1950 to 12 million acres in 1952 sorghum plantings increased to a peak of almost 27 million acres in 1957. Throughout this period the inverse relationship between cotton and wheat plantings on the one hand and sorghum on the other is very noticeable. Under provisions of the commodity programs sorghums could

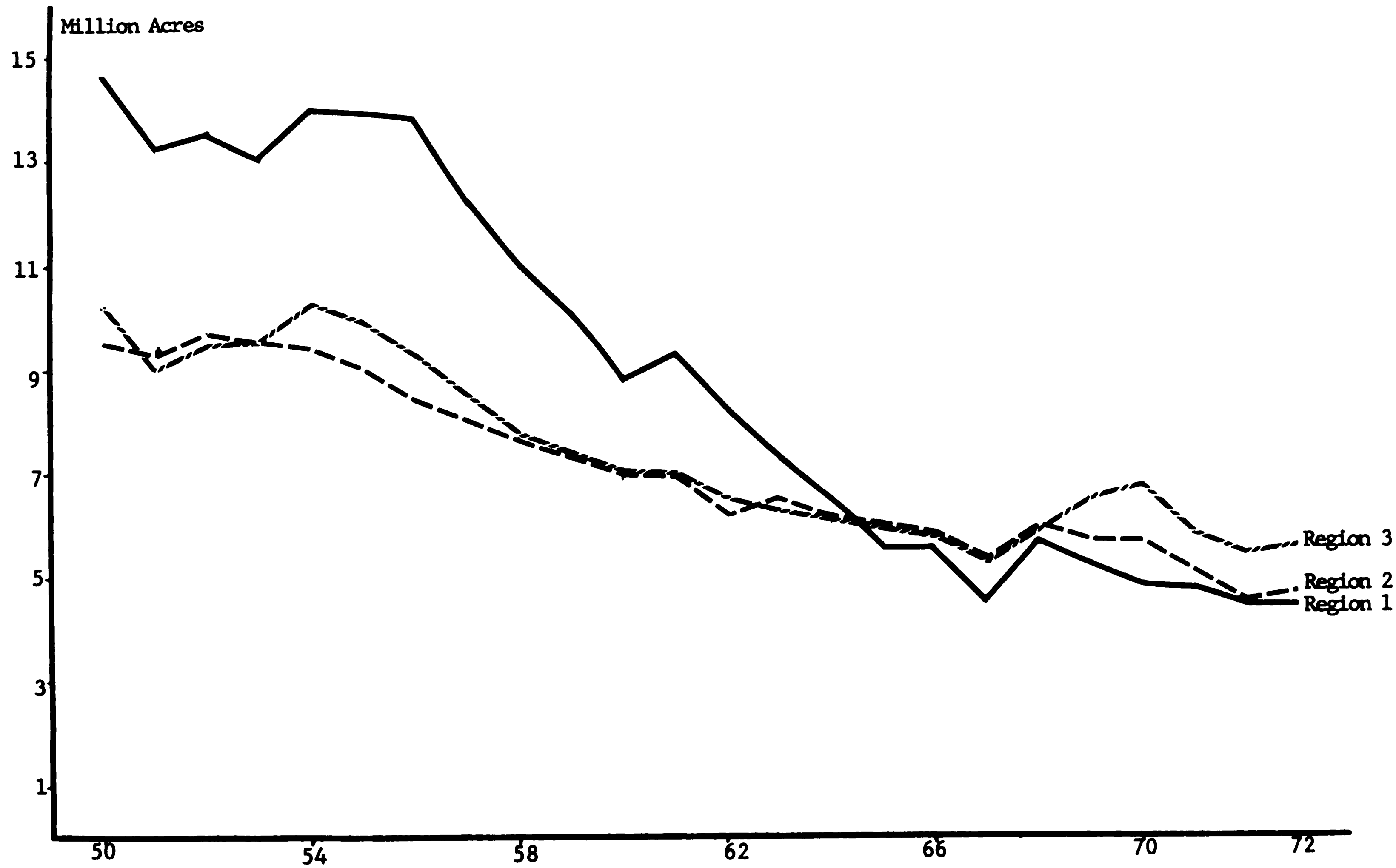

Figure 4.3. Oats plantings by region; 1950-73.

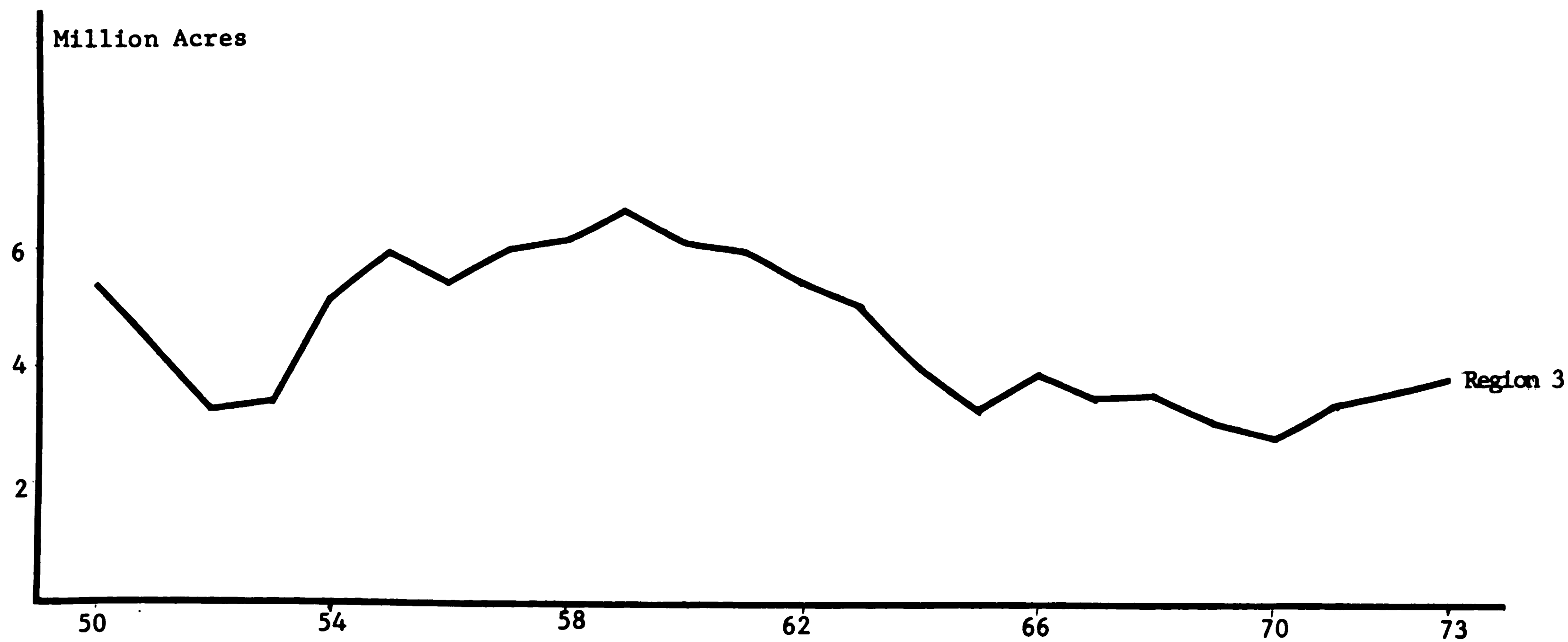

Figure 4.4. Barley plantings by region; 1950-73.

be planted on land retired from allotment crops including wheat and cotton.

Sorghum plantings in Regions 3 and 4 (Figure 4.5), the two major production areas, have behaved similarly to those nationally. Plantings in Region 3 very closely resemble those nationally except that there has been a greater proportional increase in plantings in Region 3 than occurred nationally. In Region 4 peak plantings occurred in 1954 rather than 1957, and in Region 4 there has been an overall decline in plantings. The fluctuations in the intervening years, however, typically follow the national pattern.

Soybeans

Aside from a slight decline in 1959, soybean plantings have increased continuously since 1950. Brown [1971, p. 1] shows that the percentage increase in soybean plantings in any year varied with program provisions for corn, wheat and cotton. The 1959 decline in soybean plantings, for example, corresponded with the removal of corn allotments. The increase in soybean plantings has been associated with declines in those of oats, wheat, cotton, corn and hay. But the most important contributing factor to the increased soybean acreage is the rapid increase in demand for soybean meal and oil which has maintained soybean prices and kept inventories at a minimum.

Soybean plantings by region (Figure 4.6) followed roughly the same pattern as occurred nationally. Region 5

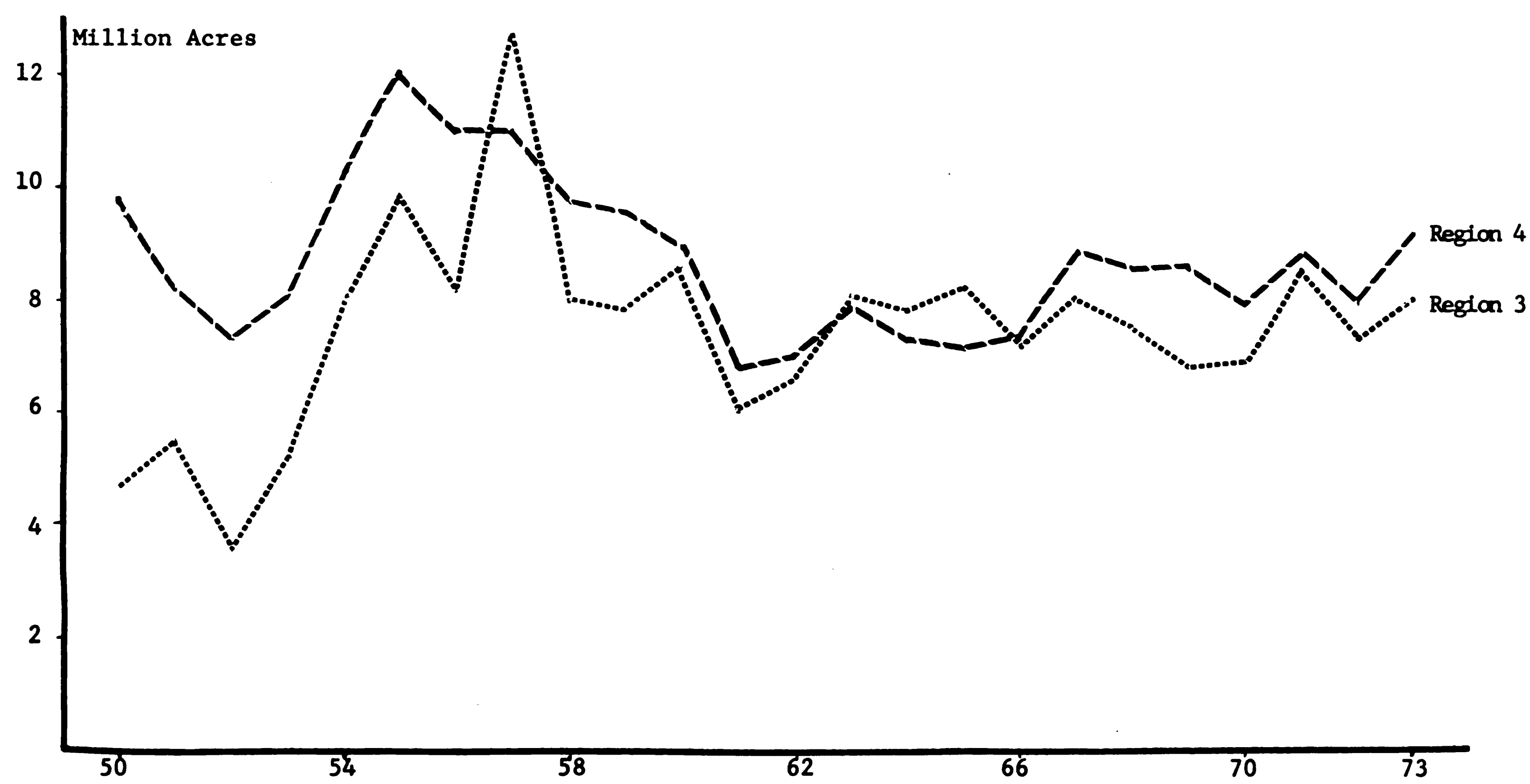

Figure 4.5. Sorghum planting by region; 1950-73.

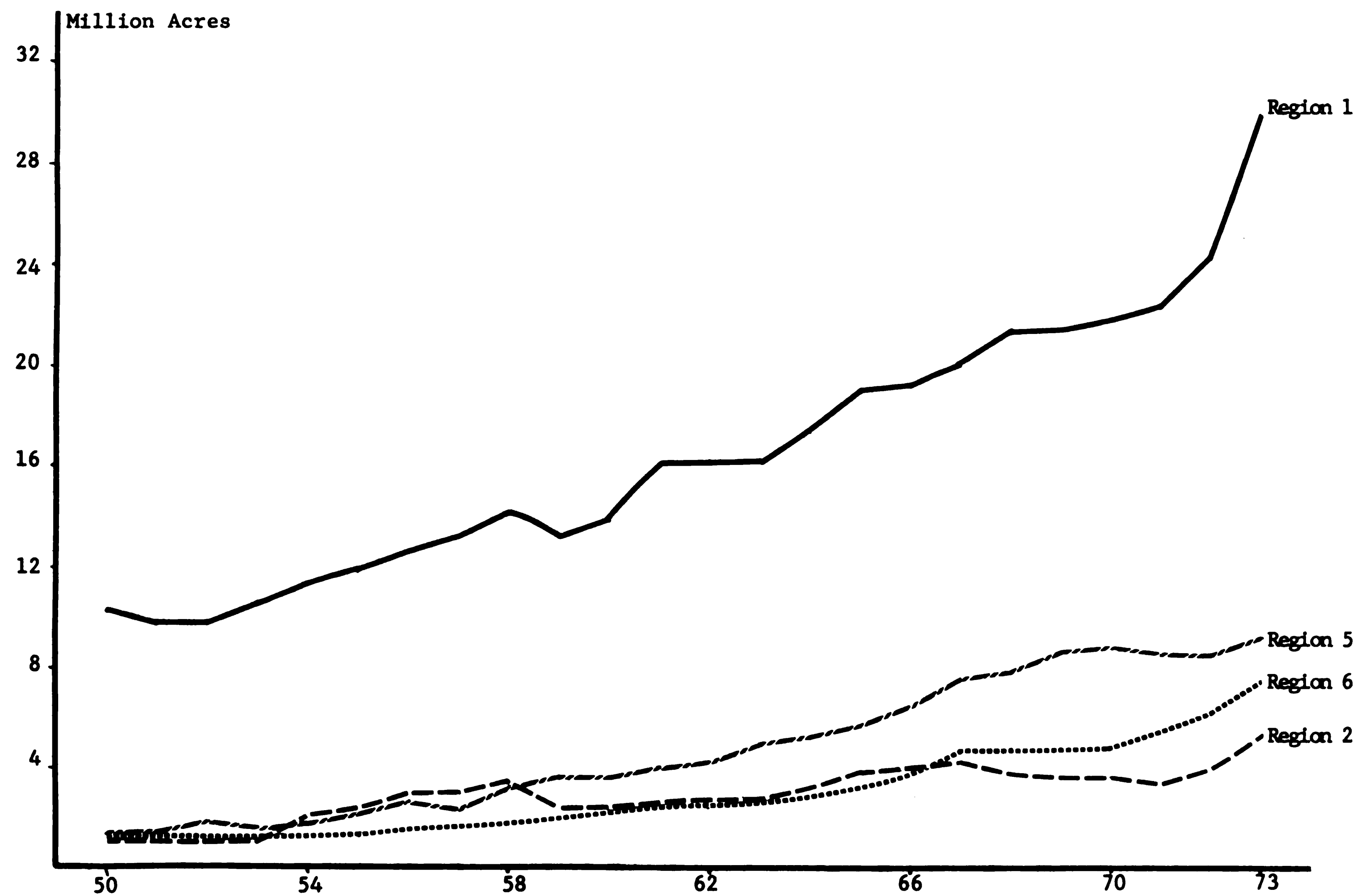

Figure 4.6. Soybean plantings by region; 1950-73.

showed the greatest proportional increase but plantings in that region have remained fairly constant since 1969. Region 2 shows the least proportional increase and plantings actually declined from 1967 through 1971. Mostly, however, the trend has been upward in all regions.

Wheat

Wheat plantings after rising from 71.2 million acres in 1950 to 78.9 million acres in 1953, then declined to 49.8 million acres in 1957. The high plantings in 1951 through 1953 were due to the fact that wheat allotments were not in effect. Allotments were reintroduced in 1954 and have been in effect each year since then. Between 1954 and 1963, marketing quotas were also in effect for wheat. Since 1964, the wheat program has been voluntary.

From 1962 on, wheat plantings have been influenced by provisions for mandatory and voluntary diversion of wheat allotment. The unusually large plantings in 1967 followed an increase in wheat allotments from 55 million acres to 68 million acres in that year. Thereafter allotments were again decreased. So, wheat plantings have been tightly controlled by government policy.

Regional plantings of wheat followed patterns similar to that nationally. Of the three northern regions, Region 3 showed proportionally greater annual shifts than occurred nationally while Region 2 showed lesser shifts. Of the three southern regions only Region 4 produces significant amounts of wheat. Annual acreage shifts in Region 4 have been proportionally less than occurred nationally and the overall decline in planting has also been less than occurred nationally.

Cotton

Cotton plantings increased from 18.8 million acres in 1950 to 29.3 million acres in 1951 and fell slightly to 26.7 million acres in 1953. The absence of cotton allotments between 1951 and 1953 explained this rise. Since then cotton allotments have been in effect each year. Plantings have fluctuated downwards as have allotments since 1954. Acreage diversion programs in effect since 1965, have reduced plantings further.

Most of the cotton planted in the U.S. is planted in Regions 4, 5 and 6. Region 4 is the principle producer. Planting patterns in all three regions followed the national trend. While plantings have trended downward in all regions the proportional decline was greatest in Region 6, and least in Region 5.

In summary the acreage planted to all seven major field crops has been greatly influenced by farm commodity programs while generally remaining responsive to market forces. The rate of acreage decline in the 1950s was not sufficient to prevent large inventory build-up while the decline in plantings throughout the 1960s and early 1970s resulted in a closer balance between production and utilization. These programs however, have been expensive to the taxpayer.

