Supply Response Under the 1996 Farm Act and Implications for the U.S. Field Crops Sector. By William Lin, Paul C. Westcott, Robert Skinner, Scott Sanford, and Daniel G. De La Torre Ugarte. Market and Trade Economics Division, Economic Research Service, U.S. Department of Agriculture. Technical Bulletin No. 1888.

Abstract

The 1996 Farm Act gives farmers almost complete planting flexibility, allowing producers to respond to price changes to a greater extent than they had under previous legislation. This study measures supply responsiveness for major field crops to changes in their own prices and in prices for competing crops and indicates significant increases in responsiveness. Relative to 1986-90, the percentage increases in the responsiveness of U.S. plantings of major field crops to a 1-percent change in their own prices are wheat (1.2 percent), corn (41.6 percent), soybeans (13.5 percent), and cotton (7.9 percent). In percentage terms, the increases in the responsiveness generally become greater with respect to competing crops' price changes. The 1996 legislation has the least effect on U.S. wheat acreage, whereas the law may lead to an average increase of 2 million acres during 1996-2005 in soybean acreage, a decline of 1-2 million acres in corn acreage, and an increase of 0.7 million acres in cotton acreage. Overall, the effect of the farm legislation on regional production patterns of major field crops appears to be modest. Corn acreage expansion in the Central and Northern Plains, a long-term trend in this important wheat production region, will slow under the 1996 legislation, while soybean acreage expansion in this region will accelerate. The authors used the Policy Analysis System-Economic Research Service (POLYSYS-ERS) model that was jointly developed by USDA's Economic Research Service and the University of Tennessee's Agricultural Policy Analysis Center to estimate the effects of the 1996 legislation.

Keywords: Supply response, major field crops, acreage price elasticities, normal flex acreage (NFA), 1996 farm legislation.

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Summary

Supply response for crops has historically been heavily influenced by the effects of agricultural commodity programs. Structural relations estimated under the previous policy environment, however, may no longer hold under the Federal Agriculture Improvement and Reform Act of 1996 (1996 Act) because most of the restrictions imposed on producers' planting decisions are now removed. A central question resulting from this policy change is how responsive plantings are to movement in market prices under the 1996 Act compared with previous legislation.

This technical bulletin estimates producers' supply response under the 1996 Act for major field crops by production region. The study also measures the effect of planting flexibility under the 1996 Act on aggregate acreage planted to major field crops, crop acreage composition, farm prices, and regional production adjustments. The general approach taken is an indepth analysis of producers' planting decisions during 1991-95, when producers were granted limited planting flexibility under the Food, Agriculture, Conservation, and Trade Act of 1990 (1990 Act), and then to infer their likely acreage response to market incentives under the 1996 Act.

Own- and cross-price acreage elasticities for major U.S. field crops are greater (producers' planting decisions are more responsive to price changes), in most cases, under the 1996 Act than those estimated under previous legislation due to almost full planting flexibility. Relative to 1986-90, the own-price acreage elasticity under the 1996 Act shows an increase in the responsiveness of U.S. wheat producers to a change in the wheat price by 1.2 percent. For other commodities, the percentage increases are as follows: corn (41.6%), soybeans (13.5%), and cotton (7.9%). In percentage terms, cross-price acreage elasticities estimated under the 1996 Act generally increase even more than own-price elasticities. This finding implies that farm commodity programs in the past might have restricted acreage shifts from program crops to other crops.

The increases in own- and cross-price elasticities tend to have offsetting effects on acreage changes in total. As a consequence, results in this study indicate that the aggregate effect of the 1996 Act on area planted to the eight major field crops (wheat, corn, sorghum, barley, oats, soybeans, cotton, and rice) is modest when compared with plantings under a continuation of the 1990 Act. The 1996 Act has the least effect on U.S. wheat acreage, in part due to small changes in acreage price elasticities between the 1990 Act and 1996 Act. Corn acreage expansion in the Central and Northern Plains, a long-term trend in this important wheat production region, will slow under the 1996 Act, while soybean acreage expansion in this region will accelerate. The 1996 Act has its biggest acreage effect on soybeans—an increase of over 2 million acres throughout the entire 1996-2005 period. Nearly full planting flexibility allows corn producers to make a switch from corn to soybeans.

Overall, the effect of the farm legislation change on regional production patterns of major field crops also appears to be modest. The effect varies among crops, ranging from the smallest for wheat to a more noticeable change for cotton. Corn production will be slightly more concentrated in the North Central region

under the 1996 Act, while soybean production will be slightly less concentrated in that region, due to projected acreage expansion in other regions.

The effects of the greater degree of producer responsiveness related to the 1996 farm legislation on crop acreage and regional production patterns were initially estimated under the high-price market conditions of 1996 and 1997. This study found that the effects of the greater degree of producer responsiveness would have been much the same under lower price market conditions as occurred in recent years, as well.

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Introduction

Supply response for crops has historically been heavily influenced by the effects of agricultural commodity programs. Structural relations estimated under the previous policy environment, however, may no longer hold under the Federal Agriculture Improvement and Reform Act of 1996 (1996 Act), because most of the restrictions imposed on producers' planting decisions are now removed.[1] With elimination of target-price-based deficiency payments, government payments have become a less important factor in producers' planting decisions. When market prices are above commodity loan rates, supply response is based largely on market incentives.[2] A central question resulting from this policy change is how responsive plantings are to movement in market prices under the 1996 Act compared with previous legislation.[3]

Ideally, if a long enough time series were available, structural supply response relationships could be re-estimated to provide a satisfactory answer to this question. However, because the 1996 Act was implemented fairly recently, historical data are not yet sufficient to re-estimate the structural relations. Yet, policymakers and market participants want to know how producers will respond to market forces under the 1996 Act and how the act will affect U.S. agriculture. Thus, the change in farm programs calls for a new, innovative approach to estimating U.S. supply response.

Greater supply response, which is manifested through enhanced planting flexibility under the 1996 Act, has a host of important implications for U.S. field crops. How will the 1996 Act alter national aggregate acreage planted to major field crops and crop acreage composition? Will the removal of acreage bases and planting restrictions trigger a shift away from continuous corn operations toward a corn-soybean rotation? Will the 1996 Act dampen or facilitate the long-term trend in the expansion of corn and soybean acreage in the Central and Northern Plains region, where over half of U.S. wheat acreage is located? Will the 1996 Act drastically alter regional production patterns for major field crops? What will be the price impacts of any acreage shifts? Will the effects of changes in the farm program on crop acreage differ in a comparison of high-price and low-price market conditions?

The purposes of this report are two-fold: (1) to estimate producers' supply response under the 1996 Act for major field crops and by production region; and (2) to measure the effect of the 1996 Act on aggregate acreage planted to major field crops, acreage planted to individual crops, regional production adjustments, and farm prices. This study recognizes the difference in producers' supply response between the 1996 Act and previous legislation and incorporates new acreage price

[1]The conservation compliance requirement, which was in effect under the Food, Agriculture, Conservation, and Trade Act of 1990 (1990 Act), still remains under the 1996 Act.

[2]Marketing loan benefits augment market returns when commodity prices are low, as occurred recently. In these circumstances, Government payments can still influence planting decisions.

[3]Earlier studies on supply response are plentiful, but those comparing free market and restrictive acreage programs are relatively few (for example, Lee and Helmberger). According to the Lee and Helmberger study, corn acreage response was found to be more responsive to own price in years of acreage control programs, 1961-73 and 1978-79, than in other years when a free market was in effect, 1948-49, 1951-53, 1959-60, 1974-77, and 1980. In contrast, soybean acreage response was found to be less responsive to its own price in years when there were feed grain programs than in a free market.

elasticities into estimates of the impact of the 1996 Act on the U.S. field crops sector. The general approach taken here is to gain an indepth understanding of producers' planting decisions during 1991-95, when producers were granted limited planting flexibility under the 1990 Act, and then to infer their likely acreage response to market incentives under the 1996 Act.

The supply response information presented in this report can be useful in analyzing U.S. agricultural policy and farm commodity programs, as well as in commodity market analysis. An indepth analysis of 1991-95 planting decisions is conducted for program-crop normal flex acreage (NFA), the 15 percent of base acreage under the 1990 Act where producers were permitted to grow any approved crops without loss of base, but received no deficiency payments. This analysis is used to infer producers' acreage response to market incentives under the 1996 Act, with estimates of own- and cross-price elasticities for major field crops derived at the national level and in specific production regions. Then, using these new elasticity estimates, the effects of supply response aspects of the 1996 Act for field crops are presented, based on a comparison of simulations of a U.S. agricultural sector model. Finally, uses of the new supply response elasticities are illustrated in short-term, acreage-forecasting applications.

Evolution of Supply Management Programs Toward Planting Flexibility

U.S. agricultural commodity policy has undergone important changes over the last 10 to 15 years, particularly regarding supply management programs. Policy changes since the mid-1980's have significantly changed agriculture from the highly managed sector of the early- and mid-1980's to a more market-oriented sector today (Nelson and Schertz; Young and Shields).

Supply Management Policy Evolution to Market Orientation

Under the 1985 Act, supply management programs significantly limited producers' planting decisions with both institutional barriers and economic barriers to acreage shifting among crops. Requirements to plant the program crop (or to certify acreage as "considered planted") to protect the farmer's acreage base for that crop were a strong institutional barrier to planting flexibility. Large deficiency payment rates, although a benefit of program participation, also represented an economic barrier to planting flexibility. As a result, program participation rates were high, supply response was significantly constrained, and the programs encouraged the planting of the same program crops over time.

Farm legislation in 1990 provided farmers some planting flexibility. Flexibility to plant other crops on 25 percent of program-crop base acres was permitted with base protection for any acreage switched, thus breaking the institutional barrier to flexibility. On 15 percent of the acreage base (normal flex acres), there were no deficiency payments regardless of the planting choice, effectively eliminating the economic barrier to use of planting flexibility. For the remaining 10 percent of the acreage base where planting flexibility applied (optional flex acres), deficiency payments were paid if the program crop was planted, but were foregone for each acre that was flexed to an alternative crop. On optional flex acres, therefore, the economic barrier to use of flexibility remained. The combination of these program changes partly opened supply response to market forces. There was considerable use of flexibility on normal flex acres, where both the institutional and the economic barriers were removed, but there was only limited switching on optional flex acres, where economic barriers (in particular, the potential loss of deficiency payments) remained.

The 1996 Act introduced nearly full planting flexibility. With only a few limitations, planting alternative crops is now permitted on a farmer's entire acreage base, thus fully eliminating institutional barriers to flexibility. Under the 1996 Act, farmers who participated in the wheat, feed grain, cotton, and rice programs in any one of the years 1991-95 could enter into 7-year production flexibility contracts and receive payments for the years 1996-2002.[4] These contract payments are not linked to production choices—farmers receive the full contract payment so long as the land is kept in an agricultural use. Thus, economic barriers to flexibility are also removed under the 1996 Act, making supply response more open to market forces.

A Closer Look at 1990 Farm Legislation

Because most of the U.S. experience with planting flexibility was during 1991-95 under provisions of 1990 farm legislation, features of that legislation and the economic planting incentives during those years are discussed in this section. This also sets the stage for the supply response estimation that follows, based mostly on analysis of normal flex acreage.

To facilitate the analysis of the economics of various planting decisions, we used a net returns framework (Westcott, 1991; Westcott and Glauber). Comparisons of net returns for different planting options form the basis for the cropping choices that farmers make to maximize profits. Of particular interest is how program payments affected producers' decisions.

Program Participation Decision (Whole Base)

Program payments under 1990 farm legislation affected producers' decisions to enroll in the annual commodity programs by influencing expected net returns. Equations 1a, 1b, and 1c indicate alternative average per-acre net returns to, respectively, (a) enrolling in the program for a program crop (and planting the program crop to the extent permitted); (b) not enrolling in the program but planting the program crop; and (c) planting an alternative competing crop.

(1a) Market returns plus Government payments for program crop; program participant:

$$NR_p = (1 - ARP)\,(P * Y - VC) + (1 - ARP - 0.15)\;D$$

[4]Contract acreage includes (1) land considered planted to program crops for any of the crop years 1991-95, (2) land enrolled in acreage reduction programs (ARP's) for any of the crop years 1991-95, and (3) land leaving the Conservation Reserve Program (CRP) that had an acreage base.

(1b) Market returns; non-participant:

$$NR_n = P * Y - VC$$

(1c) Market returns for alternative competing crop:

$$NR' = P' * Y' - VC'$$

NR_p, NR_n, and NR' are alternative expected net returns; P, Y, and VC are price, yield, and variable production costs for the program crop; P', Y', and VC' are price, yield, and variable production costs for an alternative competing crop; ARP is the annual Acreage Reduction Program land-idling requirement; and D is the deficiency payment rate on a per-acre basis.

Net returns for program participation reflect both the benefits of expected deficiency payments as well as the costs of idling land. Provisions of the 1990 farm legislation that reduced payment acres lowered the acreage eligible for deficiency payments by 15 percent of the acreage base, as indicated in equation 1a. Net returns for the program crop as a nonparticipant or for an alternative competing crop are based on the marketplace, equaling expected market receipts minus variable production costs.

The decision to participate in the program was a whole-base decision prior to the 1996 Act, meaning that farmers either enrolled their entire base acreage in the program or grew the program crop or an alternative competing crop outside of the program. Deficiency payments affected the participation decision, as indicated by the inclusion of payments in equation 1a. A choice to not participate or to plant an alternative crop would be based on the net returns associated with those decisions, compared with the net returns and program payments associated with the participation option.

Other factors that could affect the program participation decision included a lack of base protection if a producer planted an alternative crop or idled land as a nonparticipant. Flexibility provisions that allowed some shifting to other crops while protecting the program crop acreage base only applied to program participants. Thus, farmers wanting to shift to other crops without a loss of base acreage would need to enroll in the program. On the other hand, however, a program participant could not plant the program crop beyond the size of the acreage base. If a farmer wanted to overplant the acreage base and enlarge the base for future years, this could be done only as a nonparticipant for the year of overplantings.

Planting Decisions for Subcomponents of Enrolled Acreage Base

As a whole-base decision, program payments affected the decision to participate. However, once in the program, how did program payments affect marginal planting choices for different parts of the enrolled acreage base? Again, these planting decisions can be examined by analyzing net returns associated with each of the subcomponents of the enrolled base. These subcomponents include normal flex acreage, optional flex acreage, and nonflex acreage divided into two parts related to the 0/85 program. For each acreage base subcomponent, average per-acre net returns for alternative planting choices are presented. For illustration purposes, a farm with a 100-acre base is used in the discussion. Also, to simplify the arithmetic, the examples presented assume a 0-percent Acreage Reduction Program (ARP), as was implemented in 1994 for corn. Acreage designations and corresponding program payment acres for two planting alternatives, the regular program and the 0/85 program, are also illustrated in figure 1.