In the next chapter the relationships described here between farm programs and plantings are quantified for the national equations.

CHAPTER V

THE EFFECT OF FARM PROGRAMS ON PLANTINGS REGRESSION RESULTS OF NATIONAL EQUATIONS

Introduction

This chapter presents the results of the regression analyses of the national equations, quantifying the effects of commodity programs on plantings of the feed grain and soybean crops. Some preliminary results are presented first, followed by an equation by equation description.

Most of the components of a typical equation were given in Equation 3.7. The major element missing from Equation 3.7 was the identification of the structure of competition among the field crops. There exists no highly reliable way of performing this task but for this study reliance was placed on the following factors: (a) statistics on the location of production of the various crops over time; (b) information on the climatic and edaphic requirements of crops; (c) information on rotational practices in various regions; and (d) the writings of others familiar with production patterns of the major field crops in the U.S. Some of the postulated competitive relationships were not supported by significant statistical results as will be seen in the discussion of the individual equations.

Preliminary Results

These results which are presented in three different sections all have the common feature that their parameter estimates are not significant statistically.

Firstly, no significant acreage shifts among crops was detectable following the 1971 program change. This change, which allowed producers plant their entire acreage to the crop of their choice after meeting specified land retirement needs, gave producers greater flexibility in their planting decisions than they had previously. To detect if acreage shifts among crops occurred following this program change, a binary variable was included in all equations, except that of oats. This variable was assigned a value of zero prior to 1971 and a value of one thereafter. In no instance was the estimate of the coefficient associated with this variable significant statistically; therefore, there is no strong evidence that acreage shifts occurred among field crops following the 1971 program change. Such shifts may have occurred interregionally or intraregionally as a result of the program change; however, if such were the case, these shifts had no detectable effect on national plantings. This result raises doubts as to whether the major farm productivity increases of 1971 were due to acreage shifts among crops. The result is generally supportive, however, of the previous conclusion that plantings to the major field crops have moved in the direction of comparative advantage and that past programs did not cause major inefficiencies in land allocation, particularly among the feed grains and soybeans. This result also indicates that not only was the direction of acreage shifts among crops as expected but also, that the rate of adjustment was complete. The historic production patterns of the major field crops are so strongly influenced by such physical factors as climate and soil conditions that substantial changes in market forces, such as could result from government intervention, would be required in order to cause rapid and significant misallocation of cropland acreage among field crops. Typically the commodity programs for feed grains and soybeans did not take a strong anti-market position; rather policy actions were guided by the prevailing market forces.

Furthermore, feed grain programs have always been voluntary so that the individual producer had the option of complying or not in accordance with economic considerations unique to his firm. Throughout the 1960s the maximum amount of feed grain base acreage signed up under the feed grain program was only 66 percent of that eligible; a fact which suggests that many producers found it profitable not to comply with the feed grain program. This participation rate well exceeds that of the 1950s when the participation rate was typically less than 20 percent of those eligible. Vermeer [1968] found that following the 1962 feed grain program an <u>ex post</u> evaluation showed that program compliance increased the profits of only 10 percent of participants; remaining participants would have increased their profit had they not complied. This observation, together with the relatively low compliance rates (relative to that in wheat and cotton programs), indicates that the feed grain program offered little incentive to divert highly productive land or to plant it in less productive uses. A survey by Vermeer [1963], following the 1961 program showed that producers complied with the feed grain program for a number of reasons (risk reduction, land improvement, etc.) other than increased profits. These survey results demonstrate that compliance with the feed grain program was not perceived as highly profitable by many; rather, its potential benefits differed by the circumstances of the individual producer.

Under the voluntary feed grain programs corn, barley and sorghums could be substituted for each other if the producer so wished. From 1965 onward, wheat could be substituted for these feed grains and vice versa. In some years all payments under these programs could be retained when soybeans were substituted for feed grains or wheat. These substitution provisions further reduced the potential inefficiencies in land allocation among crops due to the feed grain programs.

Despite these substitution provisions, however, the percentage of eligible base acreage participating in feed grain programs reached a maximum of only 66 percent throughout the 1960s and most typically was about 60 percent. The participation rate jumped to over 80 percent following the 1971 program change and reached a high of 92 percent in 1972. Clearly the 1971 program change was seen by producers as desirable; clearly the program prior to 1971 did not offer a sufficient incentive to many producers which outweighed the opportunity costs of restricting feed grain plantings to a percentage of a given base acreage. Otherwise why would they respond so dramatically when these particular restrictions were removed? The increase in the participation rate in feed grain programs following the 1971 change does not necessarily imply an acreage shift among crops. It only shows that producers who previously did nto comply with the programs because of the restrictions imposed on planting decisions upon compliance (i.e., planting only a percentage of the base acreage allocation of the program crops) chose to comply when restrictions were removed. Generally producers could, however, maintain their past planting patterns; this appears to be what happened.

Coupling the facts that the feed grain programs were voluntary, flexible, and not highly profitable, it is not very surprising that no detectable shifts in planted acreage among crops were found following the 1971 program change. Acreage adjustments among feed grain crops were occurring on a continuous basis throughout the period of analysis and the farm commodity programs did not act as a major deterrent to these adjustments.

Secondly, preliminary results indicated insignificant coefficients associated with both the input price and the weather variables. Price variables for land, labor, capital and fertilizer were included in all equations but invariably the estimated coefficients associated with these variables were highly insignificant. They also often had the wrong sign. A high degree of multicollinearity existed among the price series used for land, labor and capital but systematic exclusion of each series from each estimated equation failed to show any significant effect on crop plantings. The oats equation did result in a significant coefficient associated with labor prices when the trend variable, T, was excluded from the oats equation. Labor prices were, however, almost perfectly correlated with the trend variable, which was probably the reason for the significant coefficient found since oats plantings have shown a continuous downward trend over the past two decades. This downward trend in oat planting was hardly due to increased wage rates.

When the individual input price series were replaced with the index of all prices paid for agricultural production the results still showed that input prices had an insignificant effect on crop plantings.

As far as weather is concerned, while it can have a very important impact in some localities in certain years its national effect, particularly on plantings, is probably randomly distributed over time.

Thirdly, preliminary results showed no shifts in planting response patterns following alterations in the payment mechanism to feed grain producers in 1963 and 1966.

These alternations were explained previously and it was thought that they might influence plantings to a significant degree. No evidence to support these hypotheses was found.

National Equation Results

Corn

The crops which seem most competitive with corn are soybeans and wheat and to a lesser degree, sorghum. Price variables for both soybeans and wheat were included in the corn equation in order to estimate the competitive relationships between these crops and corn.

The estimated coefficients of the national corn equation are given in Equation 1.1 of Table 5.1.[1] All signs are as expected, the R^2 is 0.96 and, the t values are relatively large. Corn plantings show a significant response to changes in both corn price support and corn diversion programs. The response in corn plantings to wheat program changes as reflected in the lagged wheat price is also statistically significant, while the responses to the remaining independent variables are not very significant.

An unexpected result is the apparent lack of relationship between soybean price and corn plantings. Houck and

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[1]A partial adjustment model, as presented in Chapter III, was superimposed on the national corn equation initially. The partial adjustment hypothesis was rejected however, as results showed that producers made a complete adjustment to desired planting levels in the first period following changes in expected prices. Such rapid adjustment indicates that the corn programs created a degree of certainty which resulted in rapid response by producers to changing market conditions.

Table 5.1. Ordinary Least Square Estimates, National Equations (Regression Coefficients and t-Values)

Commodity	Equation	Time Period	Dependent Variable	Independent Variables									R^2	$\bar{S}$	DW
				Constant	PV1C	PV2C	PNC_{t-1}	$PNSB_{t-1}$	$PNAW_{t-1}$	YNC_{t-1}	$YNSB_{t-1}$	$APSB_{t-1}$			
Corn	1.1	1950-73	APC_t	76653.1	10063.8 (3.03)	-71943.1 (7.98)	2196.1 (.48)	-1434.4 (.77)	-6605.8 (2.87)	108.2 (1.54)			.96	1602.4	2.25
Soybeans	1.2	1950-73	$APSB_t$	-2774.0	-10589.2 (4.41)	-12587.1 (1.88)		7810.1 (5.73)	-1524.9 (.67)		352.3 (1.35)	.70 (5.37)	.99	1151.4	
					PV1SH	PV2SH	$PNSH_{t-1}$	$PNCT_{t-1}$	$PNAW_{t-1}$	$YNSH_{t-1}$	DV				
Sorghum	1.3	1956-73	$APSH_t$	23268.7	24.7 (.01)	-13463.1 (2.68)	9335.5 (1.73)	- 142.9 (1.01)	-2337.8 (1.07)	3.9 (.03)	-3802.5 (1.7)		.87	1303.6	2.31
					PV1B	PV2B	PNB_{t-1}	PNO_{t-1}	APAW	T	DV_{65}				
Barley	1.4	1950-73	APB_t	35116.7	2230.3 (.90)	-12656.3 (2.49)	5727.8 (1.14)	-16017.7 (1.66)	- .27 (5.49)	-152.8 (1.73)	-1777.5 (1.77)		.90	987.7	1.26
					PV1O	PNO_{t-1}	APAW	T	DV_{68}						
Oats	1.5	1950-73	APO_t	64602.9	491.5 (.04)	7739.2 (.50)	- .27 (2.48)	- 1820.9 (10.78)	7204.1 (3.52)				.94	2585.1	.91

$\bar{S}$ = Standard error of estimate

DW = Durbin-Watson statistic

The values in parentheses are t-values of the regression coefficients.

Variable Description

Dependent Variables

		Unit
APC_t	= acres planted to corn in year t	(thousand acres)
$APSB_t$	= acres planted to soybeans in year t	(thousand acres)
$APSH_t$	= acres planted to sorghums in year t	(thousand acres)
APB_t	= acres planted to barley in year t	(thousand acres)
APO_t	= acres planted to oats in year t	(thousand acres)

Independent Variables

		Unit
PV1C	= effective support rate for corn	(\$/bushel)
PV2C	= effective diversion payment rate for corn	(\$/bushel)
PV1SH	= effective support rate for grain sorghum	(\$/cwt.)
PV2SH	= effective diversion payment rate for grain sorghum	(\$/cwt.)
PV1B	= effective support rate for barley	(\$/bushel)
PV2B	= effective diversion payment rate for barley	(\$/bushel)
PV1O	= effective support rate for oats	(\$/bushel)
PNC_{t-1}	= national average price of corn in year t-1	(\$/bushel)
$PNSB_{t-1}$	= national average price of soybeans in year t-1	(\$/bushel)
$PNAW_{t-1}$	= national average price of wheat in year t-1	(\$/bushel)
$PNSH_{t-1}$	= national average price of grain sorghum in year t-1	(\$/bushel)

Table 5.1 (Continued).

	Variable Description	
PNB_{t-1}	= national average price of barley in year t-1	(\$/bushel)
PNO_{t-1}	= national average price of oats in year t-1	(\$/bushel)
$PNCT_{t-1}$	= national average price of cotton in year t-1	(¢/lb.)
YNC_{t-1}	= national average yield of corn in year t-1	(Bushel/acre)
$YNSB_{t-1}$	= national average yield of soybeans in year t-1	(Bushel/acre)
$YNSH_{t-1}$	= national average yield of grain sorghum in year 5-1	(Bushel/acre)
APAW	= acres planted to wheat in year t	(thousand acres)
$APSB_{t-1}$	= acres planted to soybeans in year t-1	(thousand acres)
DV58	= 0 in 1950-57 and 1 in 1958-73	
DV65	= 0 in 1950-64 and 1 in 1965-73	
DV68	= 0 in 1950-67 and 1 in 1968-73	
T	= linear trend (1950 = 1, 1951 = 2, etc.)	

Ryan [1972, p. 189] and Ryan and Abel [1972, p. 108] both found a significant inverse relationship between soybean prices and acreage planted to corn. Penn and Irwin [1974], also found a significant inverse relationship between soybean prices and corn plantings although the actual coefficient value was less than half that of the other two studies. The difference in the result found here and that of the other studies seems to be due primarily to differences in the specification of the equation.[2]

The coefficient estimates associated with the policy variables in Equation 1.1, Table 5.1, show that a 10 cent increase in the effective price support of corn (PV1C), increases plantings by about 1 million acres, while a 10 cent increase in effective diversion payments (PV2C), reduces plantings by about 7 million acres.[3] These results suggest that policy makers can influence plantings much more readily by changing the effective diversion payments than by changing the effective price support. As a method

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[2]All three studies included, as an explanatory variable in the corn equation, the yearly plantings of sorghum prior to 1961, and the mean level of sorghum plantings in the 1950s, from 1961 onwards.

The theoretical discussion in Chapter II shows that it is the expected price and not the planted acreage of competing crops that should be included as the explanatory variable. Binary variables can be used to account for special circumstances which differ between periods. Inclusion of the acreage term leads to a simultaneous estimation problem and the ordinary least squares estimates of such an equation are inconsistent.

[3]All coefficient estimates assume that the *ceteris paribus* conditions hold with respect to the other independent variables.

of production control, however, diversion payments are very costly and as increasingly better land is bid out of production, costs will increase at an increasing rate [Vermeer and Slaughter, 1968]. Weisgerber [1969, p. iii] indicates that acreage currently diverted from feed grains is approximately 83 percent as productive as that in use (this is just a simple average of the figures Weisgerber presented for the individual feed grains). Hence, part of the success of diversion programs is that they pay farmers to remove their less productive land from cultivation.

The effect of the lagged market price of corn on plantings was very slight. This result suggests that the lagged market price of corn was largely discounted by producers when making their planting decisions. The simple correlation coefficient between the effective price support and the lagged market price of corn was 0.86, and exclusion of the latter from Equation 1.1 resulted in a slight increase in the effective price support coefficient.

Generally Equation 1.1 shows the strong effect of feed grain programs on corn plantings and also the important competition between corn and wheat. The corn-soybean interaction result reflects historical rather than current relationships between these two crops.

The Durbin-Watson statistic indicates that there is no evidence of serial correlation in the residuals of the corn equation.

Soybeans

The crops which are most competitive with soybeans are corn, wheat and cotton. Corn is the principle competitor and since the corn policy variables are the most important variables influencing corn plantings these two variables are included in the soybean equation. To capture the effects of changes in the wheat program on soybean plantings the lagged market price of wheat was included. (Wheat and soybeans are increasingly spoken of as possible complements in production rather than competitors, but such production systems are not widely used to date.) Inclusion of the lagged market price of cotton showed little interaction between changes in the cotton program and soybean plantings and so the cotton variable was omitted from the estimated soybean equation.

Initially the effective price support of soybeans was included together with the lagged price of soybeans. Results showed that as expected, the soybean support program has not influenced soybean plantings.

The estimated coefficients of the national soybean equation are given in Equation 1.2, Table 5.1. The equation is of the partial adjustment type developed by Nerlove [1958] (and discussed in Chapter III). The coefficient associated with the lagged plantings of soybeans ($APSB_{t-1}$) represents $(1 - \gamma)$ where γ is the adjustment coefficient with a value of 0.3 (1 - 0.7) in this case.

All signs are as expected, the R^2 is 0.99 and the t value are relatively large. The partial adjustment hypothesis is accepted and the results indicate that in the short run producers make only 30 percent of their desired adjustment to changing price conditions.

Such a small first period adjustment towards the desired soybean plantings level indicates that soybean producers were uncertain about future events in the soybean industry, and as a result were reluctant to rapidly commit new resources to soybean production. If future requirements are such that continued rapid increases in soybean production are needed then policy action to reduce this uncertainty would be appropriate. Maintaining the guaranteed support price of soybeans at or close to soybean market prices would reduce uncertainty and lead to faster production response on the part of producers.

Equation 1.2 of Table 5.1, suggests that the corn program has a great influence on soybean plantings. Results show that in the short run a 10 cent increase in the effective support rate for corn (PV1C), reduces soybean plantings by over 1 million acres while a 10 cent increase in corn diversion payments (PV2C) reduces soybean plantings by over 1.2 million acres.

The response of soybean plantings to the soybean price is also significant. A 10 cent increase in the lagged price of soybeans, increases current plantings by 781,000 acres. Other independent variables included in the soybean equation have little effect on soybean plantings.

Since the partial adjustment hypothesis was accepted for the soybean equation, the coefficients presented all represent short run effects. In the longer run the response to the independent variables would be more than three times that of the short run according to the estimated adjustment coefficient.

A problem with the partial adjustment model is that it can give inaccurate results in the presence of serially correlated residuals. For example, if the true equation is not a partial adjustment model but just a regular relationship with serially correlated residuals, and if in estimation the irrelevant lagged dependent variable is introduced, significant coefficients usually result and the serial correlation in the estimated residuals is reduced [Griliches, 1967, p. 126-127].

It is possible, however, to distinguish between these two hypotheses. Equation 5.1 provides a method for making this distinction,

$$\text{5.1} \quad APSB_t = \beta_0 + \beta_1 PV1C_t + \beta_2\, PV2C_t + \beta_3 PNSB_{t-1} + \beta_4 PNAW_{t-1} + \beta_5 YNSB_{t-1} + \beta_6 APSB_{t-1} + \beta_7 PNSB_{t-2} + \varepsilon_t$$

where $PNSB_{t-2}$ is the national average soybean price in year t-2. If the serial correlation model is correct the coefficient β_7 should be significant and should approximately equal minus the product of β_3 and β_6, (i.e., $\beta_3 \cdot \beta_6 = -\beta_7$). Such a test was conducted and the hypothesis that a serial correlation model was correct was rejected. The hypothesis of a partial adjustment model was accepted.

Sorghums

About 86 percent of all sorghums are produced in the Great Plains States with California being the only important producing state outside the Plains. The crop is particularly well suited to dry land farming [Hughes and Metcalfe, 1972, p. 312-314]. The crops which are most competitive with sorghums are wheat and cotton, and to a lesser degree corn; the latter mostly on irrigated land.

Until 1961, no restrictions were placed on sorghum plantings, and prior to then, sorghum could be and was planted on land diverted from cotton, wheat and corn. Major increases in sorghum yields began with the introduction of new varieties in the mid 1950s. At that same time acreage planted to sorghums also increased by substantial amounts. Due to the increased yields and plantings, sorghum production jumped from 205 to 570 million bushels between 1956 and 1957, an increase of almost 180 percent in one year. Because of the introduction of new hybrid varieties and the resulting yield and production increases, the structure of the sorghum industry since 1956 differs to some degree from earlier years. Consequently, the years 1956 to 1973 were selected in estimating the sorghum equation. In addition, the years 1956 and 1957 were years of great expansion in sorghum plantings as large amounts of land were diverted from wheat and cotton in those years. To take account of this period of dramatic expansion in plantings, a binary variable, DV_{58}, was included in the sorghum equation. This variable had an assigned value of zero for 1956 and 1957, and a value of one thereafter.

The coefficient estimates of the sorghum equation are given in Equation 1.3, Table 5.1. All signs are as expected, the R^2 is 0.87 but few of the t-values are relatively large. Statistically the most significant variable is the sorghum diversion payments (PV2SH), where the result indicates that a 10 cent increase in payments reduces plantings by 1.34 million acres. An unexpected result was the low response in plantings to sorghum support programs. Penn and Irwin [1974] also got an insignificant acreage response to the price support variable (PV1SH), although the magnitude of the estimated coefficient was much greater, both absolutely and in relation to its standard error than that found here. In some sorghum planting equations estimated by Ryan and Abel [1973, p. 52] the effect of price supports was significant and indicated that an increase of 10 cents in the support level increased sorghum plantings from 300,000 to 350,000 acres. Both of these studies had a different specification of the sorghum equation than the one used in this study.[4]

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[4]Both of these studies included, as an explanatory

The relationship between the lagged price of sorghums ($PNSH_{t-1}$) and sorghum plantings was relatively large and showed that a 10 cent increase in the lagged price increases current sorghum plantings by 930,000 acres. The lagged market price and the effective support variable were not highly correlated. The simple correlation coefficient between these two variables was only 0.35.

The competitive relationships between cotton and sorghum and wheat and sorghum, as measured by the coefficients of the lagged market prices of cotton and wheat, are not very strong.

Initially the lagged price of corn was included in Equation 1.3 but the estimated response in sorghum plantings to changing corn prices was not significant. As a result the corn price variable was omitted in the final run.

Generally Equation 1.3 implies that the sorghum diversion programs significantly decreased sorghum plantings. The effect of sorghum price support programs on plantings was slight with producers being more responsive to market prices. After account is taken of the major increase in sorghum planting in the 1950s on retired wheat and cotton acreage by means of the variable DV_{58}, the impact thereafter of cotton and what programs on sorghum planting does not seem to have been great.

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variable in the sorghum equation, a wheat acreage term. As explained in footnote 2 of this chapter such a specification gives inconsistent coefficient estimates when ordinary least squares estimation techniques are used.

The Durbin-Watson statistic indicates that there is no evidence of serial correlation in the residuals of the sorghum equation.

Barley

Plantings of barley are widely scattered throughout the U.S., but about three quarters of the national crop is grown in the northwestern states, from western Minnesota to the Pacific. The crop is well suited to hot dry conditions [Hughes and Metcalfe, 1972, p. 342]. About one quarter of the barley crop is utilized in the alcoholic beverage industry and the remainder is used as a feed grain [Ryan and Abel, Oct., 1973, p. 108].

Plantings of barley have been very much the same at the beginning and the end of the study period. The main variation in barley plantings occurred between 1954 and 1962 when barley could be and was grown on retired wheat acreage. Increases in barley production have been due to relatively modest increases in yields.

Wheat is clearly the principle competitor with barley for land and other resources. Additionally, however, oats seem to have become a competitor with barley, particularly in recent years. The binary variable, DV_{65}, is included in the barley equation to capture the effect of the 1965 program change which allowed substitution of wheat allotment for feed grain base and vice versa. One of the significant results of this change was a substitution of wheat on barley base in the northwestern states [Feed Situation, April 1966].

The results of the estimated barley equation are given in Equation 1.4, Table 5.1. All signs are as expected a priori, the R^2 is 0.90 and the t-values are relatively large. The coefficients of the barley policy variables are relatively large; however, only the coefficient on the effective diversion payment, (PV2B), is highly significant indicating that a 10 cent increase in payments reduces plantings by 1.27 million acres. The coefficient associated with the lagged market price of barley indicates that this variable did not have a significant effect on barley plantings.

The competitive relationships between oats and barley, and wheat and barley seem fairly strong in both cases. The coefficient of lagged oat prices (PNO_{t-1}) is relatively less significant than that of wheat plantings, (APAW), indicating lesser reliance can be placed on the absolute value of the oats coefficient than on the wheat coefficient.

Initially the lagged price of wheat rather than wheat plantings was included in Equation 1.4 to capture the competition between barley and wheat; with the inclusion of the former the empirical results were nonsensical. The economic model developed in Chapter II showed that the amount of land used in each production process (as well as the amount of other inputs used in each production process), was endogenous to the system. Consequently, ordinary least squares should not be used to estimate an equation where an endogenous variable of the system is included as an explanatory variable. Yet in Equation 1.4, the acreage planted to wheat (APAW) is included as an explanatory variable in the barley equation. This only makes sense if wheat plantings are exogenous to the barley planting decision as would be the case if producers, because of the relative profitability of the wheat and barley crops, decided to plant the maximum amount of wheat allowed and then plant their remaining land to barley. In such a case wheat plantings would be an effective constraint to barley plantings and could be regarded as exogenous to the barley planting decision. Credence is given to this view when one considers that wheat allotments have typically been planted to the maximum allowed and after 1965 when substitution between wheat and feed grains was allowed, the only significant response to this change was an increase in wheat plantings on barley base as indicated by the relatively significant coefficient associated with the binary variable, DV_{65}, in Equation (1.4), Table 5.1, (also see Chapter VI). In addition the only major expansion in barley plantings between 1950 and 1973 occurred when producers were allowed to plant barley on retired wheat land. Yet any relaxations in the wheat allotments quickly resulted in additional wheat plantings. This seems to suggest that the relationship between barley and wheat is such that barley has been mostly a residual crop (except, perhaps, the malting barley component) with decisions on how much of it is planted being made only after the amount of wheat to be planted is decided upon. Consequently inclusion of wheat plantings as an explanatory variable in the barley equation seems reasonable.

The inclusion of lagged barley yields in Equation 1.4 resulted in a very insignificant coefficient with the wrong sign. A trend variable, T, was then included to capture the effect of otherwise unaccounted for variables and its coefficient is fairly significant.

Generally Equation 1.4 shows the very important effect farm commodity programs have had on barley plantings where again the barley diversion program effect was highly significant. The impact of changes in the wheat program also significantly influence barley plantings as do changes in the oats programs.

No evidence of serial correlation in the residuals of the barley equation is indicated as the Durbin-Watson statistic shows.

Oats

Oats production is more widely scattered than barley. Most oat crops are used on the farm where grown for a variety of purposes. Only about three-quarters of the planted acreage is harvested as grain. Oats are planted as a nurse crop for grass and legume seedings, as a cover crop on idle land, and in crop rotation to help, among other things, in weed control. In the early 1950s new rust resistant varieties of oats were introduced [Huges and Metcalfe, 1972, p. 339] and plantings increased between 1950 and 1955. Thereafter plantings declined continuously through 1967. Since then plantings have stabilized somewhat.

Corn and soybeans rapidly replaced oats in the corn belt where oats plantings have decreased substantially. Oats do not seem to have been a major competitor for land with these crops but merely played a useful role in the rotation until replaced by chemicals as a method of weed and pest control.

In the plains where plantings have declined less rapidly than in the corn belt, oats has served among other things as a cover crop for idle land. As wheat acreage expands less cover land is required and vice versa as wheat acreage contracts. Thus oats seem to be less a competitor with wheat than a residual crop planted on acreage not planted to wheat. Consequently wheat plantings (APAW), are included as an explanatory variable in the national oats equation to measure the impact of wheat programs on oats plantings on the argument that wheat plantings are really exogenous to the oats planting decision.

The results of the estimated oats equation are given in Equation 1.5, Table 5.1. All signs are as expected, *a priori*, the R^2 is 0.94 and most of the t-values are relatively large. The effect of the oats effective price support variable (PV10), on plantings is very slight. The coefficient associated with lagged oat prices (PNO_{t-1}) while large in an absolute sense is small relative to its standard error indicating little response in oat plantings to changes in the lagged price.

Changes in wheat plantings are associated with changes in oats plantings of about 27 percent in the opposite direction. The effects of the trend variables, T and DV_{68}, are also highly significant. Inclusion of lagged barley prices, (PNB_{t-1}), in Equation 1.5 resulted in a coefficient with the wrong sign; therefore, the barley variable was omitted from the final estimated equation.

Generally, Equation 1.5 indicates little response in oats plantings to changes in its effective support price or its market price. The most significant variables in explaining what has occurred historically to oats plantings are the trend variables included although the inverse relationship between oats and wheat plantings is also significant.

Again, as was the case with all previous equations, the Durbin-Watson statistic shows that there is no evidence of serial correlation in the residuals of the oats equation.

Conclusions

The results of the national equation analyses are summarized in elasticity form in Table 5.2. Elasticities calculated for all price and policy variables whose estimated coefficients were significant at the 15 percent level. All elasticities were calculated at the mean levels of both the dependent and independent variables. Each number in Table 5.2 represents the percentage change in the dependent variable which would result from a one percent change in the independent variable, ceteris paribus.

The elasticity estimated demonstrate that corn plantints have been responsive to both support and diversion corn programs, while barley and sorghum plantings have been significantly influenced by their respective diversion programs but not by their support programs.

The levels of price support offered for barley and sorghum vis-a-vis their market price have been as high as with corn, yet the responses differ. One reason for these different responses is the structure of competition among crops in regions where these three crops are grown. Corn, for example, is the dominant crop in some northern regions while in others it is less competitive and in these latter areas corn plantings are more responsive to changing price support levels. A weighted average of the response in all regions could give a significant national response. The major proportion of barley production is in the drier northern plains on acreage not eligible for wheat programs. Other than oats, few alternative crops are grown in these areas and small changes in the level of price support has

Table 5.2. Estimated Elasticities for the National Equations.

Commodity	Dependent Variable	Independent Variables							
		PVIC	PV2C	PV2SH	PV2B	$PNSB_{t-1}$	$PNAW_{t-1}$	$PNSH_{t-1}$	PNO_{t-1}
Corn	APC	.139	-.173				-.157		
Soybeans	APSB	-.346	-.071			.636			
		(-1.15)*	(-.24)*			(2.12)*			
Sorghum	APSH			-.237				.513	
Barley	APB				-.150				-.834

*Long run elasticity estimates.

little effect on barley plantings. Similarly, sorghum plantings are mostly confined to the dry southern plains where with the exception of wheat few cropping alternatives have existed (irrigated corn is becoming more common in these areas), and so small changes in support levels have little effect on plantings. What makes the sorghum result confusing, however, is that sorghum plantings were significantly influenced by sorghum market prices. No satisfactory explanation of this result was found.

Plantings of corn, sorghum, and barley were all significantly reduced by their respective diversion programs; the greatest percentage response occurred in sorghums and the least in barley. Weisgerber [p. iii] shows that diverted acreage under all three programs was less productive than the planted acreage, which demonstrates that producers did not plant acreage where the diversion payments exceeded the opportunity costs. As better quality land is bid out of production, however, the opportunity costs increase and the costs of diversion programs would increase at an increasing rate.

Support programs for soybeans and oats had no significant effect on the plantings of either crop. Neither of these crops were subject to diversion programs.

Guaranteed support prices for soybeans have been set so low vis-a-vis their market price, that they have been totally discounted by producers in their planting decisions. One result of this policy is that producers have been slow to adjust their soybean plantings to desired levels. This has lead to excess demand for soybeans and continued upward pressure on soybean prices. The low rate of adjustment in soybean plantings is in marked contrast to corn where planting adjustment rates have been rapid and production expansion has generally kept pace with demand growth. Policy action to increase the guaranteed support price for soybeans, more in line with market price, would reduce producer uncertainty, increase the rate of adjustment in plantings and act to stabilize soybean prices.

Major structural changes on both the supply and demand sides of the oat industry over the past two decades, made oats production unprofitable for many producers. They, in turn, rapidly reduced their oat plantings and small changes in support or market prices had little impact on their decisions.

In addition to the direct program effects several significant indirect effects were demonstrated in the national equation analyses. Soybean plantings, for example, were reduced by 0.35 percent in the short run, and 1.15 percent in the long run for each one percent increase in corn support prices. And a one percent increase in the level of corn diversion payments reduced soybean plantings by 0.08 percent in the short run, and 0.24 percent in the long run. These response elasticities demonstrate the very close relationship between corn production adjustment policies and soybean plantings. Soybean support programs, however, had no impact on corn plantings.

A significant relationship between corn plantings and wheat prices was found showing that a one percent change in the latter reduces corn plantings by 0.16 percent. Consequently, factors which influence wheat prices, such as the wheat programs, have a significant effect on corn plantings.

Similarly oat prices were seen to have a very significant effect on barley plantings where a one percent increase in oat prices reduces barley plantings by 0.83 percent. Factors which influence oat prices, such as the support price offered for oats, in turn affect barley plantings.

The only crops which showed a significant response to their own market price were soybean and sorghums. The reason sorghum plantings were responsive to market prices is unclear. With soybeans lack of meaningful support programs meant that producer price expectations were based mostly on market prices.

In all cases the results presented in Table 5.2 seem to be strongly influenced by the historical structure of competition in the major production areas for each crop. To avoid this problem and to measure more local competitive relationships between crops it is necessary to do some analysis at a lower level of aggregation, the regional level for example. The next chapter presents the results of such analyses.

CHAPTER VI

THE EFFECTS OF FARM PROGRAMS ON PLANTINGS--
REGRESSION RESULTS OF REGIONAL EQUATIONS

Introduction

In this chapter the results of the regional analyses are presented for each of the five crops studied. Regions were selected on the basis of their different cropping systems, which are due primarily to the different climatic and edaphic conditions prevailing in the different regions, in order to obtain better information on the direct and indirect effects of different farm programs at the more disaggregated level. It was hypothesized that the indirect effects of some programs, which were insignificant in the national equations, would be highly significant at the regional level due to hypothesized differences in the structure of competition for cropland in different regions. Furthermore it was also hypothesized that the increase in farm productivity in 1971 was due to inter-regional shifts in plantings among crops, shifts which were directly attributable to changes in the 1971 program, but which failed to show up in a significant manner at the national level. The discussion of the results of the regional equations will center on crops rather than on regions and will emphasize the unique features in each region rather than the common features among regions or features already stressed in the previous chapter. This chapter relies heavily on the discussion in Chapters II through IV to establish the theoretical foundationof the equations estimated, the type of explanatory variables used, and the structure of competition among crops at the regional level.

As was the case with the national equations, the variables for input prices and weather were initially included in all equations, but with mixed results. On some occasions the weather variable was fairly significant. The index of input prices, which was included in all regional equations to take account of the input price effects on planting decisions was typically insignificant and often had the wrong sign. Both variables were excluded from most of the final regional equations.

Additionally most equations initially included a binary variable, DV_{71}, to measure any significant inter-regional shifts in acreage among crops attributable to the change in farm programs in 1971; again, as was the case with the national equations, the coefficients associated with this variable were generally insignificant. Occasional significant coefficients associated with this binary variable (as in the soybean equations) do not mean much on their own. A regular pattern of acreage shifts, consistent with a priori expectations as to their direction and magnitude, is required to give credence to the hypothesis that the 1971 program changes were responsible for the rapid increase in farm productivity which took place that year. Such a regular pattern did not emerge. The absence of a pattern of interregional acreage shifts suggests that the farm productivity increase which occurred in 1971 was not attributable to the farm program changes of that year and by inference this result indicates no major interregional misallocation of land among crops attributable to previous feed grain commodity programs.[1] This result is in general agreement with the earlier discussion which showed continuous interregional acreage shifts among crops since the 1950s, shifts which were in accordance with comparative advantage in cropland allocation.

With this introduction let us now discuss the results of each estimated equation crop by crop. All variables used in the regional analyses are regional variables derived as defined in Chapter III.

Corn

The results of the corn equations in all six regions are presented in Table 6.1.

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[1]The large increase in farm productivity in 1971 was probably due to a variety of factors including good weather conditions, some intraregional acreage shifts among crops perhaps, and the low level of farm productivity in 1970.

Table 6.1. Regional Equations - Corn.

Equation	Time Period	Dependent Variable	Constant	Independent Variables											R^2	$\bar{S}$
				PV1C	PV2C	PC_{t-1}	PSB_{t-1}	PAW_{t-1}	YC_{t-1}	PSH_{t-1}	DV_{58}	DV_{63}	DV_{71}	T		
1.1	1950-73	APC_t	33036.8	1713.6	- 30841.1	4691.4	- 941.3	-4794.1	37.0		3030.9	2107.1			.72	1334.1
				(.59)	(4.20)	(.89)	(.70)	(2.68)	(.62)		(1.95)	(1.60)				
1.2	1959-73	APC_t	9184.3	1432.0	- 7168.0	1630.1	- 249.5						1121.4		.95	230.5
				(.67)	(2.16)	(1.71)	(1.30)						(2.09)			
1.3	1950-73	APC_t	9208.0	4250.5	-11248.1	1122.4	-1025.6		68.8	- 864.1		-1284.4			.97	382.7
				(4.82)	(5.67)	(.74)	(2.43)		(5.88)	(.74)		(3.63)				
1.4	1950-73	APC_t	3033.9	1042.3	- 2585.8					-1537.5	-928.4				.89	290.6
				(2.08)	(2.72)					(2.30)	(4.31)					
1.5	1950-73	APC_t	3277.5	306.9	- 1426.3									-134.8	.96	220.3
				(1.47)	(1.67)									(10.01)		
1.6	1950-73	APC_t	10746.8	1721.3	- 7300.7									-211.8	.96	556.0
				(2.97)	(3.01)									(6.14)		

$\bar{S}$ = standard error of estimate.

Variable Description

Dependent Variables		Unit
APC_t	= acres planted to corn in year t (by region)	(thousand acres)
Independent Variables		
PV1C	= effective support rate for corn by region	(\$/bu)
PV2C	= effective diversion payment rate for corn by region	(\$/bu)
PC_{t-1}	= regional average price of corn in year t-1	(\$/bu)
PSB_{t-1}	= regional average price of soybeans in year t-1	(\$/bu)
PAW_{t-1}	= regional average price of wheat in year t-1	(\$/bu)
PSH_{t-1}	= regional average price of sorghums in year t-1	(\$/bu)
YC_{t-1}	= regional average yield of corn in year t-1	(bu/ac)
DV_{58}	= 0 in 1950-57 and 1 in 1958-73	
DV_{63}	= 0 in 1950-62 and 1 in 1963-73	
DV_{71}	= 0 in 1950-70 and 1 in 1971-73	
T	= linear trend (1950 = 1, 1951 = 2, etc.)	