Normal flex acreage. Normal flex acreage (NFA) covered 15 acres of the 100-acre base. On these acres, no deficiency payments were made regardless of whether or not the farmer planted the program crop. Planting flexibility provisions allowed the planting of alternative crops on these acres without penalty. Net returns for planting the original program crop were therefore based on market returns, as shown in equation 2a, while plantings of a permitted alternative crop also were based on its market returns, as in equation 2b. Because there are no deficiency payments in equation 2a, Government payments did not affect the planting decision on these acres, and the producer's planting decision was based on expected market returns among competing crops.

(2a) NFA, market returns for program crop:

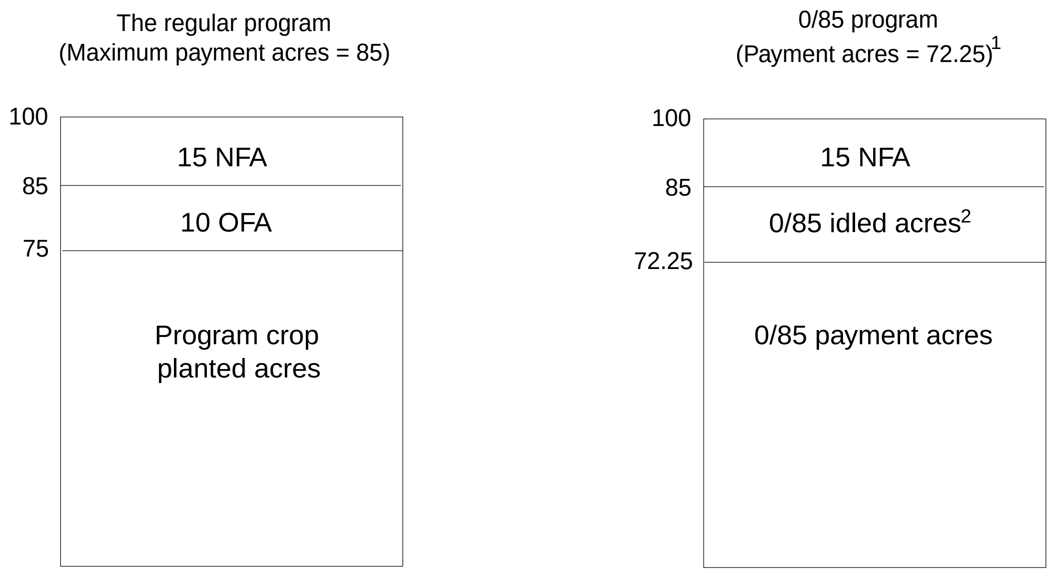
$$NR = P * Y - VC$$

(2b) NFA, market returns for alternative competing crop:

$$NR' = P' * Y' - VC'$$

Optional flex acreage. Optional flex acreage (OFA) covered 10 acres of the 100-acre base. On these acres, deficiency payments were made if the farmer planted

Figure 1
Acreage designations and payment acres on a 100-acre base farm for different program planting alternatives



[1]72.25 payment acres under the 0/85 program in this example equal 85 percent of the maximum payment acres under the regular program.
[2]Equals 12.75 acres, 15 percent of the regular program's maximum payment acres of 85.

the program crop. Planting flexibility provisions applied to these acres, but deficiency payments were forgone for each acre that was switched to an alternative crop. Net returns for planting the original program crop equaled market returns minus variable costs plus deficiency payments as shown in equation 3a, while net returns for planting an alternative crop were based on market returns for the alternative as in equation 3b. Thus, net returns to the alternative crop competed with net returns to the program crop plus program payments. On these 10 acres, program payments mattered because they affected the planting decision.

(3a) OFA, market returns plus Government payments for program crop:

$$NR = P * Y - VC + D$$

(3b) OFA, market returns for alternative competing crop:

$$NR' = P' * Y' - VC'$$

Nonflex Acres. For the remaining 75 nonflex acres of the assumed 100-acre base, a program participant's planting choices generally were to plant the program crop on this entire nonflex acreage, or to idle the land or plant a designated minor oilseed or industrial crop under 0/85 provisions (fig. 1). If the entire nonflex acreage was planted to the program crop, producers received deficiency payments. In contrast, 0/85 provisions allowed a producer to devote a part of, or all, the permitted program crop acreage to conservation uses and to receive deficiency payments on 85 percent of the maximum payment acreage.

2.75 of the Remaining 75 Nonflex Acres. For analytical purposes, the 75 nonflex acres are divided into two parts, 2.75 acres and 72.25 acres, reflecting features of the 0/85 program.[5]

For 2.75 acres of the 75 nonflex acres, deficiency payments were paid if the farmer planted the program crop.[6] Net returns equaled market net returns plus

[5]The 0/85 program replaced the 0/92 program in 1994. The breakout of enrolled acreage into subcomponents and the combinations of planting choices in a comparison of the 0/92 program and the 0/85 program differ somewhat.

[6]The 2.75 acres are the difference between the 75 nonflex acres and the 72.25 payment acres under the 0/85 option, which permitted producers to receive payments on 85 percent of the 85 maximum payment acres (MPA) under the regular program. The 85-acre MPA is calculated by subtracting ARP and NFA from base acreage, that is, 85 acres in this 0-percent ARP, 100-acre base farm example. Figure 1 illustrates the differences in receiving Government payments for these subcomponents for a 100-acre wheat farm under the regular program, where the entire nonflex acreage is planted to wheat, and the 0/85 program.

Government payments as in equation 4a. If instead, the farmer chose to idle this land, there would be no market receipts, deficiency payments for these acres were forgone, and there would be a cost associated with idling the land in a conserving use (equation 4b). Planting a designated minor oilseed or industrial crop was not an option on the 2.75 acres (see below). Thus, Government payments mattered for the planting decision on this land, since the choice to idle competed with program payments and the planting of the base crop.

(4a) Market returns plus Government payments; program crop:

$$NR = P * Y - VC + D$$

(4b) Cost of cover crop, if idled:

$$NR' = - VCC$$

72.25 of the 75 Nonflex Acres (0/85 Program). Because of 0/85 provisions, different net returns affected the planting decision on 72.25 acres of the 75 nonflex acres (based on the assumed 100-acre base). Under the 0/85 program, if a farmer idled at least 15 percent of the maximum payment acres (or planted an approved crop), deficiency payments would still be paid on 85 percent of the maximum payment acreage. For the 0-percent ARP assumed in these examples, the maximum payment acreage would be 85 acres of the 100-acre base, so 85 percent of the 85 maximum payment acres would be 72.25 acres. Planting flexibility under the 0/85 program applied to these 72.25 acres, which could be planted to the original program crop, switched to minor oilseeds and designated industrial and other crops, or idled, with deficiency payments still paid.[7]

If these acres were planted to the program crop, net returns equaled market receipts plus deficiency payments minus variable costs of production as shown in equation 5a. If the acreage was switched to a permitted alternative crop, net returns equaled market receipts minus production costs for that crop, plus deficiency payments of the program crop, as in equation 5b, with subscripts "a" for the alternative crop. If the farmer chose to idle this land, deficiency payments would still be paid, so net returns equaled those payments minus the costs associated with idling the land in a conserving use, as in equation 5c. Because the producer received deficiency payments for each option, whether the acreage was planted to the program crop, planted to a permitted alternative crop, or not planted, the planting decision was based only on market returns.

(5a) Market returns plus Government payments for program crop, if planted to program crop:

$$NR = P * Y - VC + D$$

(5b) Market returns for alternative crop plus Government payments for program crop:

$$NR_a = P_a * Y_a - VC_a + D$$

(5c) Government payments minus the cost of cover crop, if idled:

$$NR' = - VCC + D$$

Implications for Supply Response Estimation

Net returns analysis of the program participation decision and of planting choices for various planting options under 1990 farm legislation have a number of implications, particularly for the role of Government payments. As indicated by the analysis, different net returns are important for different producer decisions. Government payments mattered for the whole base decision to participate in the annual farm programs. However, once the participation decision was made, Government payments were largely irrelevant for the cropping choices for program participants. The potential forgoing of payments based on planting decisions mattered on only 12.75 acres of a 100-acre base once the participation decision had been made —10 optional flex acres and 2.75 nonflex acres that were not covered by the 0/85 program. Cropping and idling choices on the rest of the acreage base were determined largely by market returns.

This result has important implications for estimating supply response under the 1990 Act. Producers make their acreage allocation decisions by equilibrating net

[7]For producers enrolled under the 0/85-92 underplanting provision, their base was protected even if they devoted all the permitted acreage for a commodity to conservation uses. In return, they received projected deficiency payments on 85-92 percent of MPA. However, for nonparticipants, idling cropland lost base protection.

returns at the margin. Unless a producer is making this decision at the margin in the 72.25- to 85-acre portion of the 100- acre base assumed in these examples, market returns were the producer incentive at the margin. Most producers participating in the program made their acreage allocation decisions for program crops at the margin in the range of normal flex acreage during 1991-95 (in response to price signals).[8] This provides the rationale for measuring producers' supply response (and deriving elasticities) in this report by focusing on NFA data.

[8]Based on individual farm records for 1992 maintained by the Farm Service Agency, nearly 80 percent of corn producers enrolled in the corn program planted either a portion or all of their corn NFA to corn (Tice).

Previous and Current Related Research

There have been numerous published works on modeling supply response in the literature (for example, Houck and Ryan; Just; Gardner; Lee and Helmberger; Chavas and Holt; Weaver; Shumway; Coyle; Ball). However, most of this research dealt with supply response in the presence of farm commodity programs. Very few addressed the difference in supply elasticities between commodity-program and free-market regimes.

One of the few published studies that compares supply response between commodity-program and free-market regimes is the study of Lee and Helmberger. A theoretical model was developed to explain a farmer's optimal acreage allocation given the option of farm program participation. Acreage supply response for the free-market subsample years (1948-49, 1951-53, 1959-60, 1974-77, and 1980) during the 1948-80 period was estimated. Because of the small sample, time-series and cross-section data (four States in the Corn Belt) were pooled and the acreage response equations were estimated by seemingly unrelated regressions. Because this study included data prior to the 1981 Act, which authorized crop-specific base acreage and acreage reduction program (ARP) provisions, its findings have little bearing on the current policy environment.

A more recent study that addressed acreage response under the 1996 Act was conducted by Adams. This study made use of normal flex acreage (NFA) data from 1991-95, because government payments played no role in planting decisions on this cropland. Lagged prices were taken as the expected prices for major field crops. The time-series data were pooled with cross-section (three to five production regions) data to estimate acreage price elasticities on flex acreage. The acreage response equations were estimated by ordinary least squares (OLS) with no theoretical constraints (linear homogeneity and symmetry—see later discussion) imposed. The acreage price elasticities for the whole farm under the 1996 Act are estimated to lie between the elasticities estimated for entire plantings to a crop in the 1991-95 period and those estimated for the crop based on farmers' use of NFA. In the Corn Belt, for example, the corn own-price acreage elasticity under the 1996 Act is estimated at 0.372 in the Adams study, which lies between the 0.173 estimated for all plantings for 1991-95 and the 0.673 estimated for NFA. The U.S. own-price acreage elasticity for the whole farm under the 1996 Act was estimated at 0.412 for corn, 0.467 for wheat, 0.364 for soybeans, and 0.634 for cotton. Each of these elasticities is greater than that estimated under previous legislation.

McDonald and Sumner recently investigated the influence of commodity programs on rice acreage response in the United States. Their study uses information about the U.S. deficiency payment program during 1986-95 and relates producer behavior under these program regimes to what may be expected from program crop producers under the new program enacted in 1996. The acreage response model developed in this study recognizes the complexity of the rice program and traces through the effects of a price change on the movement of acres between planting options and optimal acreage planted to rice within each of the planting options. A simulation model was then developed based on marginal cost curves and was used to estimate a structural supply elasticity of 1.0 under the 1996 Act. This estimate is three to four times larger than the 0.3 acreage price elasticity that was estimated under the 1991-95 rice program, according to a review of the literature.

Holt recently adapted a linear approximate acreage allocation model within a systems framework that accounts for yield and price risks. This model, based on work by Barten and Vanloot, is used to estimate acreage supply response on corn normal flex acres (NFA) for eight States in the Corn Belt for the 1991-95 period. The estimates were obtained by first imposing and testing the theoretical constraints. New crop futures prices—December corn futures and November soybean futures from the Chicago Board of Trade (CBOT)—were taken as expected prices in March when producers make planting decisions. Average futures prices during the previous September for the July CBOT contract were used for winter wheat. These futures prices were adjusted to an equivalent state-level measure by subtracting the average expected harvest-time state-level basis. The acreage allocation model assumes that a representative farmer maximizes certainty equivalent profit, subject to a total land constraint. Variations in output price and crop yield are two important sources of risk that are explicitly factored into producers' planting decisions in the modeling framework. The own-price acreage elasticity for NFA is estimated at 1.04 for corn and 1.54 for soybeans, generally higher than previous estimates reported in the literature.

Analytical Framework for Modeling Acreage Response

The theoretical underpinning of supply response assumes that producers wish to maximize expected net returns, the difference between expected market revenue and variable costs of production. Based on the firm's implicit, multiproduct production function, it can be shown that the supply of a farm commodity is a function of output and input prices for that commodity, as well as output and input prices for competing crops (Willott and others).

This study utilizes State-level NFA data from 1991-95 to estimate regional supply response. For each program crop (except rice), acreage response on NFA is analyzed for major production regions. All acreage response equations within a region are treated as a system of acreage allocation decisions, similar to the equations estimated by Holt. Effects of imposing theoretical constraints—symmetry and linear homogeneity—were then considered.[9] These constraints are derived from a theoretical framework developed by Barten and Vanloot that allocates land input among crops to maximize profit, subject to a total land constraint. For purposes of illustration, let's assume a system based on a hypothetical situation in the Midwest which contains acreage share equations for corn, soybeans, and wheat as follows:

$$S_c = a_{11} + b_{11}\,NRT_c + b_{12}\,NRT_s + b_{13}\,NRT_w$$

$$S_s = a_{21} + b_{21}\,NRT_c + b_{22}\,NRT_s + b_{23}\,NRT_w$$

$$S_w = a_{31} + b_{31}\,NRT_c + b_{32}\,NRT_s + b_{33}\,NRT_w$$

where S_c = the percentage of the program crop NFA planted to corn,

S_s = the percentage of the program crop NFA planted to soybeans,

S_w = the percentage of the program crop NFA planted to wheat,

NRT_c = expected net returns ($/ac.) for corn,

NRT_s = expected net returns ($/ac.) for soybeans, and

NRT_w = expected net returns ($/ac.) for wheat.