Region 1

Equation 1.1 shows the results of the corn equation in Region 1. The general form of the equation is the same as the national corn equation except for the addition of two binary variables, DV_{58} and DV_{63}. The binary variable, DV_{58}, was included because of the somewhat unusual conditions prevailing in Region 1 for corn producers between 1950 and 1958. In most of these years corn allotments were in effect for this region although they were not in effect for most of the other regions. Besides this, corn plantings in Region 1 followed a somewhat unusual pattern in these years for while national corn plantings declined, those in Region 1 increased through 1954 and only declined to a significant degree following the introduction of the acreage reserve program in 1956. Throughout most of the 1950s however, market prices of corn were falling at a rapid rate (much greater than has occurred since); in addition, the effective support price of corn also dropped rapidly with the introduction of flexible levels of support in 1954 and continued a rapid decline through 1958. At the same time, large quantities of corn and other feed grains were bought and sold by the government on the open market. All of these factors contributed toward making the years 1950 through 1958 somewhat unusual and so the variable DV_{58} was included to take account of these otherwise unexplained events. Omission of DV_{58} from Equation 1.1 resulted in the wrong sign associated with the coefficient of PC_{t-1}, the lagged market price of corn.

The change in the payment mechanism for feed grains in 1963, which involved dividing the effective price support into two portions, a direct payment and a non-recourse loan, was accounted for by the binary variable, DV_{63}. This change in the method of payment was made to encourage feed grain producers who also fed livestock to participate in the feed grain program and livestock production is important in Region 1.

All coefficients in Equation 1.1 have the expected sign, most of the t-values are relatively small, and the R^2 is 0.72.

Of the coefficients estimated in Equation 1.1, the most surprising result was the insignificant estimate of the PV1C coefficient. This indicates that in Region 1 producers have not been very responsive to corn price support programs. Nor, it seems have they been very responsive to market prices of corn. With the exception of the relatively rapid decline in both these variables in the 1950s they have remained fairly stable since then, a fact which probably contributed to the insignificant coefficient estimates. Also Region 1 is and has been primarily a corn producing area with an absolute and comparative advantage in corn production.

Major price changes would be required before any great changes in the crop production pattern would occur. Such major price changes did not occur, however, over the period of study.

The coefficient of the effective diversion payments, (PV2C), was very significant suggesting that a 10 cent increase in payments would reduce corn plantings by about 3 million acres. In other words, producers, when given sufficient incentive, have been willing to remove their less productive land from corn production. The importance of the effective diversion payments in reducing plantings in Region 1 is consistent with the observed declines in plantings following the introduction of the diversion programs and with the results of the national regression analysis which were presented in Chapter V.

The competition between soybeans and corn in Region 1 seems to have been weak historically shown by the highly insignificant coefficient associated with PSB_{t-1}, the lagged market price of soybeans. This result is consistent with the result obtained for the national corn equation, but like it, reflects historical rather than current market conditions between these crops.

The effects of wheat programs on corn plantings, as reflected in the coefficient associated with lagged wheat prices, (PAW_{t-1}), are significant. Historically, the acreage of wheat grown in Region 1 has been relatively small and declining so it has not been a major competitor with corn in Region 1. The relatively high level of price support available to wheat producers, however, has maintained its competitiveness and has made it a fairly profitable crop to include in a rotation where possible.

The results of Equation 1.1 are generally similar with those obtained for the national corn equation with the important exception of the insignificant response to the effective price support for corn. The relative price stability of competing crops throughout the study period coupled with the suitability in Region 1 for corn production both probably contribute to this result indicating that without major changes in the relative prices of crops, Region 1 would remain predominantly a corn producing region.

Region 2

Corn plantings in Region 2 behaved very unusually throughout the 1950s for despite relatively large declines in effective support prices and market prices plantings increased continuously. Not even the introduction of the acreage reserve program in 1956 halted this increase as happened, for example, in Region 1. Several factors probably contributed to this behavior. First, major increases in corn yields had an offsetting effect on falling product prices thereby somewhat maintaining per acre returns. Second, and perhaps more important, is that in Region 2 which is the major dairy producing area in the U.S., corn is often used as a feed in the dairy enterprise. During the 1950s the amount of grains and concentrates fed to dairy cows increased rapidly [Dairy Statistics through 1969; Statistical Bulletin No. 303] while the number of dairy cows remained fairly constant [Livestock-Feed Relationships, Statistical Bulletin 530, p. 13]. The combined effect of increased feeding rates per cow with constant cow numbers was a rapid expansion in demand for feed, primarily corn, in Region 2. Since many producers grew corn as an input into the dairy enterprise, they would continue to expand their corn plantings so long as returns to resources in corn production exceeded their opportunity costs in alternative use.

Due to the increased plantings during a period of large price declines attempts to fit a corn equation similar to Equation 1.2, Table 6.1,for the period 1950-1973 gave nonsense results. Incluson of binary variables to take account of the unique features of the 1950s was also fruitless. Finally, it was decided to fit Equation 1.2 for the shorter time period 1959-1973.

Most of the corn produced in Region 2 is produced on the southern fringe of the region, well south of the main wheat producing areas of the region. For this reason the lagged wheat price was not included in Equation 1.2. The soybean price variable (PSB_{t-1}), was retained as soybeans is an important competing crop with corn in this region. Whenever YC_{t-1}, the lagged yield of corn was included the estimated coefficient had the wrong sign and was highly insignificant so this variable was omitted from the final equation.

The results of the estimated equation as presented in Equation 1.2, Table 6.1, have the expected sign, the t-values are reasonably large, and the R^2 is 0.95. The most significant coefficient is that associated with the effective diversion payments, (PV2C), again showing the important impact diversion programs had on corn plantings. Another interesting feature of Equation 1.2 is the significant coefficient of the binary variable, DV_{71}, indicating a significant increase in corn plantings in Region 2 in 1971 and thereafter. This result on its own, however, indicates little, and would not give rise to increases in farm productivity of the degree obtained in 1971. In the absence of a consistent pattern of such acreage shifts this single result is not very meaningful.

The results of Equation 1.2 show that neither the effective price supports or the market price of corn significantly influenced corn plantings in Region 2. Again, as in Region 1, this result is probably due to the relative stability of crop prices and to the traditional and dominant role of corn in cropping patterns throughout the southern portions of Region 2.

The competition between corn and soybeans in Region 2, as indicated by the coefficient associated with lagged soybean prices has not been very significant historically.

Region 3

The pattern of corn plantings in Region 3 was similar to the national pattern; the overall trend was downward with intervening increases and decreases similar in proportion to what occurred nationally. In Region 3 corn and soybeans are grown predominantly in the eastern portions of the region with wheat and sorghum becoming more prominent in the western, drier portions. Nebraska and Kansas grow large quantities of corn, sorghum, and winter wheat. Soybeans, and to a lesser degree sorghums and wheat, seem to be the principle competitors with corn in Region 3. Initial analysis indicated that the competition between wheat and corn was highly insignificant and the wheat variable was dropped from the final equation.

The results of the corn equation in Region 3 are given in Equation 1.3, Table 6.1. All signs are as expected, the R^2 is 0.97 and the t-values of most independent variables are fairly high.

Again Equation 1.3 shows the important role production adjustment policies played in determining corn plantings. Unlike the previous regional equations the corn effective price support coefficient in Equation 1.3 is highly significant reflecting the fact that support programs were important in influencing corn plantings in a region where substantial changes in cropping patterns have occurred in the past 25 years. Region 3 marks the interface between the corn-soybean belt and the wheat-sorghum belt. In the period under study significant changes occurred in the acreage of different crops grown in Region 3 and to some degree in the location of plantings. For example sorghum plantings increased rapidly while wheat plantings declined rapidly. For the entire region corn plantings decreased; however, corn plantings increased somwhat in the western sections of the region as shown by data on corn plantings in Colorado. Product prices would be expected to have a greater influence on planting decisions in a region undergoing changes in cropping patterns and where the crop is not the dominant crop in a region.

The competition between soybeans and corn in Region 3 is significant. This is demonstrated by the significant coefficient associated with the lagged soybean price.

The corn-sorghum competition seems to be rather weak which in the absence of large scale corn irrigation is what would be expected.

The effect of corn yields on corn plantings is very significant in Region 3. This result supports the idea that the very large increase in corn yields that occurred in Region 3 with the increased use of irrigation has made corn production profitable in areas of that region where it could not be grown successfully without irrigation. As a consequence corn yields have been a significant explanatory variable of corn planting in this region.

The coefficient of the binary variable, DV_{63}, included to measure the impact of alternations in the system of making payments to producers was also significant.

Region 4

As shown in Figure 4.2 corn plantings in Regions 4, 5 and 6 declined continuously from 1950 to 1973. Attempts to detect the effect of farm programs on these delines met with mixed success in all three regions.

The estimated coefficients of the corn equation in Region 4 are given in Equation 1.4, Table 6.1. Sorghum and to a lesser degree cotton and wheat, are the principle competitors with corn for land in this region. Most of the corn is grown in eastern Texas where sorghums and cotton are also grown. The bulk of the wheat produced in Region 4 is planted in the north and west of the region. The inclusion of cotton and wheat variables in Equation 1.4 resulted in insignificant coefficient estimates associated with both variables and typically with the wrong sign. Inclusion of the lagged corn yield variable also resulted in an insignificant coefficient with the wrong sign. The increase in corn yield in Region 4 had not been very rapid until 1970; since then corn yields have almost doubled (from 45.32 bushels per acre in 1967-69 to 86.83 bushels per acre in 1971-73).

All coefficients in Equation 1.4 have the expected sign, relatively high t-values, and an R^2 of 0.89. Both corn policy variables significantly influenced plantings. Again, as has been the case in the other equations estimated the magnitude of the coefficient associated with diversion programs, far exceeds that associated with the effective support price variable; this again demonstrates the effect diversion programs had on corn plantings. Inclusion of the lagged price of corn gave an insignificant coefficient estimate with the wrong sign and so it was omitted. The competition between sorghums and corn in Region 4 seems to be very significant reflecting the historical importance of sorghum in the southeastern section of Region 4. The binary variable, DV_{58}, which was included to capture the effects of some of the unique farm program features influencing crop planting in the early 1950s is highly significant.

Region 5

Soybeans and cotton are the principle competitors with corn for land in Region 5; however, attempts to measure the degree of this competition were unsuccessful. The downward trend in plantings overwhelmed the effects of all other explanatory variables.

The results of the corn equation for Region 5 are given in Equation 1.5, Table 6.1. All signs are as expected *a priori*, the R^2 is 0.96, but the only highly significant explanatory variable is the trend variable, T. The values of the coefficients in the corn policy variables are fairly significant indicating some slight effect of the policy variables on plantings. Again, the magnitude of the coefficient associated with PV2C, the effective diversion payment policy variable far exceeds that of the effective price support variable (PV1C). Inclusion of soybean and cotton price variables in Equation 1.5 to measure the degree of competition between these crops and corn in Region 5, resulted in insignificant coefficient estimates; the soybean coefficient typically had the wrong sign. Consequently, these variables were excluded from the final estimated equation.

Region 5 has undergone substantial shifts in cropping patterns in the last 25 years with a major increase in soybean plantings and a rapid decline in corn plantings. The competitiveness of corn in Region 5 seems to have declined greatly over this period so that corn plantings have rapidly declined being aided to some degree by the corn diversion programs.

Region 6

Soybeans and cotton are again the principal land competitors with corn in Region 6, but as was the case in Region 5, attempts to detect significant levels of competition between corn and these crops were unsuccessful.

The estimated corn equation in Region 6 is given in Equation 1.6, Table 6.1. All signs are as expected, the t-values are relatively large and the R^2 is 0.96. The corn policy variables and the trend variable significantly influence plantings.

The inability to obtain significant inverse relationships between soybean and/or cotton market prices and corn plantings was somewhat surprising. Penn [1973] found some slight evidence of competition among corn, soybeans and cotton in this region; however his estimated coefficients were not highly significant statistically. In his equation specification the lagged cotton acreage was included as an explanatory variable rather than lagged market price.

Summary

Generally all six regional corn equations fitted showed the significant impact of corn adjustment programs on corn plantings. In all cases the magnitude of the diversion payment coefficient far exceeded that of the price support coefficient. This demonstrates that at the levels of diversion payment offered producers were willing to remove large quantities of less productive land from production. As land which is more productive is bid out of production the response to diversion payments would decline.

Where corn production has been traditionally established as the dominant crop (Regions 1 and 2) the influence of corn price support programs on plantings has been insignificant while in areas where corn is not the dominant crop price support activities have had a significant effect on plantings. These results, however, were obtained during a period of relative stability in most crop prices and the magnitude of the estimated response coefficients would be expected to be much greater in a period of greater price variation.

The important indirect effects of the wheat and sorghum programs on corn plantings were also established for different regions as were the effects of conditions in the soybean market. Attempts to demonstrate a significant effect of cotton programs on corn plantings in southern regions were unsuccessful. In the southern regions the downward trend in corn plantings tended to mask the effects of other explanatory variables.

Soybeans

Soybean equations were fitted for all regions except Region 4 where very little soybeans are grown. The general form of a soybean equation in all regions is that of a partial adjustment model described previously. Another unique feature of the soybean equations was that the binary variable, DV_{71}, was retained in four of the equations because of its relative significance; but in explaining acreage shifts toward comparative advantage as a result of the 1971 program changes these results are not very important for two reasons. First, the only statistically significant acreage shifts which occurred after 1971 were a decline in soybean plantings in Region 5 and an increase in Region 6. Other than soybeans these regions are not very important feed grain producing regions which makes slight acreage shifts in these regions of lesser importance to feed grain policy makers than significant shifts in northern regions. Casual observation of planting data would suggest two possible reasons for the results obtained; (1) between Regions 5 and 6 there seemed to be some substitution of cotton for soybeans in Region 5 and some substitution of soybeans for cotton in Region 6 since 1971, and (2) since 1971 market conditions in the soybean industry have been very unusual with rapidly increasing market prices so that it is difficult to ascribe with any degree of certainty acreage shifts in soybean plantings to farm program changes. They are more likely due to the radically changed market conditions. A second reason the significant shifts in regional plantings of soybeans since 1971 are not considered important in explaining acreage shifts toward comparative advantage is that they are not supported by similar results for other crops; rather, these results occur in isolation. If significant shifts were also detected for the other crops and if these shifts were in accordance with a priori expectations which were based on knowledge of the relative comparative advantage of various crops in different regions then these particular results would be more meaningful. On their own they are of lesser importance.

A discussion of the regional soybean equations fitted follows.

Region 1

Soybeans compete for land primarily with corn and wheat in Region 1. The estimated coefficients of the soybean equation for Region 1 are given in Equation 2.1, Table 6.2. All signs are as expected, the R^2 is 0.98 and most t-values are relatively large. The results indicate that 49 percent of the desired adjustment in soybean plantings is made in the first period after expectations of market conditions change. This compares with an adjustment rate of 30 percent nationally and shows that the rate of adjustment to changing soybean market conditions was more rapid in Region 1 than nationally. It also suggests that the adjustment rate in other regions must be less rapid than the national average.

Soybean plantings in Region 1 are significantly influenced by soybean prices, corn policy variables and to a lesser degree are influenced by wheat programs. As in the national soybean equation the inclusion of the effective price support of soybeans in Equation 2.1 resulted in highly insignificant coefficient estimates indicating again that soybean price support programs had little influence on soybean plantings. Rather plantings were more influenced by market prices which typically exceeded the support rates. The affect of corn adjustment programs on soybean plantings is highly significant, especially the effective support price of corn, (PV1C), which if increased by 10

Table 6.2. Regional Equations - Soybeans.

Equation	Time Period	Dependent Variable	Independent Variables										R^2	$\bar{S}$
			Constant	PV1C	PV2C	PSB_{t-1}	PAW_{t-1}	YSB_{t-1}	$APSB_{t-1}$	DV_{71}	WR	PCT_{t-1}		
2.1	1950-73	$APSB_t$	4669.6	-5643.1 (3.67)	-3311.76 (.86)	3591.2 (4.62)	-1299.8 (1.01)	107.7 (.80)	.51 (2.49)	1631.6 (1.98)			.98	702.4
2.2	1950-73	$APSB_t$	2326.5	-2621.5 (3.97)	-3804.6 (2.18)	1080.7 (5.43)	- 299.6 (.52)	16.0 (.56)	.37 (2.31)				.95	252.7
2.3	1950-73	$APSB_t$	1307.5	-1129.9 (5.23)	- 991.7 (1.58)	852.2 (7.27)	- 574.2 (3.08)	26.3 (3.38)	.15 (1.36)	-170.8 (1.49)	-49.1 (2.30)		.98	107.6
2.5	1950-73	$APSB_t$	112.5	- 897.6 (2.87)	- 588.6 (.50)	1168.9 (4.78)		70.5 (3.12)	.77 (9.31)	-608.1 (2.11)		-61.9 (2.53)	.99	253.5
2.6	1950-73	$APSB_t$	-997.4	- 568.9 (2.50)	-1696.0 (2.12)	864.9 (5.48)		81.7 (4.14)	.75 (9.68)	433.0 (2.41)		-33.4 (2.51)	.99	163.9

$\bar{S}$ = standard error of estimate.

Variable Description

Dependent Variable	Unit
$APSB_t$ = acres planted to soybeans in year t (by region)	(thousand acres)

Independent Variable

$APSB_{t-1}$ = acres planted to soybeans in year t-1 (thousand acres)
YSB_{t-1} = regional average yield of soybeans in year t-1 (bu/ac)
PCT_{t-1} = regional average price of cotton in year t-1 (¢/lb)
WR = April-May rainfall (inches)
(Other variables as defined in Table 6.1)

cents would reduce soybean plantings by over a half million acres in Region 1 alone.

The estimate of the adjustment coefficient (1 - 0.51 = .49) indicates that the longer run coefficients of all explanatory variables would be approximately double their values in Equation 2.1.

Region 2

Soybean production in Region 2 consists of small quantities in the southern sections of Michigan and Wisconsin, with the major component produced in the southwestern corner of Minnesota. The principle land competitor with soybeans in this region is corn. Large quantities of oats are produced in the same locations as soybeans in Region 2, but oats are not regarded as very competitive with soybeans. Rather oats are regarded as a suitable crop for marginal land or as a crop fulfilling certain unique purposes in rotation such as weed and pest control or acting as a nurse crop. Some wheat is also produced in the same locations as soybeans, but this is very limited. In the northern areas of Region 2 considerable quantities of spring wheat are grown, but little or no soybeans are produced in these areas.

The coefficients of the soybean equation estimated for Region 2 are given in Equation 2.2, Table 6.2. All signs are as expected, the R^2 is 0.95 and most of the t-values are relatively large.

The adjustment coefficient for Region 2 is estimated to be 0.63 (1 - 0.37); considerably greater than nationally, indicating a relatively quick response to changing market conditions. This adjustment coefficient suggests that the longer run response coefficients of Region 2 are about one-third greater than the values presented in Equation 2.2.

As was the case with Region 1, soybean plantings in Region 2 were significantly affected by the corn adjustment programs, by soybean market prices, and, as expected, the affect of wheat programs was highly insignificant. The indirect effects of the corn adjustment programs are highly significant in reducing soybean plantings in Region 2 and unlike Region 1 both the effective price support, and the effective diversion payment, of corn have significantly reduced soybean plantings.

Region 3

Most of the soybeans produced in Region 3 are produced on the eastern edge where corn and wheat are the principle land competitors. Soybean production does not spread very much into the dryer areas of Region 3 where sorghums become an important crop.

The estimated coefficients for the soybean equation in Region 3 are given in Equation 2.3, Table 6.2. Again all signs are as expected, the t-values are relatively large, and the R^2 is 0.98. The hypothesis of a partial adjustment model in soybean plantings is rejected in

Region 3 indicating that the desired response to changed market conditions is complete or nearly so in the first year. Alternatively stated the adjustment coefficient is unity.

Again as in the two previous equations the corn policy variables significantly influence soybean plantings. Also as in Region 1, the degree of significance of the coefficient associated with the effective price support, (PV1C), is greater than that associated with effective diversion payments, (PV2C). The effect of soybean prices on own plantings is also very significant. Region 3 differs from the previous two regions in that a strong competition between wheat and soybeans is indicated in this region. So alterations in wheat programs through increased support rates and greater acreage restrictions which would increase market prices of wheat would significantly reduce soybean plantings in Region 3. Soybean yields which increased by a far greater percentage in Region 3 than in any other major soybean producing region also showed a significant influence on plantings showing the importance of increased productivity on plantings, other things constant.

Finally, of all the equations fitted in this study, Equation 2.3 was the only one to show a significant weather effect. The weather coefficient indicates that soybean plantings would be reduced by 49,000 acres for each addi-itional inch of April-May rain in Region 3. This result could have any of two meanings; it could mean that additional rain would reduce plantings as producers are unable to work the fields, or as is more likely in Region 3, additional rain in this period may encourage corn plantings and so reduce soybean plantings.

Region 5

As indicated previously soybean plantings increased by a greater percentage in Region 5 than in any of the other regions studied. The main land competitors with soybeans in Region 5 are cotton and corn.

The coefficient estimates for the soybean equation in Region 5 are given in Equation 2.5, Table 6.2. Again all signs are as expected, the R^2 is 0.99 and the t-values are relatively large. The estimated adjustment coefficient in contrast to that in the northern regions, is, at an estimated value of 0.23, less than estimated nationally indicating a relatively low response in the first year to changes in market conditions. This result says that the rate of adjustment in the short run to changed market conditions is only 23 percent of the desired change which is a very low adjustment rate.

Of the explanatory variables included in Equation 2.5 the most statistically significant explanatory variable was the lagged market price of soybeans. Its estimated coefficient also had the greatest absolute value of the included explanatory variables. Soybean yields also influenced plantings to a significant degree in Region 5. This result gives extra credence to the comparative advantage hypothesis developed earlier by indicating the importance of yield increases of soybeans in explaining their increased plantings in Region 5.

The corn policy variables and primarily the effective price support, (PV1C), again show a significant effect on soybean acreage.

An important and somewhat unique feature of Equation 2.5 is that it clearly demonstrates that changes in cotton programs as reflected in the market price of cotton significantly influence soybean plantings in Region 5. The estimated coefficient shows that an increase of 10 cents in lagged cotton prices reduces soybean plantings by over 600,000 acres in Region 5 alone. This result is important both in its magnitude and in establishing the indirect link between changes in cotton programs and soybean plantings.

The adjustment coefficient estimated for Region 5 indicates that the long run coefficient values of the explanatory variables included in Equation 2.5 are almost five times those presented.

Region 6

Soybean production in Region 6, like that in Region 5, increased rapidly over the study period. Both regions have similar production patterns in that corn and cotton are the principle land competitors with soybeans again in Region 6. The estimated coefficients of the soybean equation in Region 6 are given in Equation 2.6, Table 6.2. All signs are as expected, the R^2 is 0.99 and the t-values are relatively large.

The adjustment coefficient is estimated to be 0.25 for Region 6 which like Region 5 shows a very slow rate of adjustment toward desired adjustment levels following perceived changes in market conditions for soybeans. These low rates of adjustment in the southern regions offset the more rapid rates of the northern regions resulting in a national average rate between these two extremes. The adjustment coefficient estimated for Region 6 suggests that the longer run coefficient values of the explanatory variables included in Equation 2.6 are about four times the values presented.

The corn policy variables again significantly reduced soybean plantings in Region 6. Increases in both the effective support price and the effective diversion payments for corn significantly reduced soybean plantings.

In addition soybean plantings have been significantly increased by increases in the market prices of soybeans as well as by increases in soybean yields. Also as in Region 5, a strong competitive relationship between soybeans and cotton was demonstrated showing that changes in cotton programs which influence the market price of cotton significantly reduce soybean plantings in Region 6.

Summary

The overall fit of each of the five regional soybean equations was very good. In all regions other than Region 3 the partial adjustment hypothesis was upheld and in general indicated relatively rapid adjustment rates towards desired planting levels in the northern regions and conversely relatively slow adjustment rates in the southern regions. A possible reason for the different adjustment rates is that in northern regions acreage previously planted to oats, a relatively unprofitable crop, became available for soybean planting. On the other hand, increases in soybean plantings in southern regions meant reductions in cotton and/or corn plantings, both relatively profitable crops. So the opportunity costs of additional soybean acreage were relatively lower in northern regions than in southern regions.

The results showed that soybean plantings in all regions were significantly increased with increases in the market price of soybeans. Similarly increases in the per acre productivity of soybeans as indicated by yields caused significant increases in soybean plantings in three of the five regions.

Not alone were soybean plantings influenced by conditions in the soybean market, they were also influenced to varying degrees by corn, wheat and cotton commodity programs. Corn programs had the greatest affects on soybean plantings and these effects were significant in all regions. Changes in the wheat programs as reflected in the market price of wheat significantly reduced soybean plantings in some northern regions particularly Region 3. The effects of the cotton programs, again as reflected in the market price of cotton, were to significantly reduce soybean plantings in the southern regions. These direct and indirect responses clearly indicate to policy makers that significant competition between crops exists at the regional level and that as a result changes in production adjustment programs for one crop can have significant repercussions on the production of others.

Sorghums

Currently about 86 percent of sorghums are produced in the Plains States, i.e., Regions 3 and 4. Most of the remainder are produced in western states primarily California, New Mexico and Arizona. The regional analysis of sorghums is confined to the two important producing regions, i.e., Regions 3 and 4. Sorghums in these two regions are produced mostly in the central and northwestern areas of Texas and Oklahoma, throughout the entire state of Kansas and in the southern half of Nebraska. These are areas of relatively low rainfall and high summer temperatures; climatic features for which sorghums are well suited.

The period 1956 to 1973 was chosen for analysis as this represented a period of rapidly increasing sorghum yields resulting from the introduction of the new varieties in the mid-1950s. Increases in sorghum plantings in the mid-1950s and through 1957 were due, as stated previously, to farm program provisions which allowed sorghums to be planted on land retired from wheat, cotton and corn. To take account of the effect of these particular farm program provisions on sorghum plantings a binary variable, DV_{58}, is added to both of the regional sorghum equations.

Region 3

In Region 3 the principle land competitors with sorghums are corn and wheat. The sorghum equations fitted for Region 3 are given in Equations 3.3A and 3.3B, Table 6.3. All signs are not as expected *a priori*, the R^2 are 0.64 and 0.68, respectively and the t-values are relatively small. The only highly significant estimated coefficient was that of the lagged market price of sorghum which indicated that a 10 cent increase in lagged market prices increases sorghum plantings in Region 3 by almost 700,000 acres. The effective support price of sorghum (PV1SH), was omitted from Equation 3.3A but was included in Equation 3.3B where its estimated coefficient was not significant and had the wrong sign. The insignificant effect of the sorghum price support on plantings is difficult to explain especially since producer compliance with sorghum programs was as high as with other feed grain programs and support rates were typically set relatively high vis-a-vis own market prices.

Table 6.3. Regional Equations - Sorghum.

Equation	Time Period	Dependent Variable	Independent Variables									R^2	$\bar{S}$
			Constant	PV1SH	PV2SH	PSH_{t-1}	PC_{t-1}	PAW_{t-1}	PCT_{t-1}	YSH_{t-1}	DV_{58}		
3.3A	1956-73	$APSH_t$	8655.9		-2697.5 (1.49)	6852.9 (2.12)	-4365.6 (.93)				-2136.3 (1.78)	.64	940.7
3.3B			9177.7	-1858.9 (1.21)	-5258.5 (1.91)	8297.8 (2.45)	-3175.9 (.67)				-2284.9 (1.92)	.68	923.5
3.4	1956-73	$APSH_t$	12793.9	758.1 (.94)	-5357.9 (3.20)	1303.7 (.66)		-531.6 (.63)	-116.9 (2.52)	3.9 (.10)	-1854.6 (2.89)	.89	532.3

$\bar{S}$ = standard error of estimate.

Variable Descriptions

Dependent Variable — Unit

$APSH_t$ = acres planted to sorghums in year t (by region) (thousand acres)

Independent Variables

PV1SH = effective support rate for sorghum by region ($/cwt)

PV2SH = effective diversion payment rate for sorghum by region ($/cwt)

YSH_{t-1} = regional average yield of sorghums in year t-1 (bu/ac)

Others as identified previously in this chapter.

Although sorghum support programs had little effect on sorghum plantings in Region 3, diversion programs had a fairly significnat effect. Increases in diversion payment levels reduced sorghum plantings substantially.

Sorghum plantings in Region 3 did show significant response to changes in the corn or wheat programs. The lagged market price of corn, (PC_{t-1}), was included in Equations 3.3A and 3.3B to measure the indirect effects of corn programs on sorghum plantings but the estimated coefficient associated with lagged corn prices was highly insignificant in both equations showing that corn programs had little impact on plantings. The inclusion of the lagged market price of wheat to measure the wheat-sorghum competitive relationship resulted in insignificant coefficients with the wrong sign, so lagged wheat prices were omitted from the final estimated equation.

Region 4

Wheat and cotton are the principle competitors with sorghum for land and other resources in Region 4.

The coefficient estimates of the sorghum equation in Region 4 are given in Equation 3.4, Table 6.3. All signs are as expected, the R^2 is 0.89 and several of the t-values are relatively large.

The results indicate that the sorghum policy particularly sorghum diversion programs, significantly influenced sorghum plantings. Sorghum support programs did not have any substantial effect on own plantings. Unlike Region 3 the effect on sorghum plantings of the lagged market price was also highly insignificant. The competitive relationship between cotton and sorghum as indicated by the coefficient associated with the lagged market price of cotton is highly significant in Region 4. The estimated coefficient suggests that a 10 cent increase in the lagged price of cotton reduces sorghum planting in Region 4 by over 1 million acres. Any cotton program changes therefore which alter the market price of cotton can have a substantial inverse effect on sorghum plantings. No significant competition between wheat and sorghums was found as indicated by the insignificant coefficient associated with the lagged market price of wheat (PAW_{t-1}).

Summary

About 86 percent of the sorghum produced in the U.S. is produced in the dry Plains States where wheat and cotton are the principle land competitors. The estimated regional sorghum equations tend to confirm the national regression results showing insignificant response in sorghum plantings to sorghum price support programs and a fairly significant response (reduction) to sorghum diversion programs. In addition the indirect effect of changes in the cotton programs on sorghum plantings was clearly established in Region 4. Changes in wheat programs as reflected in the market price of wheat showed no significant effect on sorghum plantings in either Regions 3 or 4. The unique farm program features which allowed sorghum plantings on acres retired from corn, wheat and cotton during the 1950s significantly increased their plantings in all regions as the coefficients associated with the binary variable, DV_{58}, show.

Barley

In 1971-73 only about 46 percent of barley produced in continental U.S. was produced within the six regions considered for regional analysis in this study; 32 percent of the U.S. total was produced in Region 3 alone while the remaining five regions contributed a total of 14 percent of total barley production. Regional analysis on barley was confined to Region 3.

To take account for the provision allowing wheat and feed grain substitution from 1965 on a binary variable, DV_{65}, was added to the barley equation for Region 3.

Region 3

Barley plantings in Region 3 have followed a historical pattern similar to the trends in barley plantings nationally as described in Chapter IV. The specification of the barley equation for Region 3 is exactly the same as that fitted nationally. Generally, about 70 percent of the barley produced in Region 3 is produced in North Dakota where spring wheat and oats are the principle field crops produced along with barley.

The estimated coefficients of the barley equation for Region 3 are given in Equation 4.3, Table 6.4. All signs are as expected, the t-values are reasonable and the R^2 is 0.86.

Although the responses indicated to the barley policy variables are in the direction expected the coefficients are not very significant. The coefficient associated with the effective diversion payments of barley is larger relative to its standard error than the coefficient associated with the effective price support variable for barley. In the national barley equations the effect of barley support programs on barley plantings was also found to be insignificant but the effect of diversion payments was highly significant. In Region 3, however the effect of diversion payments was not highly significant indicating that their influence in other regions must be greater to account for the national level result.

The competition between oats and barley in Region 3 is significant and absolutely large as indicated by the coefficient associated with the lagged market price of oats. Any farm program changes which would influence oats prices would have a significant inverse effect on barley plantings.

Similarly, any program changes which influence wheat planting would have an inverse effect on barley plantings as indicated by the coefficient associated with APAW, the current acreage planted to wheat in Region 3. As was the

Table 6.4. Regional Equations - Barley.

Equation	Time Period	Dependent Variable	Independent Variables								R^2	$\bar{S}$
			Constant	PV1B	PV2B	PB_{t-1}	PO_{t-1}	APAW	T	DV_{65}		
4.3	1950-73	APB_t	12263.9	587.0 (.39)	-4885.4 (1.58)	3190.0 (1.30)	-9335.0 (2.32)	-.15 (3.26)	-37.1 (.70)	-1526.4 (2.36)	.86	539.2

$\bar{S}$ = Standard error of estimate.

Variable Descriptions

Dependent Variable

APB_t = acres planted to barley in year t (by region) (thousand acres)

Independent Variables

PV1B = effective support rate for barley by region ($/bu)

PV2B = effective diversion payment rate for barley by region ($/bu)

PB_{t-1} = regional average price of barley in year t-1 ($/bu)

PO_{t-1} = regional average price of oats in year t-1 ($/bu)

DV_{65} = 0 in 1950-64 and 1 in 1965-73

APAW = acres planted to wheat in year t (thousand acres)

Other variables as defined previously in this chapter.

case with the national barley equation wheat plantings were used as the independent wheat variable in Equation 4.3 and as discussed in some detail in the previous chapter this effectively assumes that barley is somewhat of a residual crop when in competition with wheat. Otherwise wheat plantings are not exogenous to the barley planting decision and the ordinary least squares estimates of Equation 4.3 would be inconsistent.

The coefficient of DV_{65} indicates that a significant amount of barley acreage was planted to wheat following the provision which allowed wheat substitution on feed grain acreage in 1965. This is in accordance with the observed results of this program change as mentioned earlier.

Inclusion of barley yields in Equation 4.3 resulted in insignificant coefficient estimates with the wrong sign. For this reason a trend variable, T, was included to measure the effects of otherwise unaccounted for changes over time, but its estimated coefficient was highly insignificant.

Summary

Generally Equation 4.3 shows that barley support programs had little effect on barley plantings while the effect of barley diversion programs on own plantings is less clear, being of the expected sign and of relatively large magnitude but not highly significant statistically.

Despite the relative insignificant direct effects of the barley policy variable on own plantings, Equation

4.3 clearly shows the significant indirect effects of oats and wheat programs on barley plantings. And finally Equation 4.3 shows that the 1965 farm program change which allowed wheat substitution on feed grain base resulted in a significant reduction in barley plantings in Region 3.

Oats

The production of oats is concentrated in Regions 1, 2 and 3 which collectively accounted for 84 percent of oats production in 1971-73. Regional equations were fitted for all three regions. All equation specifications are similar to the national oats equation because the overall historical planting trends in all regions have been similar to the national trend and all trends have declined over time, albeit at different rates, for similar reasons.

Region 1

Oats plantings in Region 1 while following the overall national pattern, declined substantially more than the national decline. The estimated coefficients of the oats equation for Region 1 are given in Equation 5.1, Table 6.5. All signs are as expected, the R^2 is 0.95 and the t-values are relatively large. Inclusion of the support and lagged price of oats, (PV1O) and (PO_{t-1}) respectively, in Equation 5.1 resulted in highly insignificant coefficient estimates associated with these variables and they typically had the wrong sign. In Region 1, once known as the corn-oats belt,

Table 6.5. Regional Equations - Oats.

Equation	Time Period	Dependent Variable	Independent Variable						R^2	$\bar{S}$
			Constant	PV10	PO_{t-1}	APAW	T	DV_{68}		
5.1	1950-73	APO_t	22101.1			- .78 (2.29)	-693.2 (13.64)	1101.8 (1.58)	.95	789.4
5.2	1950-73	APO_t	9072.4	2005.8 (2.38)			-275.0 (20.40)	985.9 (5.39)	.98	240.2
5.3	1950-73	APO_t	10621.7	2510.0 (1.10	1394.1 (.46)	- .07 (1.96)	-300.7 (8.64)	1812.0 (4.34)	.91	516.0

$\bar{S}$ = Standard error of estimate.