The symmetry restriction requires that cross-net return coefficients across the equations be equal, that is, $b_{21} = b_{12}$, $b_{31} = b_{13}$, and $b_{32} = b_{23}$. This means that, for example, the percentage point change in corn acreage associated with a 1-unit change in expected soybean net returns equals the percentage point change in soybean acreage associated with a 1-unit change in expected corn net returns.

In addition, the linear homogeneity constraint requires that

$$b_{13} = -(b_{11} + b_{12})$$
$$b_{23} = -(b_{21} + b_{22})$$
$$b_{33} = -(b_{31} + b_{32})$$

In other words, the sum of all own- and cross-return coefficients in each of the three equations must be zero. This simply reflects the fact that the profit function is linear homogenous in output and input prices, which, intuitively, means that net returns would increase by the same proportion if both output and input prices increase by a fixed proportion. The share of the program crop NFA, however, is homogenous of degree zero in prices, since the same proportional changes in net returns for the program crop and competing crops will not alter the share of NFA planted to a specific crop.

Acreage responses on the program crop NFA are estimated by Seemingly Unrelated Regressions (SUR) as a system, which is asymptotically equivalent to maximum likelihood. The acreage response associated with a farm commodity is a function of expected net returns for the primary and competing crops, as illustrated in the previous equations and estimated in the following section. In cases where imposing either of the theoretical constraints worsened or did not substantially change the regression results, acreage response equations without that theoretical constraint are used in this report.

[9]The symmetry restriction requires that cross-net return regression coefficients across the share equations be equal, while the linear homogeneity constraint requires that the sum of all own- and cross-return regression coefficients in each of the equations be zero. The symmetry restriction reflects the notion that the cross-price elasticities are linked to the ratios of the acreage shares and expected revenues between two competing crops. The linear homogeneity constraint reflects the fact that the share of a program crop's NFA is homogenous of degree zero in prices, since the same proportional change in net returns for the program crop and competing crops does not alter the share of the program crop NFA planted to a specific crop.

Supply Response Estimates on NFA

Supply response on program crops' NFA is estimated for major program crops (except rice) for the North Central, Central and Northern Plains, Southern Plains, Southeast, and Delta regions.[10] Farmers' use of NFA for a program crop is estimated by pooling time-series (1991-95) with cross-section (individual States in the region) data. As an illustration, this section focuses on supply response on corn NFA in the North Central region, which includes eight States (Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio, and Wisconsin). This region accounts for about two-thirds of U.S. corn production. The time series are based on farmers' use of corn NFA in 1991-95, when planting decisions were free of restrictions and were based solely on market incentives. The pooling provides 40 observations (5 years multiplied by eight States), which sufficiently overcomes the degrees-of-freedom problem.

Planting corn NFA to corn, to soybeans, or leaving it idle were the three most important uses of corn NFA in the North Central region. During 1991-95, these three uses accounted for 92 percent of total corn NFA in the region: 54 percent for planting to corn, 33 percent for planting to soybeans, and 5 percent for leaving NFA idle. The remaining 8 percent of NFA was planted to other program crops, minor oilseeds, sorghum, or other crops. Farmers' use of corn NFA was treated as a system of land allocation decisions in this study, encompassing corn NFA planted to corn, soybeans, other crops, or left idle. This illustration reports only the estimates of corn NFA planted to corn and soybeans.

Supply Response Estimates: Model I

We used two modeling approaches, designed to address issues related to using NFA data for estimation. In the first model (Model I), the dependent variable is specified as the percent of corn NFA planted to corn or soybeans. Explanatory variables include expected net returns for corn and soybeans, as well as a set of intercept dummies for seven of the eight States in the region. Because the corn-soybean crop rotation is common in the North Central region, producers are reluctant to plant NFA to alternative crops, unless the switching of plantings brings an increase in profits that exceeds the potential benefit of the crop rotation.[11] Expected net returns equal the expected price times the trend yield by State, minus variable cash costs of production for the North Central region. The expected prices are derived from the December corn futures price and the November soybean futures price at the Chicago Board of Trade in mid-March, the time when planting decisions are made for corn. Expected prices are further adjusted by a State-specific, 5-year average basis (the difference between the futures prices and cash prices received by farmers in the delivery month of the futures), thus arriving at a farm-level equivalent price. The trend yield is estimated using data from 1975-95. The two equations are estimated by Seemingly Unrelated Regression (SUR) with theoretical constraints—symmetry and linear homogeneity—imposed, and yield the following estimation results:

(1) Percentage of corn NFA planted to corn:

$$
\begin{aligned}
\%NFACR = {} & \underset{(21.53)}{51.580} + \underset{(4.63)}{0.336}\,ERTCR - \underset{(-4.53)}{0.324}\,ERTSOY \\
& - \underset{(-1.54)}{0.012}\,ERTWH + \underset{(1.67)}{6.075}\,D1 + \underset{(1.81)}{5.807}\,D2 \\
& + \underset{(4.89)}{16.135}\,D3 - \underset{(-0.60)}{1.886}\,D4 + \underset{(5.15)}{16.333}\,D5 \\
& + \underset{(0.82)}{2.718}\,D6 - \underset{(-0.77)}{2.478}\,D7
\end{aligned}
$$

(2) Percentage of corn NFA planted to soybeans:

$$
\begin{aligned}
\%NFASOY = {} & \underset{(10.31)}{19.489} - \underset{(-4.53)}{0.324}\,ERTCR \\
& + \underset{(3.92)}{0.324}\,ERTSOY + \underset{(5.85)}{17.423}\,D1 + \underset{(6.79)}{16.964}\,D2 \\
& + \underset{(2.67)}{6.906}\,D3 + \underset{(3.41)}{8.168}\,D4 + \underset{(1.68)}{4.121}\,D5 \\
& + \underset{(3.78)}{9.945}\,D6 + \underset{(7.47)}{18.867}\,D7
\end{aligned}
$$

where %NFACR = percentage of corn NFA planted to corn
%NFASOY = percentage of corn NFA planted to soybeans

[10]The production regions are defined in figure 2.

[11]In 1995, corn-soybean rotations accounted for about one-half of cropland planted to corn (USDA, 1996a). Crop rotation tends to result in an increase in corn yields following the rotation crop (most commonly soybeans), as insects and diseases are less of a problem with corn-soybean rotations, relative to continuous corn operations. To a large degree, the effect of crop rotations is reflected in producers' expected net returns.

Figure 2

U.S. crop production regions

ERTCR	=	expected net returns for corn per acre
ERTSOY	=	expected net returns for soybeans per acre
ERTWH	=	expected net returns for wheat per acre

D1 through D7 are State dummies for Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, and Ohio, respectively, leaving Wisconsin as the "base" State. The figures in parentheses are t-ratios. All expected net returns variables and many State dummies are statistically significant at either the 1- or 5-percent level of significance.

Estimated regression results from Model I are shown by commodity and by production region in appendix tables 1-7. The regression equations are estimated by SUR, which does not significantly alter regression coefficients from those estimated by OLS, due to the use of a small sample size, but does increase t-ratios in some cases.

Imposing the theoretical restrictions in the estimation of acreage response on NFA generally improves the regression results for the North Central and the Central and Northern Plains regions. For example, regression results without these restrictions show that the wheat expected net returns variable has a positive sign and statistically significant (with a t-ratio of 2.17) effect on soybean planted acreage in the North Central region—an unexpected result that contradicts the expectation of a negative coefficient because winter wheat competes with soybeans in this region. Imposing theoretical restrictions does not resolve the sign problem for the wheat net returns variable, but makes the regression coefficient less than statistically significant (with a t-ratio of 1.6), which is then excluded in the soybean acreage response equation in this region (appendix table 6). Imposing the theoretical restrictions also raises t-ratios for several explanatory variables in the Central and Northern Plains region.

With few exceptions (sorghum and barley in the Central and Northern Plains), most of the expected net returns variables for the program crop itself show a positive sign and are statistically significant at the 5-percent level of significance (with t-ratios greater than 2.0). Nearly all of the regression coefficients for competing crops have the expected negative sign, and many of them are statistically significant at the 5-percent level of significance. However, in the Southeast and Delta regions, the soybean expected net returns variable has a positive sign in the wheat acreage equation, suggesting that higher expected soybean net returns would lead to greater wheat seedings, due to a common practice of soybeans-wheat double cropping in these regions (appendix table 1).

Percent NFA Planted as Dependent Variable Provides Lower Bound Estimates

Specifying the dependent variable in the acreage response equation as the percent of NFA planted to corn may result in measurement problems relative to the underlying acreage shifts. Differences in the planted acreage covered by NFA associated with the change in ARP levels in the sample period introduce a downward bias (see explanation below) into the estimated own-price coefficient, suggesting that the corresponding elasticities derived from the previous model specification represent lower bounds (Westcott, 1997). The illustrations below provide examples of how this bias can occur for hypothetical farming situations, which would then have similar effects for the statistical measures used in the aggregate analysis.

To illustrate this potential for underestimating supply response, a representative farm with a 100-acre corn base is assumed. With a 0-percent ARP, the NFA covers the 86th through the 100th acre, the last 15 acres of the corn base (fig. 3). If we examine those acres more closely in figure 4, we can assume that in the first year the farmer chooses to plant corn on 94 acres of the 100-acre corn base. This represents 9 acres of the 15 normal flex acres or 60 percent of the NFA. Assume further that, in the following year, price expectations are lower, so the farmer adjusted plantings downward to 91 acres (fig. 4). With no change in the ARP, these plantings represent 6 acres of the 15 normal flex acres or 40 percent of the NFA. Thus, the year-to-year change in the percent of NFA planted measures the farmer's reduction in plantings. However, if prices are lower in the second year, a more restrictive ARP may have been implemented to assist in reducing large supplies. If we assume that a 5-percent ARP had been in place for the second year, normal flex acreage has shifted to reflect the ARP requirement, and now covers the 81st through 95th acre (fig. 5).

Because the farmer plants 91 acres in this example, the ARP is not restricting his or her planting of corn. However, these plantings now include 11 acres of NFA, representing 73 percent of the NFA (fig. 6). In this case, the producer's decision to lower plantings in response to lower prices is measured as an increase in the percent of NFA planted—from 60 percent to 73 percent. The effects of varying ARP levels on the calculation of the percent-NFA measure can result, as shown in this example, in an increase in this vari-

Figure 3

Supply function--Normal flex acres (NFA) with a 0-percent Acreage Reduction Program

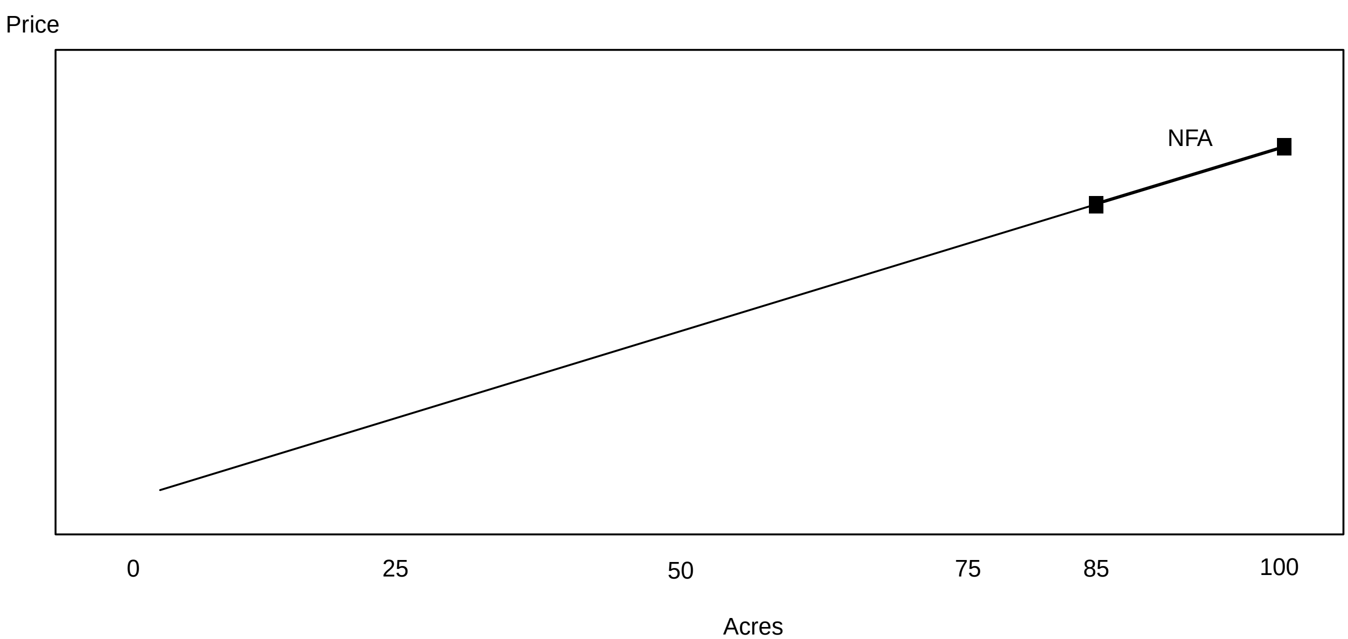
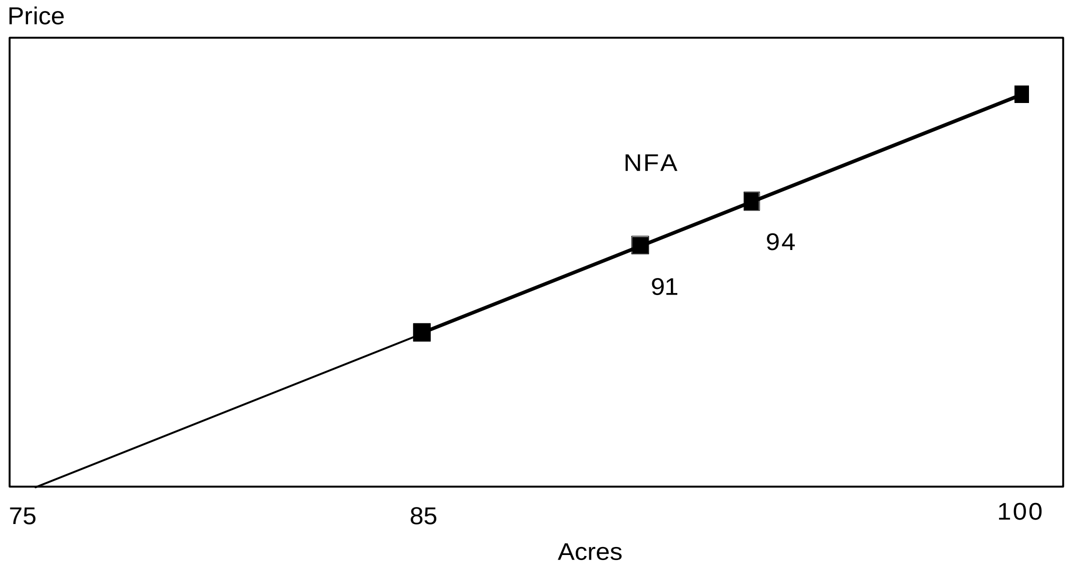


Figure 4

Supply function--Normal flex acres (NFA) planting examples, 0-percent Acreage Reduction Program



NFA examples

- First year, 94 acres are planted; 9 acres are NFA. This represents 60 percent of NFA.
- Second year, 91 acres are planted; 6 acres are NFA. This represents 40 percent of NFA.