Variable Descriptions

Dependent Variable — Unit

APO_t = acres planted to oats in year t (by region) (thousand acres)

Independent Variables

PV10 = effective support rate for oats

DV_{68} = 0 in 1950-67 and 1 in 1968-73

Others as defined previously in this chapter.

the role of oats in rotation has been largely replaced by chemicals with the result that much of the acreage planted to oats at the end of World War II is now planted to soybeans and corn. Market and/or support prices of oats did not significantly slow the rate of decline in oats plantings.

The most significant explanatory variables of oats plantings in Region 1 were the trend variables, T, and, DV_{68}. The results also indicated that as wheat plantings increased or decreased oats plantings moved in the opposite direction. Virtually all of the wheat grown in Region 1 is winter wheat and the result of the coefficient associated with wheat plantings (APAW), suggests that oats historically has played a role of a cover crop on idled wheat land. This would partially explain the inverse relationship between the plantings of these two crops in Region 1. Such a hypothesized relationship between oats and wheat would indicate that wheat plantings are exogenous to the oats planting decision.

Region 2

The estimated coefficients of the oats equation for Region 2 are given in Equation 5.2, Table 6.5. All signs are as expected, the R^2 is 0.98 and the t-values are large. Since most of the wheat produced in Region 2 is spring wheat, which is produced in locations to the north and west of the oats belt, a wheat variable was not included in Equation 5.2.

The results indicate that the most significant explanatory variables of oats plantings in Region 2 are the trend variables, T, and, DV_{68}. In addition, however, increases in the price support of oats significantly increased plantings. This latter result probably indicates the better competitive position of oats particularly on marginal land, in Region 2 than in Region 1 where support programs had no effect on plantings. Inclusion of lagged oat prices in Equation 5.2 gave an insignificant coefficient with the wrong sign.

Region 3

The estimated coefficients of the oats equation for Region 3 are given in Equation 5.3, Table 6.5. All signs are as expected, the R^2 is 0.91 and the t-values are relatively large. Again the most significant explanatory variables are the trend variables. The effect of oat price supports while of the expected sign is small relative to its standard error and the coefficient estimate is not very reliable. As in Region 1 the inverse relationship between oats and wheat planting is again fairly significant.

Summary

The results of the regional oats equations were generally similar to those obtained for the national oats equation. In all cases the most significant explanatory variables of oats plantings were the trend variables, T, and, DV_{68}. Earlier graphical analysis showed the almost constant downward trend in oats plantings from the mid-1950s through 1967 after which oats plantings stabilized somewhat. In addition to the trend variables wheat plantings showed a significant inverse relationship with oats plantings in most regions.

Generally, however, oats plantings did not show significant response to oats price support programs or to their own market prices. The only exception to this was in Region 2 where the effective price support of oats significantly influenced plantings; a result probably reflecting the competitiveness of oats on marginal land in Region 2.

Conclusions

The results of the regional equation analyses are summarized in elasticity form in Table 6.6. Elasticities were calculated, at the mean, for all price and policy variables with coefficients significant at the 15 percent level. Each number in Table 6.6 represents the percentage change in the dependent variable which would result from a 1 percent change in the independent variable, *ceteris paribus*.

Elasticities presented in Table 6.6 generally substantiate those presented for the national equations but in addition they show that the regional impacts of market prices and policy variables vary to great degree. They also show that the competitive relationships among crops are quite different regionally.

Table 6.6. Estimated Elasticities for the Regional Equations.

Region	Commodity	Dependent Variable	Independent Variables										
			PV1C	PV2C	PV2SH	PV2B	PV1O	PC_{t-1}	PSB_{t-1}	PSH_{t-1}	PAW_{t-1}	PCT_{t-1}	PO_{t-1}
1	Corn	APC_t		-.167							-.250		
	Soybeans	$APSB_t$	-.176						.282				
2	Corn	APC_t		-.117				.167					
	Soybeans	$APSB_t$	-.809	-.203					.867				
	Oats	APO_t					.176						
3	Corn	APC_t	.326	-.150					-.193				
	Soybeans	$APSB_t$	-.718	-.110					1.329		-.652		
	Sorghum	$APSH_t$			-.204*					1.023*			
	Barley	APB_t				-.146							-1.213
4	Corn	APC_t	.739	-.338						-1.104			
	Sorghum	$APSH_t$			-.208							-.356	
5	Corn	APC_t	.200	-.169									
	Soybeans	$APSB_t$	-.194						.576			-.377	
6	Corn	APC_t	.211	-.157									
	Soybeans	$APSB_t$	-.193	-.099					.666			-.318	

*Elasticity estimates obtained from Equation 3.3B, Table 6.3. (Only short run elasticities are presented for the soybean equations.)

The direct influences of the corn, barley and sorghum commodity programs, particularly their respective diversion programs, on regional plantings were highly significant. These programs also had important indirect effects. Neither oats or soybeans were subject to diversion programs and their respective support programs generally had little direct or indirect influence on crop planting decisions.

The regional responses in corn plantings to own support programs show that in regions where corn had an absolute advantage in production support programs had little effect on plantings, while in regions where corn was less competitive the response was very significant. Corn plantings in Regions 3, 4, 5 and 6 were significantly influenced by the corn support programs while plantings in Regions 1 and 2 were not. In regions showing a significant response the rate of response differed; responses in Regions 5 and 6 were similar, that of Region 3 was somewhat greater, while the response in Region 4 was substantially greater. Response rates were greatest in regions where significant evidence of crop substitutability was found. In Region 3, for example, corn and soybeans were found to be good subsitutes. The large degree of response found in Region 4 was due in part to the substitutability between sorghums and corn in that region as indicated by the fact that a 1 percent increase in sorghum prices reduces corn plantings by 1.1 percent.

Acreage diversion programs significantly reduced corn plantings in all regions. The estimated elasticities were similar in all regions except Region 4 where the estimated response was substantially greater than elsewhere. The significant influence of diversion program shows that in all regions producers were willing to divert their less productive land in return for diversion payments.

Regional differences in the structure of competition among crops was evident from the corn equations. A strong competitive relationship between wheat and corn was detected in Region 1. This relationship was also significant in the national corn equation, showing the influence of Region 1 on the national corn equation estimates. In Region 3, a strong inverse relationship was found between soybean prices and corn plantings; this result was not detected in the national equations. Another competitive relationship not detected in the national equations was the relationship between sorghum prices and corn plantings found in Region 4. Knowledge of these different competitive relationships is necessary to determine the impact of policy changes in different regions.

Plantings of barley or of sorghum show no response to own support programs at the regional level. Both of these crops are grown in dry areas where apart from wheat, few profitable cropping alternatives exist. Since wheat planting are restricted, small changes in the support prices of barley or sorghum would have little effect on their respective plantings. The sorghum result is confusing, however, as sorghum plantings are responsive to own market prices in Region 3. Sorghum guaranteed support prices have been relatively high vis-a-vis own market prices making this result difficult to explain.

Plantings of barley and sorghum were significantly reduced as a result of diversion programs. The estimated regional responses for both crops were similar to their national responses.

Both barley and sorghum showed a high degree of substitutability with other crops. A strong competitive relationship between barley plantings and oat prices was found in Region 3 indicating that in that region, and particularly in its northern sections where barley production is greatest, oats and barley are highly substitutable for each other on land not planted to wheat.

Similarly a significant relationship between sorghum plantings and cotton prices was found in Region 4. The sorghum-cotton relationship was not apparent in the national sorghum equation. Factors which influence cotton prices, such as cotton commodity programs, would significantly influence sorghum plantings in Region 4.

Turning now to the oats and soybean support programs; the results show little evidence of significant effects of either. Oat plantings in Region 2 were influenced by oat support programs but no similar evidence was found in other regions. The result in Region 2 probably indicates that in that region oats remain competitive with other crops particularly on poorer quality land.

Regionally soybean plantings showed no response to soybean support programs. Soybean plantings were, however, very responsive to own market prices. They were also very responsive to changes in both corn support and diversion programs. The response rates to these variables differed among regions. Also the competitive relationships between soybeans and other crops were quite different among regions.

The response in soybean plantings to changes in own market price was closely tied to the substitutability in production between corn and soybeans in each region. This substitutability is demonstrated by the relationship between soybean plantings and corn programs. A large inverse relationship as is evidenced in Regions 2 and 3, indicates a high degree of substitutability, while a small inverse relationship, as in Region 1, indicates little substitutability. Where corn and soybeans were highly substitutable in production (Regions 2 and 3), small increases in soybean prices had a greater impact on soybean plantings than in regions where these crops were not as substitutable (Regions 1, 5 and 6).

Soybean plantings were significantly reduced by increases in corn price supports and in corn diversion payments. The inverse relationship between soybean plantings and corn diversion payments indicates that as diversion payments for corn were increased, so as to reduce corn plantings, producers diverted land under the corn program which otherwise would have been planted to soybeans. The diversion payments which were introduced to reduce the production of corn, a crop in excess supply, had the indirect effect of reducing soybean plantings, a crop in excess demand. It is doubtful that policy makers desired this result.

The regional soybean equations showed differences in the competitive relationships among crops. In Region 3, for example, a significant relationship was found between soybean plantings and wheat prices. In Regions 5 and 6, cotton prices significantly influenced soybean plantings. Factors, such as wheat and cotton programs, which influence market prices of these crops in turn influence soybean plantings in these regions.

Another useful result of the regional soybean equations was the substantiation of the earlier finding that producers were slow to increase soybean plantings to desired levels as a result of the uncertainty which exists in the soybean market. This uncertainty is partly due to the absence of meaningful soybean support programs. The rates of adjustment in plantings differed among regions. In northern regions where large amounts of land previously planted to oats became available, adjustment rates were fairly rapid.

In southern regions, however, where soybeans had to compete with cotton and corn for land the opportunity costs of planting soybeans were relatively high and adjustment rates were lower.

Generally the results of the regional analyses substantiate and extend the findings of the national equation estimates. They also provide new information on the structure of competition among crops regionally; information which is useful in determining the regional effects on plantings of future programs.

CHAPTER VII

SUMMARY AND CONCLUSIONS

Summary

This study was designed to measure the direct and indirect effects of commodity programs on land allocation among the feed grains and soybean crops and to evaluate whether a major misallocation of land among these crops occurred as a result of the commodity programs. To meet the first objective, which involved isolating and quantifying program effects on plantings, an economic model was formulated based on factor demand theory from which estimable equations were obtained. These equations proported to explain changes in the planted acreage of the selected crops due to economic, technical and institutional forces, including government farm programs.

Cropland can be used to produce a variety of crops and the profit maximizing individual allocates his land on the basis of returns in different uses subject to operational constraints. As shown in Chapter II, the factor demand equations for land in its alternative uses were obtained as reduced form equations from a system of simultaneous equations depicting the profit maximizing behavior of producers. Furthermore, as was stated in Chapter II, the reduced form equations of a simultaneous system can be estimated using ordinary least squares and the resulting coefficient estimates are consistent. Ordinary least squares techniques were used to estimate all equations in this study.

Many of the explanatory price variables of the theoretic factor demand equations involved expectations. Such variables required redefinition in terms of observable variables. The price expectation model hypothesized stated expected prices as a linear function of lagged market prices and commodity program adjustment variables; the latter were expressed as specially constructed policy variables. Variables were also included for such shift factors as changing technical conditions, weather conditions, and various institutional factors such as major program changes not included in the constructed policy variables.

The competitive structure among crops for land was hypothesized as a result of graphic and tabular analysis of historical plantings and information on rotational practices. Casual observation showed that some crops were grown primarily in specific locations whereas other crops were produced across wider geographic areas. Sorghums, for example, were produced almost exclusively in the Plains States; corn was produced over a much wider area. Most of the crops of interest were produced in an area bounded on the west by a line drawn from the western border of North Dakota south to Texas and bounded on the east by the Atlantic Ocean with the exclusion of the New England States and Florida. Within this geographic portion of the U.S. several regions were demarcated where, because of different climatic and edaphic features, different crop production systems exist. Regional and national equations were estimated.

To evaluate whether or not a significant misallocation of land among the feed grains and soybeans occurred as a result of the commodity programs, two lines of analysis were followed. First planting data of the major field crops were analyzed to see if adjustments in land allocation among crops and regions were in accordance with observed comparative advantage in production. In general this was found to be the case. So it appears that farm commodity programs did not prevent efficient adjustments in cropland allocation over time. This does not say, however, that the rate of adjustment towards comparative advantage was optimal for achieving the most efficient use of resources.

Examination of historical planting trends did not provide much information on the rate of adjustment toward comparative advantage. Commodity programs seem to have encouraged excess plantings during the 1950s and insufficient plantings during the 1960s; the latter occurred in order to reduce the amount of expensive inventories accumulated during the 1950s. Commodity program changes in 1971, however, provided a rare opportunity to test the question of whether the rate of adjustment was optimal.

In 1971 commodity program provisions were introduced which offered definite incentives for acreage readjustment among crops. Had major land misallocations among crops and regions existed prior to 1971, then rapid readjustments would have been expected following the 1971 program change. To test the hypothesis that major acreage shifts among crops and regions followed the 1971 program change, a binary variable, DV_{71}, was included in almost all estimated equations. Significant coefficients associated with this binary variable would indicate that major acreage shifts had indeed occurred as a result of the program changes. Such shifts, if systematic and in the direction of comparative advantage, would indicate that farm programs prior to 1971 had prevented the most efficient allocation of land among crops and that as a result of the acreage readjustment major increases in farm productivity occurred. No evidence was found to support these hypotheses.

Conclusions

The major conclusions of this research include: (1) feed grain, wheat and cotton programs have had substantial, direct and indirect effects on crop plantings; (2)

oats and soybean programs have had little impact on crop plantings; (3) diversion programs have had a greater effect on own crop plantings than have price support programs; (4) increases in soybean plantings have fallen short of desired levels partly because of the absence of effective soybean support programs; (5) regional responses to commodity programs differ greatly; they depend on the structure of competition among crops in each region; (6) commodity programs have not prevented the efficient allocation of land among crops and regions; and (7) input prices have not had a great impact on plantings over the past 25 years.

Production of corn, barley and sorghum, exceeded demand during the 1950s. The excess supply resulted from high levels of price support and limited planting restrictions during that decade. Accumulations of costly feed grain inventories resulted. In efforts to reduce the feed grain inventory levels, the 1961 feed grain program was introduced. This program sought to restrict feed grain production by reducing plantings of corn, barley and sorghum. Producers responded by diverting their less productive land and applying ever increasing quantities of fertilizer on their planted acreage. Yields of all three crops, and particularly of corn and sorghum, increased rapidly. These factors partially offset the decline in plantings. Demand for feed grains, however, expanded more rapidly than production and inventories declined steadily. So the diversion programs, while costly, succeeded in reducing equally costly inventories by reducing planting of feed grains.

Looking at the individual feed grain crops, corn plantings have been very responsive to corn programs. Increases in the level of corn price supports have increased plantings while increases in diversion payments have reduced plantings. The percentage response to diversion payments was significant in all regions and was of similar magnitude in all but Region 4. A possible reason for the greater response in Region 4 is that adverse planting conditions, as could occur with very dry weather would cause producers to divert land that otherwise would be planted. The fact that responses elsewhere were similar indicates that the proportion of corn acreage for which diversion payments exceeded opportunity costs was the same in all regions. Corn programs, therefore, did not maintain relatively more unproductive corn producing land in one region, than in others. This indicates that corn programs did not cause a major misallocation of cropland.

The percentage response to corn price supports, however, has differed substantially among regions, being greatest in regions where corn does not dominate production, and least in regions where corn is the dominant crop. Where profitable cropping alternatives to corn were available a greater response to corn price support programs would be expected than where alternatives were not available.

Various competitive relationships were identified between corn and other crops regionally. Corn and sorghums were shown to be highly substitutable in the Southern Plains. In the Northern Plains a strong competitive relationship was identified between corn and soybeans; and in the Corn Belt some competition between corn and wheat was evident. Some of these regional responses were not evident from the national corn equation, yet they are important in evaluating how changes in other crop programs would influence corn plantings.

The results of the national corn equation reflected responses in all regions but were heavily influenced by responses in the major corn producing regions.

Barley and sorghum have also been subject to price support and acreage diversion programs. Plantings of either crop have not been greatly influenced by their individual price support programs, either at the national or regional level. This was due in part to the fact that both crops were produced in dry areas where wheat is the only other major competitor for cropland, and wheat plantings have been restricted. So in these regions small changes in price support levels, of either barley or sorghum, have little effect on plantings.

Although barley and sorghum price support programs had little effect on the plantings of either crop, the diversion programs, in operation for each crop, had. When in effect, they substantially reduced planting of their respective crops.

The significant response to diversion programs in corn, barley and sorghum reflects the fact that producers, throughout the U.S., were willing to remove from production poorer quality cropland in return for diversion payments. As better land is bid out of production, however, the response to diversion payments would decline.

Oats production has declined over the past two decades. Demand for oats has also declined and at a rate equal to the production decline. The result is that oat prices have been maintained at a fairly constant level throughout this period. The decline in oats production was due to a rapid drop in plantings since the 1950s. This rapid decline in plantings made it unnecessary to introduce diversion programs for oats. Price support programs were in effect, for oats, each year but they had little effect on yearly plantings.

Soybean production has increased rapidly since 1950. Yield increases in soybeans have been modest and the major source of the production expansion has been increased plantings. Much of the increased soybean plantings have been on acreage previously planted to oats although soybeans have replaced other crops, particularly corn, in some areas. Demand for soybeans has increased more rapidly than production in the last twenty years, and particularly in the last decade. Consequently no efforts have been made to restrict soybean plantings. Soybean price support programs have been in effect each year since 1950 but guaranteed support prices have typically been so low vis-a-vis soybean market prices that producers have totally discounted the former in their planting decisions. A result of soybean price support policy has been that producers were relatively uncertain about future soybean prices and so were reluctant to increase their soybean plantings rapidly. This slow rate of increase in soybean plantings, coupled with rapidly increasing demand, has meant that soybean prices have risen year after year.

While soybean plantings were not influenced by own support programs, they were influenced by soybean market prices, by corn programs, and in southern regions of the U.S., by cotton prices. The response in soybean plantings to changes in own market price was closely tied to the substitutability in production between corn and soybeans. Where corn and soybeans were highly substitutable in production small increases in soybean prices had a greater impact on soybean plantings than where these crops were not as substitutable.

Soybean plantings were significantly reduced by increases in corn price supports and in corn diversion payments. The inverse relationship between soybean plantings and corn diversion payments indicates that as diversion payments for corn were increased, so as to reduce corn plantings, producers diverted land under the corn program which otherwise would have been planted to soybeans. The diversion payments which were introduced to reduce the production of corn, a crop in excess supply, had the indirect effect of reducing soybean plantings, a crop in excess demand. It is doubtful that policy makers desired this result.

The regional soybean equations showed, that not only was the structure of competition between soybeans and other crops different in different regions, but also that the rates of adjustment in soybean plantings to desired levels differed substantially among regions. In northern regions where large amounts of land previously planted to oats became available, adjustment rates were fairly rapid. In southern regions, however, where soybeans had to compete with cotton and corn for land the opportunity costs of planting soybeans were relatively high and adjustment rates were lower.

As was the case with the other crops the regional analyses of soybeans substantiate and extend the findings of the national equation estimates.

Although the farm commodity programs have influenced year to year plantings, regional land allocation among feed grain and soybean crops has, with few exceptions, been in accordance with comparative advantage in production.

This is important since it indicates that the farm programs generally did not foster a major misallocation of land among crops and regions. Not alone has adjustments in land allocation been in the direction of comparative advantage, but the rate of adjustment also seems efficient. This latter conclusion is based on the fact that following farm program changes in 1971, which offered definite incentives to producers to base their planting decisions on market conditions, no significant acreage shifts among crops and/or regions took place.

Over the period of this study, prices of such inputs as land, labor, capital and fertilizer have not influenced plantings of feed grains or soybeans to any noticable degree. The reason for this is that prices of these inputs have not varied greatly over the study period and so have not made much difference in planting decisions. This does not mean, however, that input price levels are unimportant in planting decisions; it merely says that given their levels and in the last 25 years, they have not played a crucial role in planting decisions.

Some Implications

Without major changes in the competitive relationships among crops, future responses to farm commodity programs would be similar to those which held historically. Reintroduction of diversion programs would cause producers to retire less productive land. High diversion payments for corn would continue to reduce soybean plantings. Price support programs would have little effect on plantings of barley and sorghum unless wheat programs were altered substantially. The effect of price support programs on corn plantings would probably decline as corn production becomes more concentrated in areas where corn has a strong absolute advantage in production. Continuation of low level price supports for soybeans would probably result in even slower rates of adjustment in plantings as oat plantings stabilize. Without continued increases in corn and sorghum yields the problem of land availability for soybean plantings would become even more acute.

Historically participation in feed grain programs has not been very profitable. This is partly due to the fact that diversion programs kept production down and market prices up. Without the diversion programs market prices would have been lower than they were, and given the level of price supports offered costly inventories would have accumulated. Consequently although participation was not very profitable given that diversion programs were in effect; participation would have been very profitable had high price supports without acreage restrictions been in existence, for in such a case market prices would be very low. Diversion programs reduced plantings and production, thereby raising market prices over what they otherwise would be. Given the inelastic demand for feed grains, diversion programs also increased the total returns to crop producers.

In addition, diversion programs, by removing land from production, made the production responses of feed grains to price supports more inelastic than they otherwise would have been. The long term effect of price inelastic supply and demand responses is that small quantity changes result in large price changes. This creates the potential for market instability, particularly in crop production which is so dependent on weather conditions. With highly inelastic supply and demand relationships, however, relatively small inventories would maintain market stability. But small inventories offer little insurance against successive crop disasters.

In recent years foreign demand, for U.S. produced feed grains and soybeans, is expanding rapidly. Prospects are that this increased demand will continue for some time. Such demand expansion increases the price elasticity of demand for these crops making it undesirable to control supplies, for, in these circumstances, such action could reduce rather than increase returns to producers. And consumers welfare would be increased by removing supply controls.

Removing acreage restrictions and diversion payments would give the added benefit of increasing the price elasticity of supply of the controlled crops. With more price elastic supply and demand relationships, quantity changes would cause less price fluctuations than under inelastic conditions. Given the dependency of crop production on weather it would still be advisable, however, to maintain stand-by inventories as insurance against crop disasters. Such inventory programs could be used to stabilize prices in periods of gluts and shortages. Inventory levels could be maintained by offering guaranteed price supports to producers at such levels that would maintain price stability while not encouraging surplus accumulation.

Further Questions

This study takes an extensive look at the effects of farm commodity programs on plantings. A more complete analysis of program effects on plantings would require additional analysis of the effects of wheat and cotton programs. Also, the effects of farm programs on yields of the various crops need to be analyzed. Such analyses should be conducted at the national, regional and perhaps even the intra-regional level.

Extending the type of analysis conducted in this study to wheat and cotton programs would involve some problems not encountered in this study. These programs traditionally have been more restrictive on producers' planting decisions than the feed grain and soybean programs. In most years, cotton and wheat producers faced acreage allotments and market quotas. These additional restrictions would have to be considered in the construction of the policy variables designed to estimate the effects of these programs.

Some of the data problems which emerged in this study need to be resolved. Much better data than those currently available are required on input prices and the variable costs of producing different crops. Currently great uncertainty exists on the availability and future prices of certain important inputs for crop production such as fuel and fertilizer. Without improved data which are useful in estimating the effect of these inputs on crop production historically, it would be difficult to project future consequences of changes in their availability or prices. Improved descriptive data are necessary for projective and prescriptive uses.

Another variable requiring careful study is the weather variable. Weather affects crop production in many ways, but in many regression studies it is relegated to the error term or at best approximated by some single observable variable such as rainfall. With recent predictions by meteorologists of significant changes in the climatic conditions in the U.S. it will become important to be able to estimate the possible effects such changes could have on food production.

Many important issues in policy analysis were not addressed in this study, issues such as the effects of farm programs on consumer food prices, on farmers' income and the distribution of these incomes, on the structure of the agricultural industry, and on the monetary costs of these programs. Some of these issues have been well analyzed elsewhere. Others have not. No attempts were made to compare and evaluate past commodity programs with alternative possible programs including a free market program, although such analysis is important in order to inform policy makers of the relative costs and returns of different possible programs. The stated objectives of this study were limited as far as overall policy analysis and evaluation is concerned. In meeting the stated objectives, however, information is provided which is useful both in evaluating past programs and projecting the consequences of similar programs in the future.

APPENDICES

APPENDIX A

SOURCES OF DATA

Data on acreage planted, acreage harvested, production, and yields for all crops, were obtained for each state from USDA Statistical Bulletin No.s 185, 290, 384 and 498, and for 1970 through 1973 from Crop Production, 1973 Annual Summary. Data on average prices received by crop and by state were obtained from USDA Statistical Bulletins Nos. 208, 311, 404 and 513, and for 1970 through 1973 from various issues of Field Crops: Production, Use, Sales and Value. All data on upland cotton prior to 1970 were obtained from USDA, Statistical Bulletin Nos. 417 (1950-1953) and 471 (1954-1969). The policy variables for corn, sorghum and barley were those presented by Ryan and Abel, October 1972, April 1973, and October 1973, respectively. Policy variables for years not included in these publications were calculated in the manner discussed in Chapter III. Data on the oats and soybean policy variables were obtained from USDA, Agricultural Statistics, various issues. Information on precipitation was obtained from U.S. Department of Commerce, Climatological Data, various issues 1950-1973. Price series on labor, capital, fertilizer as well as the index for all commodities bought were obtained from USDA, Agricultural Statistics, 1973.

Data on the value of land and buildings were obtained from various issues of USDA, Farm Real Estate Market Developments.

APPENDIX B-1[1]

CALCULATIONS OF THE POLICY VARIABLE PV1C FOR CORN, 1950-1973

<u>Formula: PV1C = r PA</u>

Where PA is the announced support rate for corn produced (the loan rate in most years) and r is an adjustment factor reflecting planting restrictions. If no planting restrictions are imposed, r equals 1.0; the tighter the restrictions the closer r will be to zero. Values for PA are announced each year. The values for r must be estimated from program provisions as announced. The procedure followed is detailed below.

Year	Loan* Rate	PA*	Estimation of r	PV1C*
1950	1.47 (1.10)	1.47 (1.10)	Price support = loan only. Higher rate offered in commerical corn area contingent upon planting restriction; lower rate offered in noncommercial areas with no planting restrictions. About 60 percent of corn acreage was commercial and 34 percent noncommercial in 1949, the base year. The restriction was stated in terms of an allotment for 1950 which	

*Values are in dollars per bushel of corn.

[1]Most of the material in Appendix B-1 through Appendix B-4 was provided to me by J. P. Houck and M. E. Ryan.

Year	Loan Rate	PA	Estimation of r	PV1C
			was about 20 percent less than 1949 acreage planted. These values enter into the calculation of PV1C as follows: (1.47)(.66)(0.8) + (1.10)(.34) (1.0) =	1.15
			In each term, the first values are the loan rates and the second are weights, reflecting shares of U.S. acreage. Together these values constitute PA. The third values in each term are estimates of r, the respective planting restrictions. In the commerical area, r was assumed to be 0.8 (1.0 - .2), reflecting the required 20 percent reduction from 1949 acreage. No planting restriction in the noncommercial area meant that r = 1.0.	
1951	1.57	1.57	Price support = loan only. No planting restriction, so r = 1.0 and PV1C =	1.57
1952	1.60	1.60	Price support = loan only. No planting restriction, so r = 1.0 and PV1C =	1.60
1953	1.60	1.60	Price support = loan only. No planting restriction, so r = 1.0 and PV1C =	1.60
1954	1.62 (1.22)	1.62 (1.22)	Price support = loan only. Higher rate offered in commercial corn area, contingent upon reduction from 1953 acreage of about 18 percent. No planting restrictions applied for the lower loan rate, offered in noncommercial areas. The acreage distribution between commercial and noncommerical areas was 70 percent and 30 percent, respectively, in 1953.* Hence, (1.62)(.7)(.82) + (1.22)(.3)(1.0)=	1.30

*These percentages were applied as weights for 1954-1958.

Year	Loan Rate	PA	Estimation of r	PV1C
			where the value .82 (1.00 - 1.18) is assumed to reflect the planting restriction imposed for obtaining a loan rate of $1.62, and the other values are as identified under 1950.	
1955	1.58 (1.18)	1.58 (1.18)	Price support = loan only. Higher rate in commerical corn area. The 1955 allotment was 108 percent of the 1954 allotment, so r for the commercial area is 1.08 x .82 = .88, where .82 is the r for the 1954 commercial area. Hence, (1.58)(.7)(.88) + (1.18)(.3)(1.0) =	1.33
1956	1.50 (1.24)	1.50 (1.24)	Price support = loan only. Higher rate in commercial corn area. The 1956 allotment was reduced 15 percent from 1955, so r for the commercial area is .85 x .88 = .75, hence, (1.50)(.7)(.75) + (1.24)(.3)(1.0) =	1.16
1957	1.40 (1.27)	1.40 (1.27)	Price support = loan only. Higher rate in commercial corn area. The 1957 allotment was reduced 16 percent from the 1956 allotment, so r for the commercial area is .84 x .75 = .63, hence, (1.40)(.7)(.63) + (1.27)(.3)(1.0) =	1.01
1958	1.36 (1.02)	1.36 (1.02)	Price support = loan only. Higher rate in commercial corn area. Allotment in 1954 was about the same as 1957, so r for 1958 = r for 1957, hence, (1.36)(.7)(.63) + (1.02)(.3)(1.0) =	.92

Year	Loan Rate	PA	Estimation of r	PV1C
1959	1.12	1.12	Price support = loan only. No planting restriction, so r = 1.0 and PV1C =	1.12
1960	1.06	1.06	Price support = loan only. No planting restriction, so r = 1.0 and PV1C =	1.06
1961	1.20	1.20	Price support = loan only, if planting restricted. The restriction was based on an average of 1959-60 plantings and provided each participant a choice of the amount of land he wished to divert from corn production. The minimum he could divertwas 20 percent of his base acreage, leaving 80 percent for corn planting. The maximum he could divert was 40 percent of his base, leaving 60 percent for corn planting. To account for the range from 60 percent to 80 percent, a simple average was taken to reflect the overall restrictiveness of the program.* So r = 1/2 (0.6 + 0.8) = 0.7, hence, (1.20)(0.7) =	.84
1962	1.20	1.20	Same as 1961	
1963	1.07	1.25	Total price support consisted of a loan rate of $1.07 and a direct payment of $.18 for all corn grown in compliance with planting restrictions. Maximum and minimum diversion requirements were 40 percent and 20 percent, respectively, leaving 60 percent to 80 percent of base acreage for corn planting. So,	

*Special diversion provisions for small producers are not accounted for in these calculations for 1961-1970. The program also provided payments for land diversion; these are contained in the calculations of PV2C, Appendix B-2.

Year	Loan Rate	PA	Estimation of r	PV1C
			r = 1/2 (0.6 + 0.8) = 0.7, hence, (1.07)(0.7) + (.18) (0.7), or (1.25)(0.7) =	.88
1964	1.10	1.25	Total price support consisted of a loan rate of $1.10 and a direct payment of $.15 for all corn grown in compliance with planting restrictions. Maximum and minimum diversion requirements were 50 percent and 20 percent respectively, leaving 50 percent to 80 percent of base acreage for corn planting. So, r = 1/2 (0.5 + 0.8) = 0.65; hence, (1.10)(0.65) + (.15)(0.65) or (1.25)(0.65) =	.81
1965	1.05	1.25	Total price support consisted of a loan rate of $1.05 and a direct payment of $.20 for all corn grown in compliance with planting restrictions. Remaining provisions were the same as 1964, giving an r of 0.65, hence, (1.05)(0.65) + (.20) (0.65) or (1.25)(0.65) =	.81
1966	1.00	1.00	Price support = loan only* Remaining provisions were the same as 1964, giving an r of 0.65 hence, (1.00)(0.65) =	.65
1967	1.05	1.05	Price support = loan only. Only one level of diversion was specified--20 percent of base acreage, leaving 80 percent available for corn, so r = 0.8, hence, (1.05)(0.8) =	.84

*A change in program provisions limiting the support payment to a maximum of 50 percent of base acreage, and discontinuing a separate payment for minimum diversion, made the support payment function as a payment for minimum diversion. Therefore beginning with 1966, support payments are included with diversion payments in the calculations of PV2C, Appendix B-2.

Year	Loan Rate	PA	Estimation of r	PV1C
1968	1.05	1.05	Price support = loan only, if planting restricted. Remaining provisions were the same as 1964, so r = 0.65, hence, (1.05)(0.65) =	.68
1969	1.05	1.05	Same as 1968	.68
1970	1.05	1.05	Same as 1968	.68
1971	1.05	1.05	Price support = loan only. No planting restriction, so r = 1.0 and PV1C =	1.05
1972	1.05	1.05	Price support = loan only. No planting restriction applied at the minimum level of participation. Various options were offered for the maximum level of participation. It was assumed that the maximum level of diversion was 20 percent of base acreage leaving 80 percent available for corn. So, r = 1/2 (1.0 + 0.8) = 0.90; hence, (1.05)(0.90) =	.94
1973	1.05	1.05	Price support = loan only. No planting restriction, so r = 1.0 and PV1C =	1.05

APPENDIX B-2

CALCULATION OF THE POLICY VARIABLE PV2C FOR CORN, 1950-1973

Formula: $PV2C = wPR$

Where PR is the payment rate for diversion or set aside for withdrawal of land from corn production, and w is the proportion of acreage eligible for diversion or set aside payments. If all land is eligible for payment, w equals 1.0; the smaller the permitted diversion acreage, the closer w is to zero.

Year	PR*	Estimation of w	PV2C*
1950-1955	0	No government payment was offered, so w = 0, and PV2C =	0
1956	0	Payments were offered under acreage reserve provisions of the soil bank program, but the announcement came after planting so did not affect planting decisions, and therefore were disregarded in the research	0
1957	.95	Payments for acreage withdrawn from corn production under acreage reserve provisions of soil bank were $37.50 to $42.66 per acre. At a yield of 42 bushels per acre; this amounts to $.89 to $1.01 per bushel or an average of $.95 per bushel. To obtain an estimate of w a ratio was computed of the total	

*Values dollars per bushel of corn.

Year	PR	Estimation of w	PV2C
		corn acreage placed in the acreage reserve to corn acreage planted in an historical base year (assumed here to be 1953). The computed ratio is 0.09. Thus PV2C would be (.09)(.95) = 0.86 To make this calculation of PV2C correspond as closely as possible with calculations for 1961 to 1972, the equation was multiplied by 0.5. Hence, PV2C =	.043
1958	.95	Same as 1957 except that more acreage was placed in the program, yielding a ratio of .11 for 1958. Hence, PV2C is 1/2 [(.11)(.95)] =	.052
1959-1960	0	No government payment, so w = 0 and PV2C =	0
1961	.60 (.72)	Two different payment rates applied. For the first 20 percent of base acreage diverted, the minimum requirement, the payment was $.60 per bushel on estimated production from that land. For additional diversion, up to a maximum diversion of 40 percent of base acreage, the payment rate was $.72 per bushel on estimated production from the idled land. To account for both minimum and maximum diversion provisions, a simple average was taken to reflect the overall diversion payment provisions, thus: 1/2 [(.2 x .60) + (.2 x .60 + .2 x .72)] =	.192
		where (.2 x .60) represents minimum diversion provisions and (.2 x .60 + .2 x .72) represents maximum diversion provisions.	