Figure 5

Supply function--Normal flex acres (NFA) with a 5-percent Acreage Reduction Program

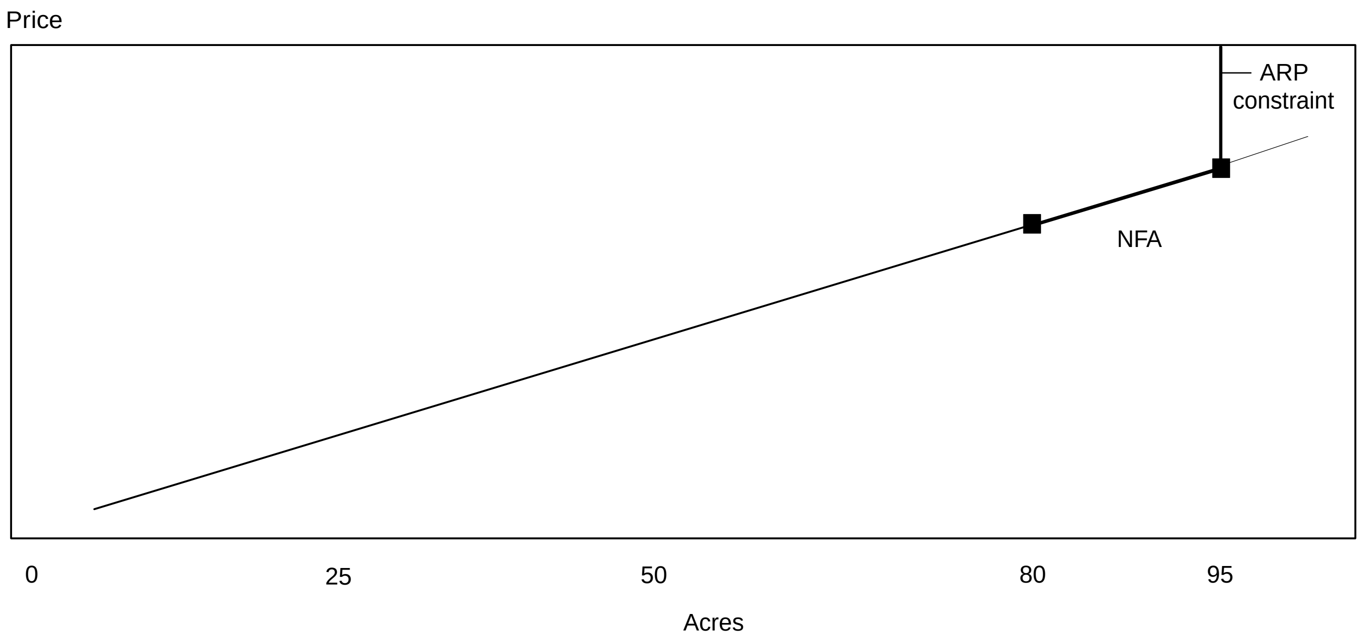
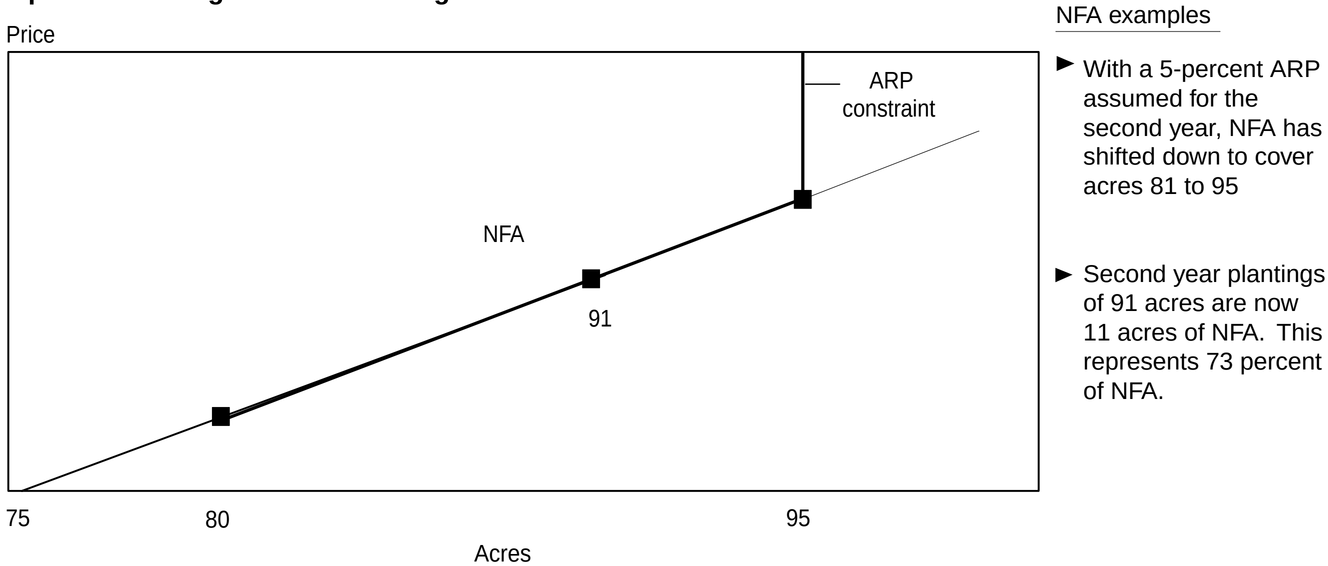


Figure 6
Supply function--Normal flex acres (NFA) planting examples, 5-percent Acreage Reduction Program



able—even when plantings actually fell in total on that farm (from 94 to 91 acres in this example). This effect diminishes the positive relationship between price and acreage and results in a downward bias in the elasticity estimate, suggesting that the implied elasticity should be interpreted as a lower bound.

Supply Response Estimates: Model II

In the second model (Model II), an alternative dependent variable, defined as the percent of the combined NFA and ARP acreage, is used to derive estimates which have an upward bias, providing an upper bound (explained below). Together, results from Model I and Model II give a range for the elasticities under investigation.

The lower bound interpretation of estimates from Model I, using the dependent variable of percent NFA planted, results from interaction of NFA acreage with the year-specific ARP. A possible adjustment to address this concern is to incorporate the ARP into the dependent variable. One way to do this is to define the dependent variable as the percentage of the combined NFA plus ARP land that was planted. The percentage of combined corn NFA and ARP planted to corn (%NFAARPCR) in the acreage response equation, based on this specification, is estimated as follows:

%NFAARPCR= 36.027 + 0.255 ERTCR
(9.95) (4.68)

- 0.215 ERTSOY - 0.040 ERTWH
(-3.65) (-1.34)

+ 3.696 D1 + 3.664 D2
(0.75) (0.77)

+ 10.126 D3 - 0.639 D4
(2.04) (-0.14)

+ 11.467 D5 + 2.751 D6 - 1.948 D7
(2.41) (0.58) (-0.41)

Expected net returns are, again, based on futures prices adjusted for the basis at the State level. All variables were defined earlier.

This alternative reduces the downward bias described earlier, but does not fully eliminate it. It also adds a policy-related upward bias to the measurement of acreage shifts, as described below.

Alternative Dependent Variable (Model II) Provides Upper Bound Estimates

To illustrate the upward bias resulting from Model II, we again use the representative farm with a 100-acre corn base. With a 0-percent ARP, NFA covers the 86th through the 100th acre. If we assume the producer plants the full 100-acre base, 15 normal flex acres are planted, which represent 100 percent of the combined NFA plus ARP acreage (fig.7). If we again assume that price expectations for the following year are lower, the farmer may adjust plantings downward to, for example, 98 acres as also shown in figure 7. With no change in the ARP, these plantings represent 13 acres of the 15 normal flex acres, or 87 percent of the combined NFA plus ARP acreage. The year-to-year change in the percent of NFA plus ARP planted (13 percent in this example) measures the farmer's reduction in plantings.

If, however, the assumed lower prices for the second year led to an increase in the ARP, dependent variable measurement problems arise again. An ARP increase to 5 percent moves the NFA down to cover the 81st to the 95th acre (fig. 8). The 5-percent ARP prohibits the producer from planting the 98 acres that would be allowed with a 0-percent ARP while still remaining within program rules. Instead, 5 acres must be idled as a condition for program participation, and 95 acres are planted to corn. All 15 normal flex acres are planted and these plantings represent 75 percent of the

Figure 7

Supply function--Additional normal flex acres (NFA) planting examples, 0-percent Acreage Reduction Program

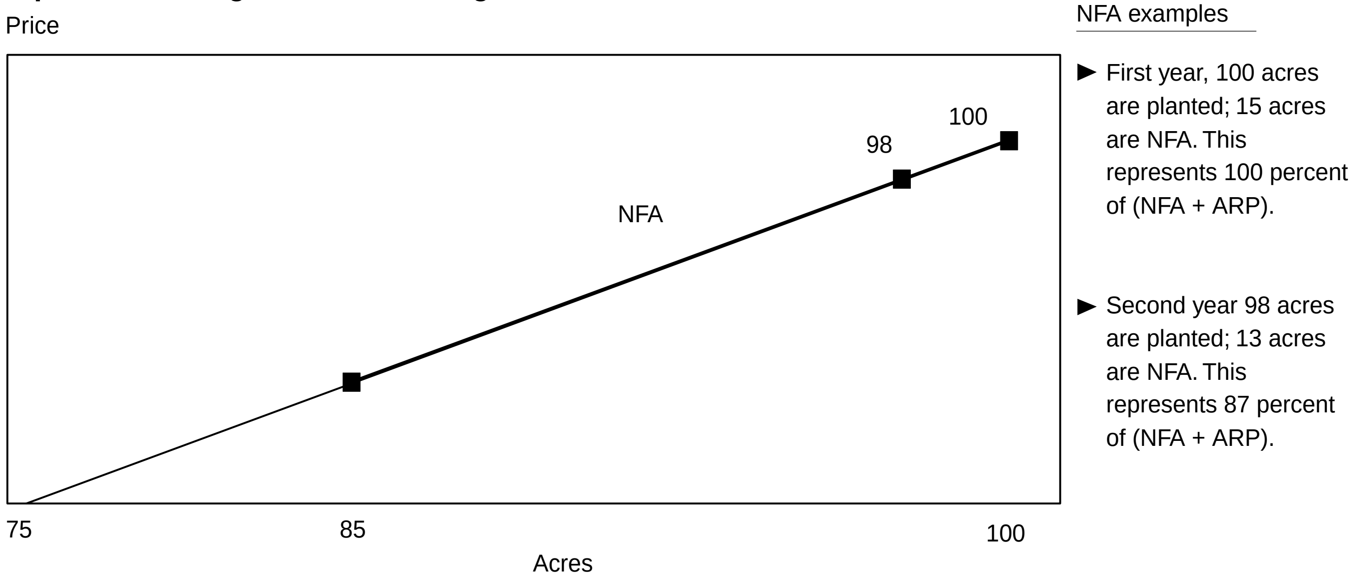
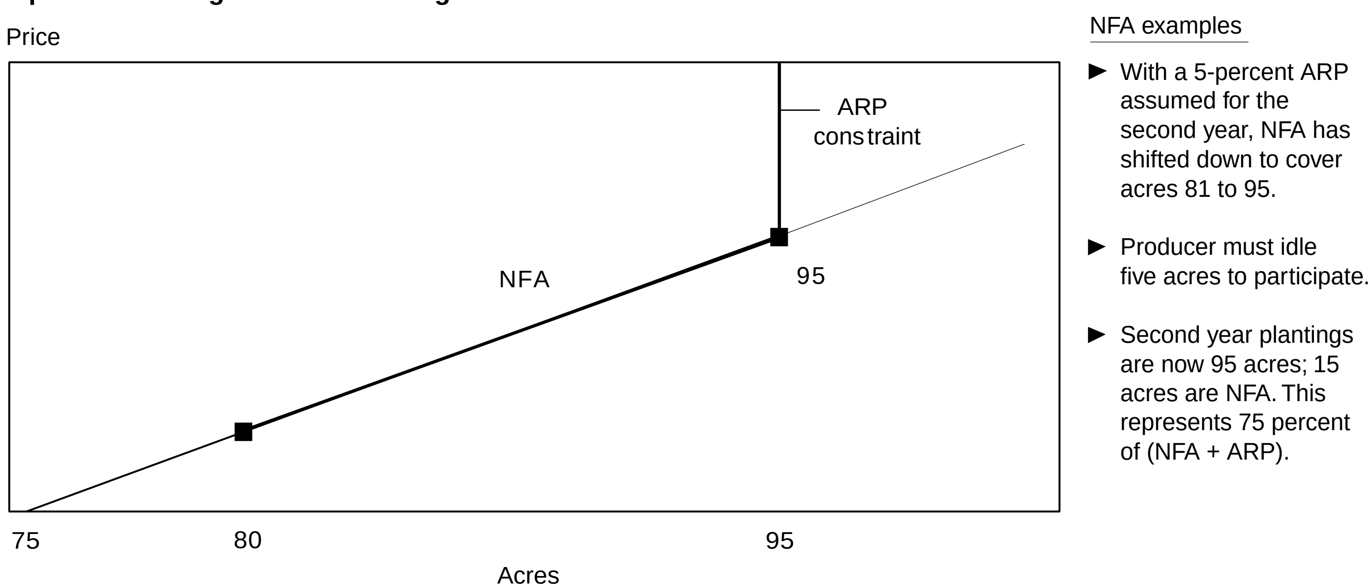


Figure 8

Supply function--Additional normal flex acres (NFA) planting examples, 5-percent Acreage Reduction Program



combined NFA plus ARP acreage. This reduction from 100 percent of the combined NFA, plus ARP acreage to 75 percent of the combined NFA plus ARP acreage, overstates the producer's response to price. Some of the measured acreage shift results from the change in the ARP, but would be attributed to price in the model estimation. Thus, model estimates using this dependent variable should be viewed as providing an upper bound.