Year	PR	Estimation of w	PV2C
1962	.60 (.72)	Same as 1962	.192
1963	.25 (.625)	Two different payment rates applied. For the first 20 percent of base acreage diverted, the minimum requirement, the payment rate was $.25 per bushel. An additional 20 percent diversion was optional and the rate was $.625 per bushel. These values are combined, as follows, to compute PV2C: 1/2 [(.2 x .25) + (.2 x .25 + .2 x .625)] =	.112
1964	.25 (.625)	Two different payment rates applied. The lower rate, $.25 was paid for minimum diversion of 20 percent of the base. But if an additional 30 percent of the base was idled, $.625 per bushel was paid for estimated production on all acreage diverted. Averaging minimum and maximum rates gives 1/2 [(.2)(.25) + (.5)(.625)] =	.181
1965	.25 (.625)	Same as 1964	.181
1966	.75 (.65)	The payment for minimum diversion was $.75 per bushel on estimated production for 20 percent of base acreage. This was called the support payment in program language but it functions as a payment for minimum diversion. Payment for an additional 30 percent diversion was $.65. Averaging minimum and maximum values gives 1/2 [(.2 x .75) + (.2 x .75 + .3 x .65)] =	.248
1967	.75	Payments were offered only for minimum diversion, $.75 per	

Year	PR	Estimation of w	PV2C
		bushel on 20 percent of base acreage. Hence, (.2)(.75) =	.150
1968	.75 (.6075)	The payment for minimum diversion was \$.75 on 20 percent of the base. An additional 30 percent of diversion was allowed, at a rate of \$.6075. And averaging the two, 1/2 [(.2 x .75) + (.2 x .75 + .3 x .6075)] =	.241
1969	.75 (.6075)	Same as 1968	.241
1970	.75 (.54)	Same as 1968, except for a lower payment rate for the additional diversion allowed. So PV2C is 1/2 [(.2 x .75) + (.2 x .75 + .3 x .54)] =	.231
1971	.80	Payments were offered only for minimum diversion, \$.80 per bushel on 20 percent of base acreage. Hence, (.2)(.80) =	.160
1972	.80 (.80)	For minimum diversion of 25 percent of base acreage, the rate was \$.80 per bushel. Various other plans were available for additional diversion. Under one such plan which seemed reflective of what happened, 10 percent of base acreage was allowed at a rate of \$.80, the same rate as for the first 25 percent diversion. So PV2C is 1/2 [(.25 x .80) + (.25 x .80 + .10 x 80)] =	.240
1973	1.60	Many changes were made in diversion provisions prior to planting. The one most reflective of what actually happened	

Year	PR	Estimation of w	PV2C
		was one requiring diversion of 10 percent of base acreage. Hence, (.1)(1.60) =	.160

APPENDIX B-3

CALCULATIONS OF THE POLICY VARIABLE

PV1SH FOR SORGHUMS, 1956-1973

Formula: PV1SH = r PA

Where PA is the announced support rate for sorghums produced (the loan rate in most years) and r is an adjustment factor reflecting planting restrictions.

Year	Loan* Rate	PA*	Estimation of r	PV1SH*
1956	1.97	1.97	Price support = loan only. No planting restriction so, r = 1.0 and PV1SH =	1.97
1957	1.86	1.86	Price support = loan only. No planting restriction, so r = 1.0 and PV1SH =	1.86
1958	1.83	1.83	Price support = loan only. No planting restriction, so r = 1.0 and PV1SH =	1.83
1959	1.52	1.52	Price support = loan only. No planting restriction, so r = 1.0 and PV1SH =	1.52
1960	1.52	1.52	Price support = loan only. No planting restriction, so r = 1.0 and PV1SH =	1.52
1961	1.93	1.93	Price support = loan only, if planting restricted. Restrictions same as with corn in 1961.	

*Values are in dollars per hundred weight (cwt.).

Year	Loan Rate	PA	Estimation of r	PV1SH
1961*			So r = 1/2(0.6 + 0.8) = 0.7, hence, (1.93)(0.7) =	1.35
1962	1.20	1.20	Same as 1961	1.35
1963	1.71	2.00	Total price support consisted of a loan rate of $1.71 and a direct payment of $.29 for all sorghum grown in compliance with planting restrictions. Restrictions same as with corn in 1963. So, r = 1/2(0.6 + 0.8) = 0.7, hence, (1.71)(0.7) + (.29)(0.7), or (2.00)(0.7) =	1.40
1964	1.77	2.00	Total price support consisted of a loan rate of $1.77 and a direct payment of $.23 for all sorghum grown in compliance with planting restrictions. Restrictions same as with corn in 1964. So, r = 1/2 (0.5 + 0.8) = 0.65; hence, (1.77)(0.65) + (.23)(0.65) or (2.00)(0.65) =	1.30
1965	1.65	2.00	Total price support consisted of a loan rate of $1.65 and a direct payment of $.35 for all sorghum grown in compliance with planting restrictions. Remaining provisions were the same as 1964, giving an r of 0.65, hence, (1.65)(0.65) + (.35)(0.65) or (2.00)(0.65) =	1.30
1966	1.52	1.52	Price support = loan only.** Remaining provisions were the same as 1964, giving an r of	

*Special diversion provisions for small producers are not accounted for in these calculations for 1961-1970. The program also provided payments for land diversions; these are contained in the calculation of PV2SH, Appendix B-4.

**A change in program provisions limiting the support payment to a maximum of 50 percent of base acreage, and discontinuing a separate payment for minimum diversion, made

Year	Loan Rate	PA	Estimation of r	PV1SH
			0.65, hence (1.52)(0.65) =	.99
1967	1.61	1.61	Price support = loan only. Only one level of diversion was specified--20 percent of base acreage, leaving 80 percent available for sorghum, so r = 0.8, hence, (1.61)(0.8) =	1.29
1968	1.62	1.62	Price support = loan only, if planting restricted. The same range of division was allowed as for 1964, so r = 0.65, hence (1.62)(0.65) =	1.05
1969	1.61	1.61	Same as 1968	1.05
1970	1.61	1.61	Same as 1968	1.05
1971	1.73	1.73	Price support = loan only. No planting restriction, so r = 1.0 and PV1SH =	1.73
1972	1.79	1.79	Price support = loan only. No planting restriction applied at the minimum level of participation, so r = 1.0. Two options were offered for the maximum level of participation. Under one option, called Plan A, still no restriction applied to sorghum planting. Under the second option, Plan B, higher payments were offered *if* sorghum acreage was reduced below 1971 plantings. At the maximum level of diversion, 1972 sorghum acreage must cut back 30 percent from 1971, so the estimate of r from Plan B is 0.7. Following the practice adopted for previous years of averaging the	

the support payment function as a payment for minimum diversion. Therefore beginning with 1966, support payments are included with diversion payments in the calculations of PV2SH.

Year	Loan Rate	PA	Estimation of r	PV1SH
			most restrictive and the least restrictive program provisions, r = 1/2 (1.0 + 0.7) = 0.85 where 1.0 reflects participation at minimum level diversion and 0.7 reflects maximum diversion under Plan B, the more restrictive of the two plans. Hence, PV1SH is (1.79)(0.85) =	1.52
1973	1.79	1.79	Price support = loan only. No planting restriction, so r = 1.0 and PV1SH =	1.79

APPENDIX B-4

CALCULATION OF THE POLICY VARIABLE

PV2SH FOR SORGHUMS, 1956-1973

Formula: PV2SH = wPR

Where PR is the payment rate for diversion or set aside, and w is the proportion of acreage eligible for diversion or set aside payments.

Year	PR*	Estimation of w	PV2SH*
1956-1960	0	No government payment, so w = 0 and PV2SH =	0
1961	.965 (1.158)	Two different payment rates applied. For the first 20 percent of base acreage diverted, the minimum requirement, the payment was .965 per cwt. on estimated production from that land. For additional diversion, the payment rate was $1.158 per cwt on estimated production from the idled land. To account for both minimum and maximum diversion provisions, a simple average was taken to reflect the overall diversion payment provision, thus 1/2 [(.2 x .965) + (.2 x .965 + .2 x 1.158)] = where (.2 x .965) represents minimum diversion provisions and (.2 x .965 + .2 x 1.158) represents maximum diversions provisions.	.309

*Values are expressed in dollars per hundred weight (cwt).

Year	PR	Estimation of w	PV2SH
1962	.965 (1.158)	Same as 1962	.309
1963	.40 (1.00)	Two different payment rates applied. For the first 20 percent of base acreage diverted, the minimum requirement, the rate was $.50 per cwt. The rate for an additional optional diversion of 20 percent was $1.00 per cwt. Averaging minimum and maximum values gives 1/2 [(.2 x .40) + (.2 x .40 + .2 x 1.00)] =	.180
1964	.40 (1.00)	Two different payment rates applied, and the allowable maximum diversion was increased from 40 percent to 50 percent. The lower rate, $.40 was paid for minimum diversion of 20 percent of the base. If an additional 30 percent of the base was idled, $1.00 per cwt. was paid for estimated production on all acreage diverted. Averaging minimum and maximum rates gives 1/2 [(.2)(.40) + (.5)(1.00)] =	.290
1965	.40 (1.00)	Same as 1964	.290
1966	1.325 (1.025)	The payment for minimum diversion was $1.325 per cwt on estimated production for 20 percent of base acreage. This was called the support payment in program language but it functions as a payment for minimum diversion. Payment for an additional 30 percent diversion was $1.025. And averaging minimum and maximum values gives 1/2 [(.2 x 1.325) + (.2 x 1.325 + .3 x 1.025)] =	.418

Year	PR	Estimation of w	PV2SH
1967	1.325	Payments were offered only for minimum diversion, \$1.325 per cwt on 20 percent of base acreage. Hence, (.2)(1.325) =	.265
1968	1.325 (.968)	The payment for minimum diversion was \$1.325 on 20 percent of the base. An additional 30 percent of diversion was allowed, at a rate of \$.968. Averaging the two, 1/2 [(.2 x 1.325) + (.2 x 1.325 + .3 x .968)] =	.410
1969	1.325 (.963)	Same as 1968, except lower payment rate for additional diversion. So PV2SH is 1/2 [(.2 x 1.325) + (.2 x 1.325 + .3 x .963)] =	.409
1970	1.325 (.856)	Same as 1968, except lower payment rate for additional diversion. So, PV2SH is 1/2 [(.2 x 1.325) + (.2 x 1.325 + .3 x .856)] =	.393
1971	1.295	Payments were offered only for minimum diversion, \$1.295 per cwt on 20 percent of base acreage. Hence, (.2)(1.295) =	.259
1972	1.358 (.876)(1.36)	For minimum diversion of 25 percent of base acreage, the rate was \$1.358 per cwt. Under Plan A, diversion of an additional 20 percent of base acreage was allowed at a rate of \$.876. Thus, PV2SH for maximum diversion under Plan A is (.25)(1.358) + (.20) (.876) =	.514
		Under Plan B, diversion of an additional 15 percent of base acreage was allowed at a rate of \$1.358, the same rate as for the first 25 percent diversion. Thus PV2SH for	

Year	PR	Estimation of w	PV2SH
		maximum diversion under Plan B is (.25)(1.358) + (.15)(1.358) or (.40)(1.358) =	.543
		And following the practice adopted for earlier years of averaging minimum and maximum diversion provisions, PV2SH for the entire program is 1/2 [(.25)(1.358) + (.40)(1.358)] =	.442
		where (.25)(1.358) reflects minimum diversion provisions and (.40)(1.358) reflects maximum diversion provisions under Plan B. Plan B maximum provisions are employed instead of Plan A provisions because the calculated value of PV2SH is greater under Plan B (.543) than under Plan A (.514).	
1973	2.68	Many changes were made in diversion provisions prior to planting. The one most reflective of what actually happened was one requiring diversion of 10 percent of base acreage. Hence, (.1)(2.68) =	2.68

APPENDIX B-5

CALCULATIONS OF THE POLICY VARIABLE PV1B FOR BARLEY, 1950-1973

Formula: PV1B = r PA

Where PA is the announced support rate for barley produced (the loan rate in most years) and r is an adjustment factor reflecting planting restrictions.

Year	Loan* Rate	PA*	Estimation of r	PV1B*
1950	1.10	1.10	Price support = loan only. No planting restriction, so r = 1.0 and PV1B =	1.10
1951	1.11	1.11	Price support = loan only. No planting restriction, so r = 1.0 and PV1B =	1.11
1952	1.22	1.22	As above, price support = loan only. No planting restriction, so r = 1.0 and PV1B =	1.22
1953	1.24	1.24	As above, price support = loan only. No planting restriction, so r = 1.0 and PV1B =	1.24
1954	1.15	1.15	As above, Price support = loan only. No planting restriction, so r = 1.0 and PV1B =	1.15
1955	.95	.95	As above, price support = loan only. No planting	

*Values in dollars per bushel of barley.

Year	Loan Rate	PA	Estimation of r	PV1B
			restriction, so r = 1.0 and PV1B =	.95
1956	1.02	1.02	As above, Price support = loan only. No planting restriction, so r = 1.0 and PV1B =	1.02
1957	.94	.94	As above, Price support = loan only. No planting restriction, so r = 1.0 and PV1B =	.94
1958	.93	.93	As above, price support = loan only. No planting restriction, so r = 1.0 and PV1B =	.93
1959	.77	.77	As above, price support = loan only. No planting restriction, so r = 1.0 and PV1B =	.77
1960	.77	.77	As above, price support = loan only. No planting restriction, so r = 1.0 and PV1B =	.77
1961	.93	.93	As above, price support = loan only. No planting restriction, so r = 1.0 and PV1B =	.93
1962	.93	.93	r = 0.7 (see corn 1962) Hence, PV1B =	.65
1963	.82	.96	Total price support consisted of a loan rate of $.82 and a direct payment of $.14 for all barley grown in compliance with planting restrictions. Restrictions were the same as with corn 1963, so 4 = 0.7 Hence, (.82)(0.7) + (.14)(0.7), or (.96)(0.7) =	.67

Year	Loan Rate	PA	Estimation of r	PV1B
1964	.84	.96	Total price wupport consisted of a loan rate of $.84 and a direct payment of $.12 for all barley grown in compliance with planting restrictions. Restrictions were the same as with corn 1964, so r = .65, hence, (.96)(0.65) =	.62
1965	.80	.96	Total price support consisted of a loan rate of $.80 and a direct payment of $.16 for all barley grown in compliance with planting restrictions. Remaining provisions were the same as 1964, giving an r of 0.65 hence (.96)(0.65) =	.62
1966	.80	.80	Price support = loan only* Remaining provisions were the same as 1964, giving an r of 0.65, hence, (.80)(0.65) =	.52
1967	.90	.90	Price support = loan only. No planting restrictions, so r = 1.0 and PV1B =	.90
1968	.90	.90	Price support = loan only. No planting restrictions, so r = 1.0 and PV1B =	.90
1969	.83	.83	Price support = loan only, if planting restricted. Remaining provisions were the same as 1964, so r = 0.65, hence, (.83)(0.65) =	.54

*A change in program provisions limiting the support payment to a maximum of 50 percent of base acreage, and discounting a separate payment for minimum diversion, made the support payment function as a payment for minimum diversion. Therefore beginning with 1966, support payments are included with diversion payments in the calculations of PV2B, Appendix B-6.

Year	Loan Rate	PA	Estimation of r	PV1B
1970	.83	.83	Same as 1969	.54
1971	.81	.81	Price support = loan only. No planting restrictions, so r = 1.0 and PV1B =	.81
1972	.86	.86	Price support = loan only. No planting restrictions, so r = 1.0 and PV1B =	.86
1973	.86	.86	Price support = loan only. No planting restrictions, so r = 1.0 and PV1B =	.86

APPENDIX B-6

CALCULATION OF THE POLICY VARIABLE

PV2B FOR BARLEY, 1950-1973

<u>Formula: PV2B = w PR</u>

Where PR is the payment rate for diversion or set aside, and w is the proportion of acreage eligible for diversion or set aside payments.

Year	PR*	Estimation of w	PV2B*
1950-1961	0	No government payment, so w = 0 and PV2B =	0
1962	.46 (.56)	Two different payment rates applied. For the first 20 percent of base average diverted, the minimum requirement, the payment rate was \$.46 per bushel on estimated production from that land. For additional diversion, up to a maximum diversion of 40 percent of base acreage, the payment rate was \$.56 per bushel on estimated production from that land. For additional diversion, up to a maximum diversion of 40 percent of base acreage, the payment rate was \$.56 per bushel on estimated production from the idled land, thus 1/2 [(.2 x .46) + (.2 x .46 + .2 x .56)] =	.149

*Values are expressed in dollars per bushel of barley.

Year	PR	Estimation of w	PV2B
		where (.2 x .46) represents minimum diversion provisions and (.2 x .46 + .2 x .56) represents maximum diversion provisions	
1963	.192 (.46)	Two different payment rates applied. For the first 20 percent of base acreage diverted the minimum requirement, the payment rate was $.192 per bushel. For additional diversion, to a maximum of 40 percent of base acreage, the rate was $.46 per bushel. These values are combined to compute PV2B, 1/2 (.2 x .192) + (.2 x .192 + .2 x .46) =	.86
1964	.192 (.46)	Two different payment rates applied. The lower rate, $.192, was paid for minimum diversion of 20 percent of the base. But if an additional 30 percent of the base was idled, $.46 per bushel was paid for estimated production on all acreage diverted. Averaging minimum and maximum rates gives 1/2 [(.2)(.192) + (.5)(.46)] =	.139
1965	.192 (.46)	Same as 1964	.139
1966	.50 (.50)	The payment for minimum diversion was $.50 per bushel on estimated production for 20 percent of base acreage. This was called the support payment in program language but it functions as a payment for minimum diversion. Payment for an additional 30 percent diversion was also $.50. Averaging minimum and maximum value gives 1/2 [(.2 x .50) + (.2 x .50 + .3 x .50)] =	.175

Year	PR	Estimation of w	PV2B
1967	0	No government payment, so w = 0 and PV2B =	0
1968	0	No government payment, so w = 0 and PV2B =	0
1969	.50 (.46)	The payment rate was $.50 on 20 percent of the base. An additional 30 percent of diversion was allowed, at a rate of $.46. Averaging the two, 1/2 [(.2 x .50) + (.2 x .50 + .3 x .46)] =	.170
1970	.50 (.41)	Same as 1969, except for a lower payment rate for the additional diversion allowed so, PV2B is 1/2 [(.2 x .50) + (.2 x .50 + .3 x .41)] =	.162
1971	0	No government payment, so w = 0 and PV2B =	0
1972	.64 (.42)	Two different payment rates applied. For the first 25 percent of base acreage diverted, the minimum requirement, the payment rate was $.64 per bushel. For additional diversion, to a maximum of 40 percent of the base acreage, the rate was $.42 per bushel. These values are combined to compute PV2B 1/2 [(.25 x .65) + (.25 x .64 + .2 x .42)] =	.200
1973	1.30	Many changes were made in diversion provisions prior to planting. The one most reflective of what actually happened was one requiring diversion of 10 percent of base acreage. Hence, (.1)(1.30) =	.130

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