Estimated regression results from Model II (upper bound) also are shown by commodity and by production region in appendix tables 1-7. As for Model I, Model II regression equations are estimated by SUR. Again, imposing the theoretical restrictions in the estimation of acreage response on NFA generally improves the regression results for the North Central and Central and Northern Plains regions. For example, regression results without these restrictions show that the soybean expected net returns variable has a positive sign and highly significant (with a t-ratio of 13.29) effect on corn plantings in the North Central region—a result of multicollinearity between corn and soybean expected net returns (with a correlation coefficient of 0.87). Without imposing theoretical restrictions, one might drop the soybean expected net returns variable, which would ignore the strong competition for cropland use between the two principal crops in this region. However, imposing the restrictions produces a coefficient for the soybean net returns variable which not only has a negative sign (as expected), but also is statistically significant (with a t-ratio of -3.65). In addition, with the restrictions, the coefficient of the wheat net returns variable has a negative sign and is modestly significant (with a t-ratio of -1.34) in the corn NFA acreage response equation. Without the restrictions, the variable has an unexpected positive sign, but is not statistically significant (with a t-ratio of 0.71).

With few exceptions (sorghum and barley in the Central and Northern Plains), most of the expected net returns variables for the program crop itself result in positive signs that are statistically significant (with t-ratios greater than 2.0). All of the regression coefficients for competing crops have the expected negative sign, and many are statistically significant.

Relative to Model I, regression coefficients in Model II are typically larger, suggesting that acreage price elasticities estimated from Model II would be on the high side (upper bound). For example, the coefficient for the wheat net returns variable in the wheat NFA acreage response equation in the Central and Northern Plains region is estimated to be 0.359 from Model II, which is higher than the 0.147 estimated from Model I (appendix table 1).

Acreage Price Elasticities

Acreage price elasticities are estimated from producers' acreage response on program crop NFA, because the majority of producers made their 1991-95 planting decisions, at the margin, within this range. Again, as an illustration, we use the case of corn NFA planted to corn to show how acreage price elasticities are derived from the estimated corn NFA acreage response equations in this study. Acreage price elasticities are obtained in two steps: (1) by determining the effect of a 1-percent price (own- and cross-price) change on corn NFA planted to corn and (2) by extending the effect on corn plantings to the hypothetical 100-acre whole farm.

Estimating Acreage Price Elasticities

Own- and cross-price acreage elasticities are estimated for all major program crops and soybeans in each of the major production regions. The estimate obtained from Model I (where the dependent variable is specified as, for example, the percentage of corn NFA planted to corn) provides a lower bound, while that derived from Model II (where the dependent variable is defined as, for example, the percentage of combined NFA and ARP acreage that was planted to corn) gives an upper bound. The midpoint average is reported as the best estimate of the elasticity in most cases. In cases where an explanatory variable occurs in only one model's specification, but not in the other model's, a simple average is calculated assuming an elasticity of zero for the latter equation. An example of this situation is for wheat acreage response in the Central and Northern Plains region (appendix table 1), where barley net returns occur only in Model I, because this variable has the wrong sign in Model II.

Own-Price Elasticity

Using equation 1 of Model I and additional calculations, corn NFA planted to corn in the North Central region would increase by 0.0793 acre as the expected corn price increases by 1 percent, translating into an acreage price elasticity of 0.9766 for NFA (see box 1, lines D & E). The 0.9766 acreage price elasticity applies only to the corn NFA (15 percent of the base), and does not necessarily apply to the whole farm. Given that the corn ARP between 1991 and 1995 averaged 6 percent, this hypothetical 100-acre corn farm idled 6 acres, and had the flexibility to plant almost any crop on the 15-acre NFA. The remaining 79 acres (known as maximum payment acres) would be planted to corn (assuming that the 10-percent OFA were planted to corn as well).

Under the 1996 Act, the elimination of the ARP would mean a net increase of about 4.8 idled acres in corn plantings, assuming a 20-percent acreage slippage (Lin, 1989).[12] Adding the 4.8 acres (80 percent of 6 acres) to the 79 acres originally planted to corn gives a total of 83.8 acres—the acreage this 100-acre corn farm would plant to corn outside of his or her NFA acres under the 1996 Act, assuming corn prices remain unchanged (line F). As the expected corn price increases by 1 percent, the corn farm is expected to expand its corn plantings beyond those 83.8 acres. Because producers' acreage response on corn NFA is already estimated in this study (part I in box 1, p. 17), the elasticity from a pre-planting flexibility period is used to capture acreage response for the non-NFA acres that were guided by non-flexibility provisions. This approach avoids double counting the effect captured in the NFA. Using an acreage price elasticity of 0.159 estimated for corn during the years 1986-90 (Adams) implies an increase of 0.1332 acre on the non-NFA "rest of base" in response to a 1-percent increase in the expected corn price (Line G).[13]

Thus, corn plantings on the whole farm would increase by 0.2125 acre (see box 1, line H, p. 17) in response to a 1-percent increase in the expected corn price. This represents 0.246 percent of base corn plantings including the return of 4.8 acres of ARP cropland to production (see box 1, line I, p. 17). That is, the Model I acreage price elasticity for corn plantings on the farm is 0.246. This elasticity is much smaller than the 0.9766 estimated for corn NFA alone, but is higher than the 0.173 estimated for the 1991-95 period (Adams) and the 0.159 estimated for the 1986-90 period (as described above).

[12] Acreage slippage refers to the deviation between the anticipated and realized reduction in harvested acreage resulting from the ARP. Slippage occurs because nonparticipants increase their acreage in anticipation of higher prices due to the ARP.

[13] The 0.159 acreage price elasticity estimated for the 1986-90 period is used because producers, once having decided to participate in the previous farm commodity program, would base their planting decisions on nonflex acreage (planting the base crop versus participating in the 0/85-92 program) primarily on market incentives (see earlier discussion). Using the 0.159 acreage price elasticity estimated for the 1986-90 period, instead of that for 1991-95, avoids double counting the effect of acreage response in the NFA, since NFA acreage response was already estimated in this study as a part of the elasticity calculation.

Box 1: Steps to Derive the Own-Price Elasticity for Corn Plantings in the North Central Region, Model I

The following steps are used to determine the effect of a 1-percent change in the expected corn price on corn NFA planted to corn in the North Central region, according to Model I, and to extend the effect on corn planting to a 100-acre corn farm:

I. Determine the effect of a 1-percent increase in the expected corn price on NFA planted to corn:

A. Calculate the elasticity of the percentage of corn NFA planted to corn with respect to a 1-percent change in expected corn net returns (ERTCR) by multiplying the regression coefficient of ERTCR (0.336 in equation 1) by the mean value of corn's expected net returns ($108.4), and dividing by the mean value of the percentage of NFA planted to corn (54.101). That is, 0.336 x (108.4/54.101) = 0.6735

B. Calculate the effect of a 1-percent increase in expected net returns for corn per acre (ERTCR) on corn NFA planted to corn:

a. 54.101% x 15 = 8.1152 acres (NFA planted to corn before returns increase)
b. 54.101% x (1 + 0.6735%) x 15 = 8.1698 acres (Planted to corn after returns increase)
c. 8.1698 - 8.1152 = 0.0546 acre.

C. Estimate the relationship between the percentage change in expected corn net returns associated with a 1-percent change in the expected corn price (Enr.p) through a regression analysis: $E_{nr.p} = 1.45$

D. Calculate the effect of a 1-percent increase in the expected corn price on corn NFA planted to corn: 0.0546 x 1.45= 0.0793 acre

E. Calculate the acreage price elasticity for corn NFA: (0.0793/8.1152) x 100 = 0.9766

II. Extend the effect on corn plantings to the 100-acre whole farm

F. Calculate the maximum payment acres (MPA) that were planted to corn for a 100-acre hypothetical corn farm, after meeting the average set-aside requirement (6 acres) and deducting the 15-acre NFA: 100 - 6 - 15 = 79 acres, or 83.8 (79 + 4.8) acres after the return of ARP acreage to production (with a 20-percent acreage slippage).

G. Calculate the effect on corn plantings on the rest of base associated with a 1-percent increase in the corn price: 83.8 x 0.159% = 0.1332 acre, where 0.159 is the acreage price elasticity estimated for the 1986-90 period (Adams).

H. Add the effect of a 1-percent increase in the corn price on NFA planted to corn (line D) and corn planting on the rest of base (line G): 0.0793 + 0.1332 = 0.2125 acre

I. Calculate the whole farm acreage price elasticity for corn: (0.2125/(2.7057 + 83.8)) x 100 = 0.246, where 2.7057 is average NFA planted to corn for producers making planting decisions within the NFA range.

Following the same procedures, the own-price elasticity based on Model II, where percentage of corn NFA and ARP area planted to corn is used as the dependent variable, is estimated at 1.013 for corn NFA alone, and 0.250 for the whole farm.

Thus, the own-price elasticity for farms making marginal planting decisions in the range of NFA lies between 0.246 (the lower bound) and 0.250 (the upper bound).[14] This represents an increase of 42 to 45 percent over the 0.173 own-price elasticity for corn reported in Adams for the period 1991-95 (before the enactment of the 1996 Act), and 55 to 57 percent over the 0.159 corn elasticity from 1986-90, when there was almost no planting flexibility under the 1985 Act.

Cross-Price Elasticity on NFA

Following the same procedures, corn plantings on NFA for this hypothetical corn farm in the North Central region would decline by 0.0684 acre in response to a 1-percent increase in the expected soybean price (see line D, box 2, p. 19), and a -0.8427 cross-price elasticity is estimated for corn NFA in Model I (see line E). To extend the response to the whole farm, corn plantings outside NFA would decline by 0.0737 acre based on a cross-price elasticity of -0.088 in response to a 1-percent change in the expected soybean price. The -0.088 elasticity was estimated for the 1986-90 period under 1985 Act provisions (Adams).

Thus, corn plantings for the whole farm would decline by 0.1421 (0.0684 + 0.0737) acre in response to a 1-percent increase in the expected soybean price. This decline would amount to 0.164 percent of base corn plantings after allowing for the return of 4.8 acres of ARP cropland to production. In other words, the cross-price elasticity, estimated at -0.164 from Model I, is smaller (in absolute value) than that measured for NFA alone, but 86 percent higher than the -0.088 estimated for 1986-90 when planting restrictions were in effect (Adams).

The cross-price acreage elasticity is estimated at the same -0.164 for the whole farm from Model II. Thus, a -0.164 cross-price elasticity indicates that a decline of 0.164 percent in corn plantings is associated with a 1-percent increase in the expected soybean price.

Elasticity Results

Three topics are discussed regarding the resulting elasticity calculations. First, a comparison of elasticities with and without theoretical restrictions is illustrated. Second, elasticities are presented by major production region and by program crop. Finally, national acreage price elasticities are presented.

Elasticities With vs. Without Restrictions

Imposing theoretical restrictions on the acreage response equations has its largest effects on improving regression results in the North Central and the Central and Northern Plains regions. To illustrate the differences in estimated results, appendix table 8 shows NFA and whole-farm acreage price elasticities under the 1996 Act obtained from Model I (lower bound) and Model II (upper bound) for the North Central region without theoretical restrictions. Appendix table 9 presents elasticities estimated for that region with theoretical restrictions imposed.

A comparison of appendix tables 8 and 9 shows that theoretical restrictions generally lower the magnitude of acreage price elasticities (in absolute value). For example, corn own-price elasticities on NFA and for the whole farm in the North Central region are estimated at 1.465 and 0.293 (average of Model I and Model II results), respectively, when restrictions are not imposed. However, these elasticities become smaller with restrictions imposed in the estimation, declining to 0.995 on NFA and 0.248 for the whole farm.

Elasticities by Major Production Region and by Crop

In addition to the elasticity results shown in appendix table 9 for the North Central region, appendix tables 10-12 show acreage price elasticities for other regions. NFA acreage price elasticities mostly are greater than those for the whole farm because of the planting flexibility allowed on NFA land. Acreage price elasticities (whole-farm under the 1996 Act) estimated from this study generally tend to be somewhat smaller than those estimated by Adams.

Appendix tables 13-20 then show acreage price elasticities for each of the eight major field crops (wheat,

[14]The range of lower-bound and upper-bound estimates is much narrower for the North Central region than for other regions. For example, for the same commodity (corn) in the Central and Northern Plains, the corn own-price acerage elasticity is estimated at 0.171 for the lower bound, and at 0.312 for the upper bound.

Box 2: Steps to Derive the Soybean Cross-Price Elasticity for Corn Plantings in the North Central Region, Model I

The following steps are used to determine the effect of a 1-percent change in the expected soybean price on corn NFA planted to corn in the North Central region according to Model I, and to extend the effect on corn planting to a 100-acre corn farm:

I. Determine the effect of a 1-percent increase in the expected soybean price on corn NFA planted to corn:

A. Calculate the elasticity of the percentage of NFA planted to corn with respect to a 1-percent change in expected soybean net returns (ERTSOY) by multiplying the regression coefficient of ERTSOY (-0.324 in equation 1) by the mean value of soybean's expected net returns ($119.1) and dividing by the mean value of the percentage of NFA planted to corn (54.101). That is, -0.324 x (119.1/54.101) = -0.7141.

B. Calculate the effect of a 1-percent increase in expected net returns for soybeans per acre (ERTSOY) on corn NFA planted to corn:

   a. 54.101% x 15 = 8.1152 acres (NFA planted to corn before returns increase)
   b. 54.101% x (1-0.7141%) x 15 = 8.0572 acres (Planted to corn after returns increase)
   c. 8.0572 - 8.1152 = -0.0580 acre.

C. Estimate the relationship between the percentage change in expected soybean net returns associated with a 1-percent change in the expected soybean price, Enr.p, through a regression analysis: Enr.p = 1.18

D. Calculate the effect of a 1-percent increase in the expected soybean price on corn NFA planted to corn: -0.0580 x 1.18 = -0.0684 acre.

E. Calculate the cross-price elasticity for corn NFA: (-0.0684/8.1152) x 100 = -0.8427.

II. Extend the effect on corn plantings to the 100-acre whole farm

F. Calculate the maximum payment acres (MPA) that were planted to corn for a hypothetical 100-acre corn farm, after meeting the average set-aside requirement (6 acres) and deducting the 15-acre NFA: 100 - 6 - 15 = 79 acres, or 83.8 (79 + 4.8) acres after the return of ARP acres to production.

G. Calculate the effect on corn plantings on the rest of base associated with a 1-percent increase in the soybean price: 83.8 x (-0.088%) = -0.0737 acre, where -0.088 is the cross-price elasticity (with respect to soybean prices) estimated for the 1986-90 period (Adams).

H. Add the effect of a 1-percent increase in the soybean price on NFA planted to corn (line D) and corn planting on the rest of base (line G): -0.0684 - 0.0737 = -0.1421

I. Calculate the whole farm cross-price elasticity (with respect to soybean prices) for corn: (-0.1421/(2.7057 + 83.8)) x 100 = -0.1643, where 2.7057 is average NFA planted to corn for producers planting corn within the NFA range.

corn, sorghum, barley, oats, soybeans, cotton, and rice).[15] Own- and cross-price acreage elasticities under the 1996 Act, with its nearly full planting flexibility, are mostly greater than those estimated under previous legislation, especially compared with elasticities for 1986-90, before planting flexibility was introduced.[16] In most cases, cross-price elasticities increase even more than own-price elasticities. For example, while the own-price elasticity for corn plantings in the North Central region increases by 56 percent when the 1996 Act estimates are compared with 1986-90, the cross-price elasticity with respect to a 1-percent change in the expected soybean price increases by 86 percent (appendix table 14).

Relative to elasticities for the 1986-90 period, the own-price elasticity at the national level increases as follows: wheat, 1.2 percent; corn, 41.6 percent; soybeans, 13.5 percent; and cotton, 7.9 percent.[17] Compared with elasticities for 1991-95, the own-price elasticity under the 1996 Act either increases by a smaller amount or, in the cases of wheat, barley, oats, and soybeans in the Central and Northern Plains region, becomes smaller.

Wheat

The own-price supply elasticity of U.S. wheat (the weighted average of regional own-price elasticities based on the regional share of U.S. wheat planted acreage in 1991-95) is estimated at 0.340 under the 1996 Act, slightly above the estimate for 1986-90 but below the estimate for 1991-95 (table 1). This is in direct contrast with corn and soybeans, where larger increases in the own-price acreage elasticity are reported. This is because corn and soybean producers in the North Central region have more planting options than wheat producers in the Great Plains region. In the absence of planting flexibility, the own-price elasticity was estimated at 0.336 for U.S. wheat during 1986-90 (Adams). Similarly, the wheat own-price elasticity in the Central and Northern Plains was estimated at 0.240 under the 1996 Act, slightly higher than the 0.201 estimated for the 1986-90 period (appendix table 13).

At the national level, sorghum and barley are found to be the two primary competing crops for wheat. For example, a cross-price elasticity of -0.075 with respect to the sorghum price means that a 0.075-percent decline in U.S. wheat planted acreage is associated with a 1-percent increase in the expected sorghum price. This represents an increase of 29 percent and 12 percent over the elasticities estimated for 1986-90 and 1991-95, respectively (table 1). Corn, cotton, and oats also are important competing crops, although the extent of competition depends on the geographic area.

The own-price elasticity for U.S. winter wheat is estimated at 0.361 under the 1996 Act, compared with 0.291 for U.S. spring wheat.[18] Winter wheat confronts a larger number of competing crops (including sorghum, corn, barley, soybeans, and cotton) than does spring wheat (mainly barley, oats, and sorghum), giving a larger own-price supply elasticity. Sorghum is the primary competing crop for winter wheat. However, barley is the dominant competing crop for spring wheat. In the Southeast and Delta regions, a higher expected soybean price means more wheat plantings because a higher expected soybean price tends to encourage more winter wheat and soybean double-cropping.

Supply elasticities vary among major production regions. The own-price elasticity in the Central and Northern Plains (0.240) is the lowest, while that for the North Central region (0.567) is the highest (appendix table 13). The wheat own-price elasticity in the Central and Northern Plains is the lowest mainly because producers have limited alternatives to growing wheat. In contrast, the elasticity is the highest in the North Central region because wheat in that area has more cropping alternatives, competing with corn, soybeans, oats, and minor oilseeds. In the Central and Northern Plains, where over 50 percent of U.S. wheat is grown, the own-price elasticity under the 1996 Act is about 20 percent higher than under the 1986-90 legislation, but slightly below the estimate for 1991-95. Among the major production regions, the North Central region has the smallest increase in the own-

[15]Acreage price elasticities (except rice) are estimated from this study. Elasticities for rice are estimated by Adams.

[16]Some own- and cross-price acreage elasticities under the 1996 Act are smaller than those estimated for 1991-95 in part because the elasticity estimated for 1986-90 was used to estimate the elasticity for the "rest of base" for the 100-acre base hypothetical farm.

[17]Acreage price elasticities for 1986-90 and 1991-95 are as reported in Adams.

[18]The own-price elasticities for winter and spring wheats were estimated in Lin (1999a) by decomposing the own-price elasticity for all wheat using relative acreage shares in 1995—about 70 percent for winter wheat and 30 percent for spring wheat. An own-price elasticity of 0.291 for U.S. spring wheat was derived in that study from regional estimates (for spring wheat in the Central and Northern Plains and all wheat in other regions). The own-price elasticity for winter wheat is then estimated at 0.361, based on the 0.340 own-price elasticity for all wheat and the 0.291 elasticity estimate for spring wheat.

Table 1—Acreage price elasticities for U.S. wheat under the 1996 Act vs. previous legislation

Item	1986-90[1] (1)	1991-95[1] (2)	1996 Act (3)	Difference (3) vs. (1)	(3) vs. (2)
	Elasticity			Percent	
Wheat price	0.336	0.410	0.340	+1.2	-17.1
Barley price	-.080	-.078	-.076	-5.0	-2.6
Sorghum price	-.058	-.067	-.075	+29.3	+11.9
Corn price	-.030	-.041	-.046	+53.3	+12.2
Soybean price	-.002	-.007	-.010	+400.0	+42.9
Cotton price	-.028	-.029	-.014	-50.0	-51.7
Oat price	n.a.	n.a.	-.011	n.a.	n.a.

n.a. = Not applicable.
[1]Acreage price elasticities for the 1986-90 and 1991-95 periods are from Adams.

price elasticity in a comparison with 1986-90—only 2.5 percent.

Corn and Other Feed Grains

Relative to previous legislation, the 0.293 own-price acreage elasticity for U.S. corn estimated under the 1996 Act is 25-percent higher than during 1991-95 and 42-percent higher than during 1986-90 (table 2). The cross-price acreage elasticity with respect to the expected soybean price (-0.145) under the 1996 Act shows comparable increases, 27-percent higher than during the 1991-95 period and 47-percent higher than during 1986-90.

The own-price elasticity in the Central and Northern Plains region (0.242) is the lowest among the regions, while that for the Southeast and Delta regions (0.794) is the highest (appendix table 14). A larger number of competing crops (cotton, soybeans, winter wheat, and sorghum) in the Southeast and Delta contribute to a higher acreage price elasticity than in the Central and Northern Plains region, where competing crops are primarily limited to wheat, soybeans, and sorghum. In the North Central region, where nearly two-thirds of U.S. corn is grown, the own-price elasticity (0.248) under the 1996 Act is 43 percent higher than under 1991-95 legislation and 56 percent higher than under 1986-90 legislation.

The cross-price elasticity with respect to the expected soybean price in the North Central region is 58 percent higher than during 1991-95 and 86 percent higher than during 1986-90. Both of these gains exceed the respective increases in own-price elasticities in that region. The increase in the cross-price elasticity implies that corn programs in the past might have restricted the acreage shift from the program crop (corn) to competing crops (such as soybeans). While the 15-percent NFA provided by the 1990 farm legislation seems adequate for farmers in aggregate to respond to changing market price signals (Evans), flexibility limitations may have constrained large acreage shifts by some producers who would have switched more acreage had the NFA percent been higher. Also, the 1996 Act might facilitate the corn-soybean rotation, which allows operations that had previously planted continuous corn, or that had a higher proportion of corn than would be desirable for agronomic reasons, to shift to higher soybean plantings. The greater increase in the soybean cross-price elasticity is consistent with the increasing soybean share of combined corn-soybean acreage since 1996.

The own-price elasticity for oats and barley increases very little over 1986-90 legislation, and becomes smaller when compared with 1991-95 legislation (appendix tables 15-17). The decreases or lack of apparent increases in the own-price elasticity for these other feed grains suggest likely shifts of their acreage to corn, soybeans, or minor oilseeds if expected prices of these competing crops rise.

Table 2—Acreage price elasticities for U.S. corn under the 1996 Act vs. previous legislation

Item	1986-90[1] (1)	1991-95[1] (2)	1996 Act (3)	Difference (3) vs. (1)	(3) vs. (2)
	Elasticity			Percent	
Corn price	0.207	0.235	0.293	+41.6	+24.7
Soybean price	-.099	-.114	-.145	+46.5	+27.2
Wheat price	-.022	-.024	-.065	+195.5	+170.8
Cotton price	-.030	-.026	-.028	-6.7	+7.7
Sorghum price	-.003	-.002	-.010	+233.3	+400.0

[1]Acreage price elasticities for the 1986-90 and 1991-95 periods are from Adams.

Soybeans

Supply response estimates for soybeans are derived from NFA data for competing program crops. The own-price acreage elasticity for U.S. soybeans is estimated at 0.269, virtually unchanged from 1991-95 but 14 percent higher than during 1986-90 (table 3). In the absence of planting flexibility, the own-price elasticity was estimated at 0.237 for 1986-90. In the North Central region, where nearly two-thirds of U.S. soybeans are grown, the own-price elasticity is estimated at 0.298 under the 1996 Act, 14 percent higher than during 1991-95 and 17 percent higher than during 1986-90 (appendix table 18).

Corn is the primary competing crop for soybeans. The -0.229 cross-price elasticity with respect to the expected corn price means that a decline of 0.229 percent in soybean plantings is associated with a 1-percent increase in the expected corn price (table 3). This magnitude of the impact on soybean plantings is far greater than that caused by the same percentage increase in the expected prices for wheat and cotton combined.

The own-price elasticity of soybean plantings ranges from 0.20 to 0.30, depending on the production region. The own-price elasticity is the lowest in the Central and Northern Plains (0.198), while that for the North Central (0.298) is the highest (appendix table 18). The increase in the own-price elasticity is also the greatest (17 percent) in the North Central region relative to 1986-90. To the extent that the 1996 Act may cause soybean acreage to expand and prices to decline over time, the largest increase in the own-price elasticity for the North Central region suggests that soybean plantings would be less concentrated in that region.

Cotton

The own-price supply elasticity of U.S. cotton is estimated at 0.466 under the 1996 Act, 16 percent higher than during 1991-95, and 8 percent higher than during 1986-90 (table 4). The increase in cotton's own-price elasticity becomes much more pronounced at the regional level. In the Southern Plains, where over 40 percent of U.S. cotton is grown, the own-price elasticity is estimated at 0.48, 83 percent higher than during 1991-95, and 39 percent higher than during 1986-90 (appendix table 19). At the national level, corn, wheat, sorghum, and soybeans are the primary competing crops for cotton. For example, a cross-price elasticity of -0.072 with respect to the corn price means that a 0.072-percent decline in U.S. cotton planted acreage is associated with a 1-percent increase in the expected corn price. Similarly, the -0.081 cross-price elasticity with respect to the soybean price means that a 0.081-percent decline in U.S. cotton plantings is associated with a 1-percent increase in the expected soybean price. While the own-price elasticity shows an increase of 16.0 percent when compared to 1991-95, the increase in cross-price elasticities are much more pronounced. For example, the increase in the cross-price elasticity with respect to the corn price is more than four times. Much lower capital requirements for growing competing crops, such as corn and soybeans, entice cotton producers to more readily make a switch in their planting decisions than many other crop producers. Also, producers continued to grow cotton to protect their base under previous legislation because

Table 3—Acreage price elasticities for U.S. soybeans under the 1996 Act vs. previous legislation

Item	1986-90[1] (1)	1991-95[1] (2)	1996 Act (3)	Difference (3) vs. (1)	Difference (3) vs. (2)
	Elasticity			Percent	
Soybean price	0.237	0.271	0.269	+13.5	-0.7
Corn price	-.172	-.230	-.229	+33.1	-.4
Wheat price	.007	-.007	-.007	-200.0	0
Cotton price	-.044	-.040	-.020	-54.6	-50.0

[1]Acreage price elasticities for the 1986-90 and 1991-95 periods are from Adams.

Table 4—Acreage price elasticities for U.S. cotton under the 1996 Act vs. previous legislation

Item	1986-90[1] (1)	1991-95[1] (2)	1996 Act (3)	Difference (3) vs. (1)	Difference (3) vs. (2)
	Elasticity			Percent	
Cotton price	0.432	0.401	0.466	+7.9	+16.2
Corn price	-.019	-.014	-.072	+278.9	+414.3
Wheat price	-.026	-.035	-.058	+123.1	+65.7
Sorghum price	-.085	-.076	-.103	+21.2	+35.5
Soybean price	-.046	-.034	-.081	+76.1	+138.2

[1]Acreage price elasticities for the 1986-90 and 1991-95 periods are from Adams.

cotton offered one of the largest deficiency payments on a per acre basis.

Supply elasticities vary somewhat among major production regions. The own-price elasticity in the Southeast and Delta (0.435) is slightly lower than the 0.480 for the Southern Plains (appendix table 19). Relative to 1986-90, the own-price elasticity shows a larger increase in the Southern Plains—an increase of 39.1 percent. In contrast, the own-price elasticity shows only a 6.1-percent increase in the Southeast and Delta regions. This suggests that cotton plantings under the 1996 Act associated with a decline in cotton prices would fall relatively less in the Southeast and Delta regions than in the Southern Plains.

National Acreage Price Elasticity Summary

U.S. acreage price elasticities are summarized in appendix table 21 to indicate the acreage responses for major field crops to 1-percent changes in their own prices and prices for competing crops. These U.S. acreage price elasticities are weighted averages of the elasticities in major production regions based on the regional shares of U.S. planted acreage for each crop in 1991-95.

Impact of the 1996 Act on the U.S. Major Field Crops Sector

This section describes simulations based on the Policy Analysis System-Economic Research Service (POLYSYS-ERS) model jointly developed by ERS and the Agricultural Policy Analysis Center, University of Tennessee, and discusses impacts of increased planting flexibility under the 1996 Act on the major U.S. field crops.

POLYSYS Simulation Procedures

POLYSYS is a simulation modeling framework that provides policy analysts and researchers with an analytical tool for estimating a variety of impacts resulting from policy, economic, environmental, or other changes. Based on a systems approach to modeling, POLYSYS operates an umbrella framework, facilitating the interaction of agricultural supply, demand, and income modules (Ray and others). POLYSYS is designed to anchor its analysis to a baseline of projections for all model variables. This design, along with reliance on predetermined price-response parameters, allows POLYSYS to produce detailed and complex estimates quickly.

Within the linear programming (LP) supply framework of POLYSYS, agricultural production response and resource use indicators are disaggregated to 305 regions, each of which is characterized by homogeneous production characteristics within the region. Based on expected prices, the supply module—a set of 305 regional LP models maximizing returns above variable costs—estimates planted and harvested acres, yields, and production costs. The aggregation of crop production by region results in national crop production which, together with beginning stocks and any imports, provides an estimate of supply. The demand module estimates domestic demand, exports, and ending stocks at the national level for each crop. Supply of the commodity is then fed into the demand component of POLYSYS as a fixed number to generate the market-clearing price based on a set of price flexibility functions for each crop. The market-clearing price is then recursively fed into LP models to solve for planted and harvested acres for the following year and the simulation process continues through the year 2005.

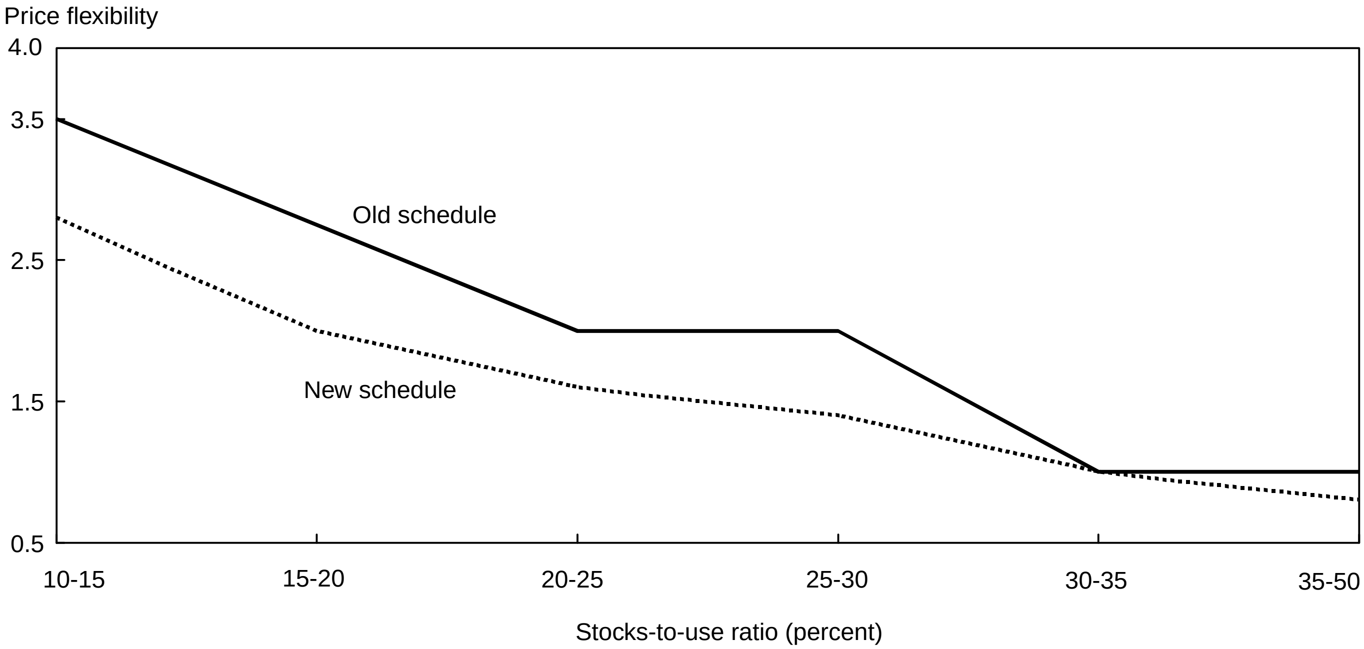
In this analysis, the impact of the 1996 Act (through planting flexibility) at both the national and regional levels is determined by comparing the results of the baseline that reflects the 1990 Act with an alternate scenario that reflects the increased planting flexibility under the 1996 Act. The 1996 Act scenario explicitly incorporates the acreage price elasticities under the new legislation (reported earlier) and completely revises the price flexibility functions for U.S. wheat, corn, other feed grains, soybeans, cotton, and rice previously reported by Ray and others so that they are consistent with the current policy environment (appendix table 22).

"Price flexibility" refers to the percentage change in commodity farm prices associated with a 1-percent change in quantity demanded, moving along the demand function. The slope of the price flexibility function may vary, depending on the stocks-to-use ratio. More specifically, a higher slope is associated with the stocks-price relationship at a low stocks-to-use ratio, and a lower slope occurs at a high stocks-to-use ratio. Price flexibility functions for corn, wheat, soybeans, cotton, and rice are estimated using the following steps: (1) obtain the stocks-to-price relationships for corn, as estimated by Westcott and Hoffman, that are consistent with the current policy environment of lower loan rates and only small Government-owned stocks; (2) estimate the stocks-to-use relationships for wheat, soybeans, cotton, and rice, following the same basic approach as used in estimating corn by Westcott and Hoffman; and (3) calculate price flexibilities at various stocks-to-use ratios based on the stocks-price relationships obtained in step 1 and estimated in step 2. The newly estimated price flexibility functions lie below the ones embedded in the earlier version of POLYSYS (fig. 9). For example, at a stocks-to-use ratio of 19 percent (a point in the 15- to 20-percent range as shown in appendix table 22) for U.S. corn, a price flexibility of -2.00 is estimated according to the newly estimated price flexibility function for corn, compared with the -2.75 used in the earlier version of POLYSYS.

Several important changes are made in the POLYSYS framework to include the new supply response structure used in the simulation analyses presented here. Also, various specific assumptions are employed in the simulation analysis. The key steps (and assumptions) in the POLYSYS simulation include:

- Use the February 1996 USDA baseline (the last baseline that reflects the 1990 Farm Act) as the base scenario for this analysis. This base line, reflecting stronger market conditions for major field crops than more recent, low-price markets, serves as the benchmark for compar-

Figure 9
Price flexibility functions for U.S. corn: Old vs. new schedule



Price flexibilities are negative.

ing the revised supply response under the 1996 Act scenario with the 1990 Act baseline.

- Generate the regional acreage that corresponds with the February 1996 USDA baseline from the LP supply component to obtain the regional benchmarks. Estimates of acreage, input expenditures, crop yields, season average prices, and Government program variables in the February 1996 USDA baseline are disaggregated into the seven production regions. The regional LP models are used to allocate acreage in the February 1996 USDA baseline among the seven regions, given regional prices, yields, and costs of production (see Ray and others).[19]

- For the 1996 Act scenario, replace the linear programming (LP) supply component in the earlier POLYSYS with one based on the acreage price elasticities presented earlier in this report.

- Use the intended acreage in USDA's *Prospective Plantings* report at the end of March 1996, as the planted acreage in the initial year of simulation (1996). Using acreage that reflects farmers' planting intentions removes the effect of nonprice factors on farmers' planting decisions.

- Use farm prices lagged by 1 year as expected prices for the current year, and determine planted acreage for the current year by the change in expected prices and acreage price elasticities.

- Determine market-clearing prices by adjusting the baseline numbers by multiplying the percentage change in total use by the revised price flexibilities (appendix table 22) estimated by ERS analysts.

Simulation Results

Simulation results presented show crop-specific and aggregate acreage impacts for individual regions and the national level. Price effects, which provide dynamic price-output linkages in the simulation model, are also presented.

[19]Using the regional LP models to allocate national acreage in the February 1996 USDA baseline among the seven regions could introduce measurement errors into the simulation results, because of the shift in model structure from an LP framework to an elasticity-driven approach. We have investigated this potential source of errors and found the errors, to the extent they exist, to be not significant.

Aggregate Area Planted to the Eight Major Field Crops

The simulation results reaffirm earlier studies indicating that aggregate area planted to the eight major field crops (wheat, corn, sorghum, barley, oats, soybeans, cotton, and rice) under the 1996 Act would not differ much from that under the 1990 Act (Young and Westcott). Plantings are projected to increase to 261.7 million acres by the year 2005 under the 1996 Act (fig. 10). In contrast, plantings would have been about 2 million acres higher (263.6 million acres) by the year 2005 if the 1990 Act provisions had continued in force.

Aggregate area planted to the eight major field crops in the simulations was initially about 1 million acres lower under the 1996 Act scenario than under the 1990 Act baseline in 1996, reflecting the discrepancy between acreage projected in the February 1996 USDA baseline (reflecting 1990 farm law) and farmers' 1996 crop planting intentions at the end of March 1996 (fig. 10). Then, for 1998 through 2002, aggregate area planted to the eight major field crops under the 1996 Act scenario exceeds that projected under the 1990 Act baseline, reflecting greater supply response to rising farm prices under the 1996 Act scenario. After 2002, aggregate planted area continues to rise under the 1990 Act baseline, but area under the 1996 Act scenario increases more slowly in response to more modest increases in farm prices for corn and wheat—the two major program crops where acreage expands under the 1990 Act baseline. Thus, by 2005, aggregate planted area under the 1996 Act scenario is projected to be about 2 million acres less than planted under the 1990 Act baseline.

Wheat

Wheat acreage could be affected significantly by the size and composition of the Conservation Reserve Program (CRP), because a large portion of the cropland enrolled in the CRP is wheat land. However, because acreage enrolled under the CRP in the 1996 Act scenario remains unchanged from that under the 1990 Farm Act baseline, the impact of the 1996 Farm Act on the U.S. wheat sector mainly reflects the effect of enhanced planting flexibility, not the CRP.

The effect of changing farm legislation on the U.S. wheat industry appears to be less dramatic than its effect on the corn, soybeans, and cotton sectors. U.S. wheat planted acreage under the 1996 Act scenario is simulated to decline by 1-2 million acres during 1997-98, reflecting the significant reduction in Export Enhancement Program funding and consequently the reduction in wheat exports (fig. 11). Wheat plantings then regain strength to slightly exceed the 1990 Act baseline acreage during 2000-02, reflecting higher season average farm prices under the 1996 Act scenario during the 1998-99 crop years (fig. 12). Due to larger

Figure 10
Aggregate area planted to eight major field crops, 1990 Act baseline and 1996 Act

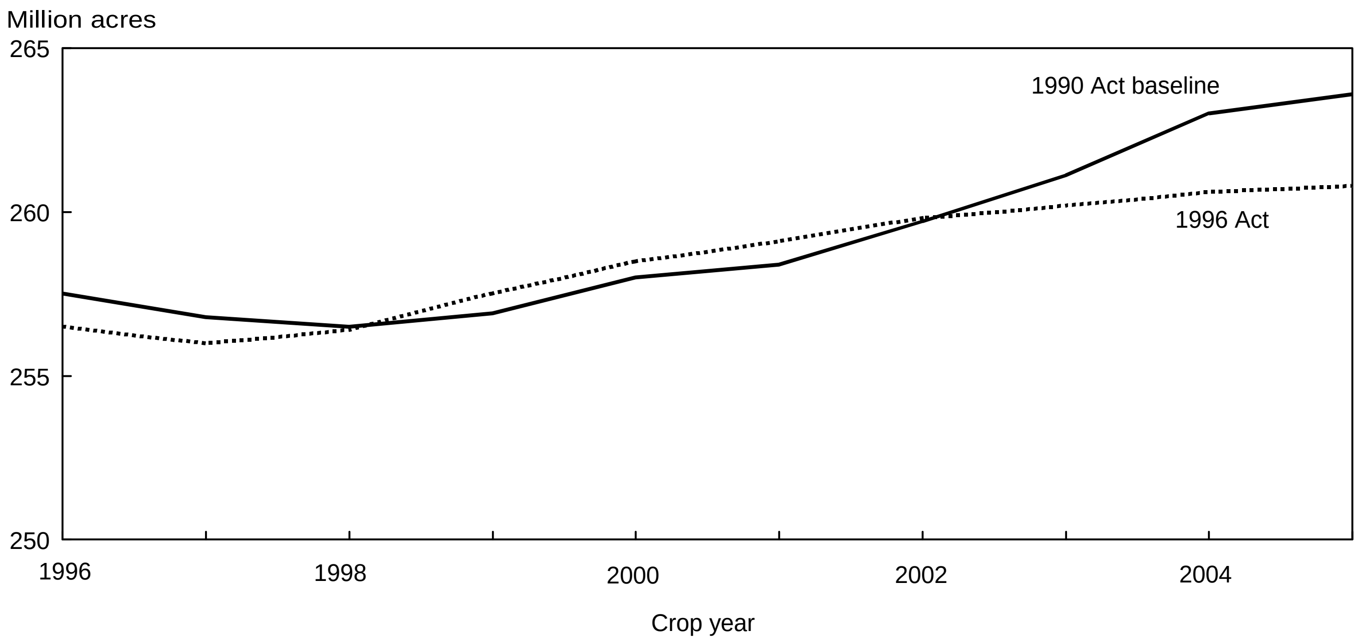


Figure 11
Wheat planted acreage, 1990 Act baseline and 1996 Act

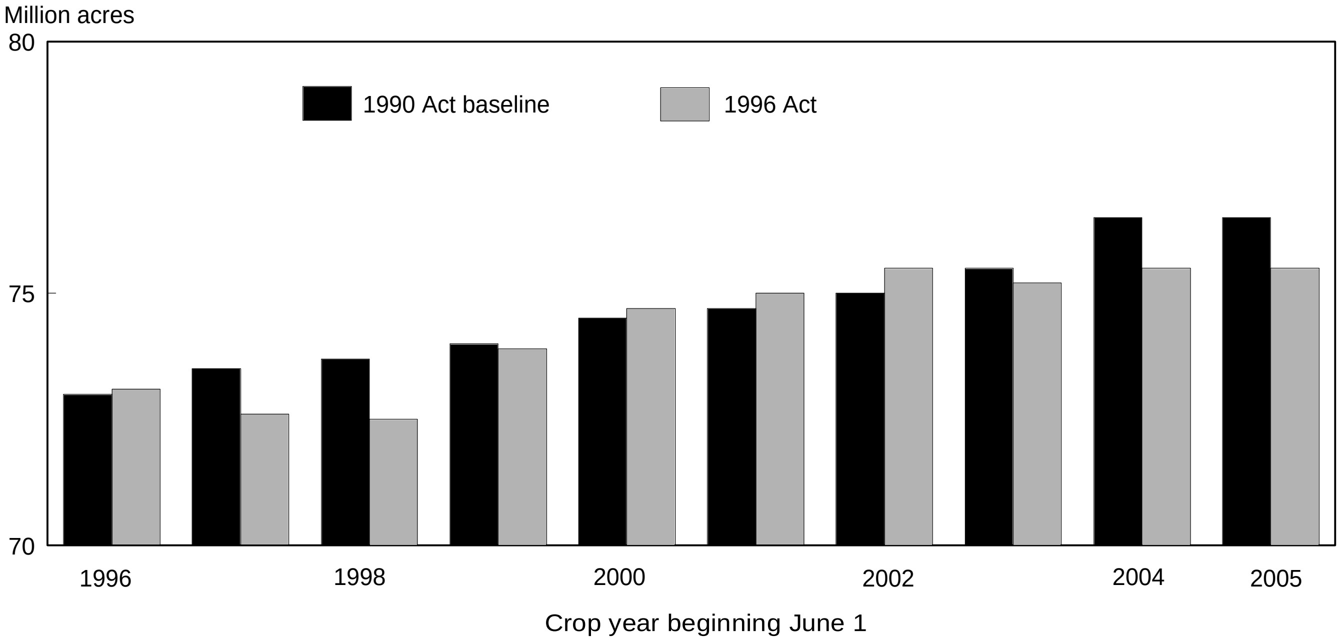
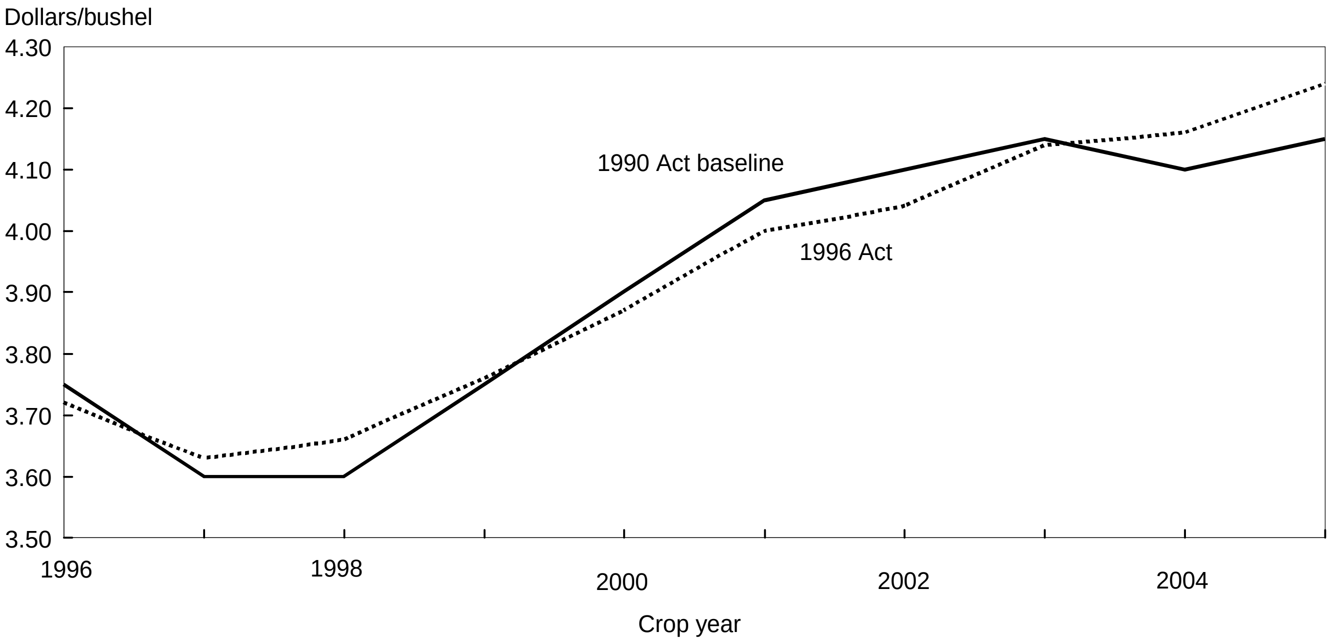


Figure 12
Farm prices of wheat, 1990 Act baseline and 1996 Act



acreage, market-clearing prices are simulated to fall, which triggers a decline in wheat planted acreage. By the year 2005, U.S. wheat acreage under the 1996 Act is simulated to be 0.8 million acres lower than under the 1990 Act.

This reduction in U.S. wheat acreage simulated under the 1996 Act has different incidences for major production regions. The reduction in wheat acreage is greatest in the Southern Plains, a decline of 0.67 million acres. Similarly, wheat acreage in the Central and Northern Plains is simulated to decrease by 0.45 million acres, about half of the 0.8-million-acre decline in

U.S. wheat planted acreage under the 1996 Act. This share reflects the 53.8 percent of wheat acreage accounted for by this region during 1994-95. In contrast, wheat acreage is shown to increase by 0.39 million acres under the 1996 Act in the North Central region.

U.S. wheat prices are simulated to be higher in the late 1990's under the 1996 Act scenario than under the 1990 Act baseline, reaching a 6-cent per bushel rise in the 1998 crop year. Wheat prices are projected to be lower during 2000-03 as planted acreage becomes larger than under the 1990 Act baseline, and then to increase by 6-10 cents per bushel during 2004-05. On average, U.S. wheat prices under the 1996 Act are comparable with those under the 1990 Act. This finding suggests that the current low wheat prices received by farmers (for example, cash grain bids of U.S. No. 1 hard red winter (HRW) wheat at country elevators in western Kansas were priced at $2.17-$2.25 per bushel as of April 12, 2000) are a phenomenon caused more by large wheat crop production in the United States and in foreign markets, and the financial crisis in Asia, than by implementation of the 1996 Act.

Due to small changes in acreage price elasticities between the 1996 Act and 1990 Act across production regions, regional production patterns for U.S. wheat would remain largely unchanged. The Central and Northern Plains remains the most important production region for U.S. wheat, and its share of U.S. wheat acreage under the 1996 Act stays about 54 percent.

The North Central region would likely marginally gain in its share of U.S. wheat acreage, by an average of 0.5 percentage point per year during 1996-2005, at the expense of the Southern Plains. Because of higher costs of production on a per bushel basis, the Southern Plains is likely to have a slightly reduced competitive edge in wheat production under the 1996 Act. The share of U.S. wheat acreage in the Southeast and Delta regions would remain unchanged.

Corn

The change in farm legislation from the 1990 Act to the 1996 Act will have a bigger impact on the U.S. corn industry than on the wheat industry. During the simulation period, 1996-2005, U.S. corn planted acreage under the 1996 Act scenario, on average, is projected to be 1-2 million acres lower than under the 1990 Act baseline (fig. 13). More important, U.S. corn acreage under the 1996 Act is simulated to be less than under the 1990 Act baseline in every year of the 1996-2005 simulation period. By the years 2004-05, U.S. corn acreage under the 1996 Act scenario is projected to be about 2 million acres less than under the 1990 Act baseline. With greater supply response under the 1996 Act, producers can more readily make a switch from corn to soybeans, or other competing crops.

As a result of lower planted acreage, farm prices for U.S. corn under the 1996 Act scenario are projected to be 10-15 cents per bushel higher than under the 1990 Act baseline (fig. 14). In the initial years of the simulation period, corn prices under the 1996 Act are projected to be about 10 cents per bushel higher than under the 1990 Act baseline, reflecting a slightly lower stocks-to-use ratio (9 percent) under the 1996 Act scenario than under the 1990 Act baseline (10 percent). However, beginning in the early 2000's, the gap is projected to widen, reaching a difference of 16 cents per bushel by the year 2005. The stocks-to-use ratio is projected to be at 6 percent for that year under the 1996 Act scenario, compared with 7 percent under the 1990 Act baseline.

U.S. corn production will be slightly more concentrated in the North Central region, which accounts for nearly two-thirds of U.S. corn acreage. That region has a larger increase in own-price elasticity than in other regions, and projections indicate higher corn prices under the 1996 Act than under the previous legislation. Relative to the region's estimated elasticity of 0.173 for 1991-95 (Adams), the own-price elasticity estimated under the 1996 Act of 0.248 for this region indicates a 43.4-percent increase. This increase is the largest among major production regions. However, the change in the region's share of U.S. corn acreage is small. In addition, the Southeast and Delta regions are projected to gain a larger share of U.S. corn acreage at the expense of the Central and Northern Plains (fig. 15). In fact, corn acreage in the Central and Northern Plains is lower under the 1996 Act than under the 1990 Act baseline.

More specifically, corn plantings in the Central and Northern Plains are projected to continue their expansion trend in the 1990 Act baseline simulation, increasing from 17.4 million acres in the year 1996 to 18.4 million by 2005. However, the region's corn acreage is projected to be lower under the 1996 Act scenario, remaining near 16.9 million acres (fig. 16). Since U.S. corn acreage is projected to be smaller under the 1996 Act, planting flexibility would permit producers to switch from corn to competing crops (primarily soy-

Figure 13
Corn planted acreage, 1990 Act baseline and 1996 Act

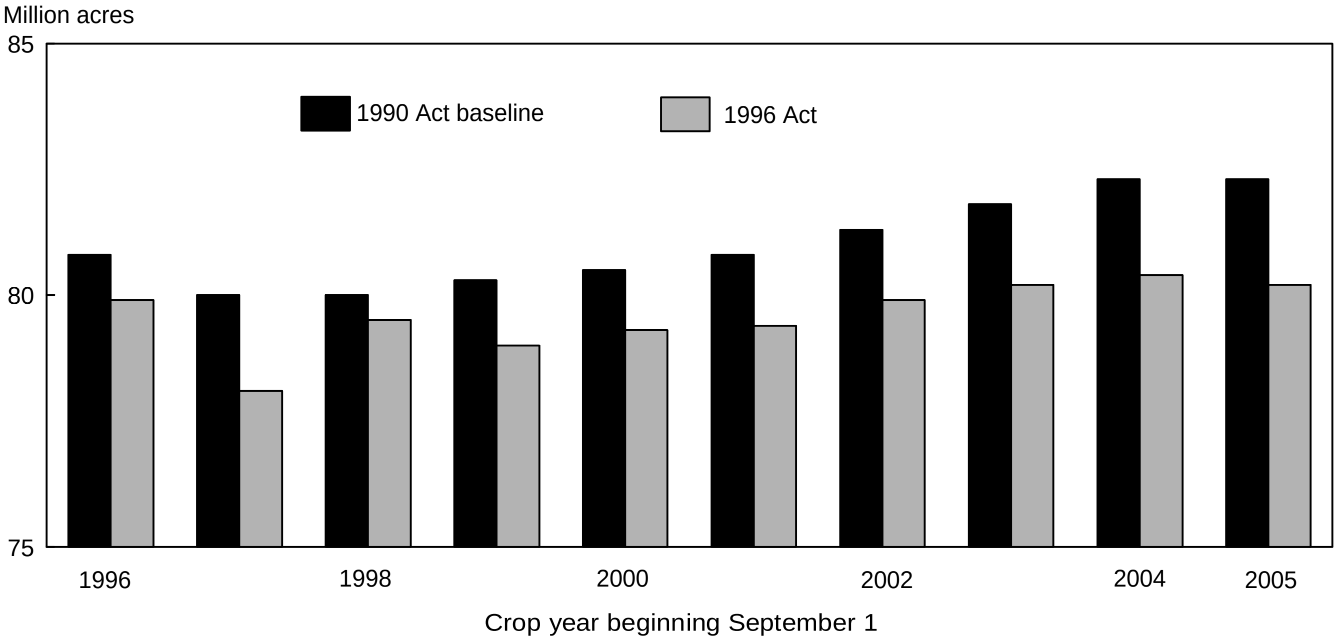


Figure 14
Farm prices of corn, 1990 Act baseline and 1996 Act

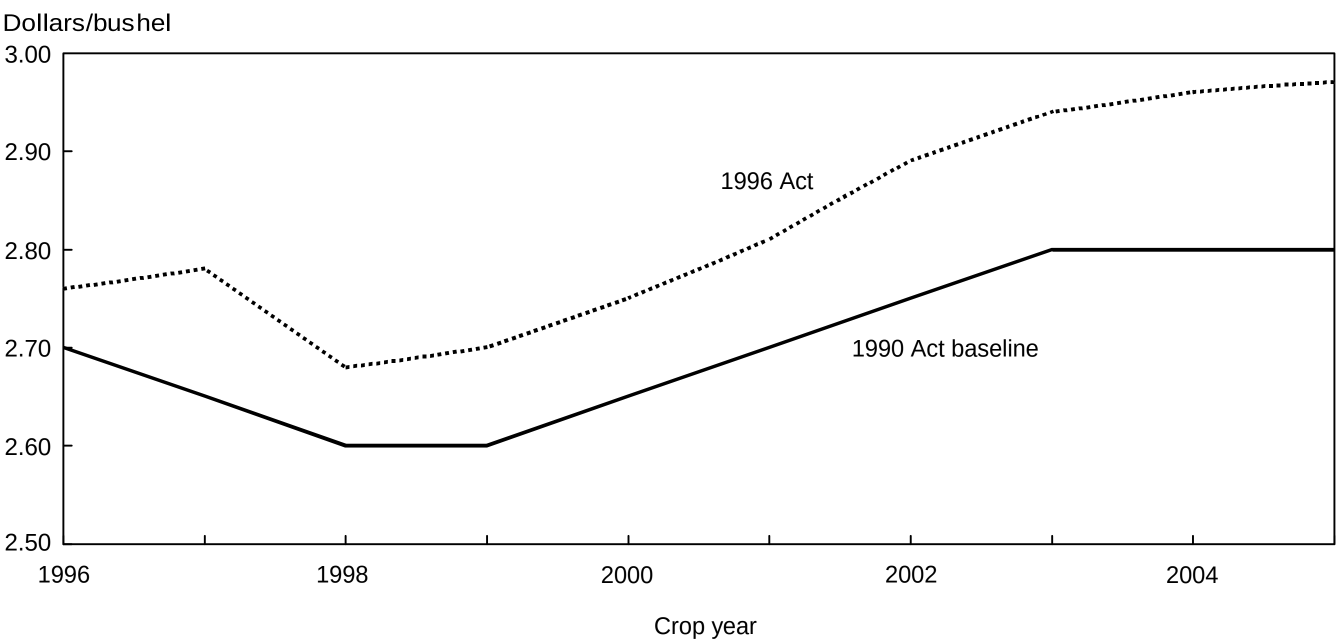
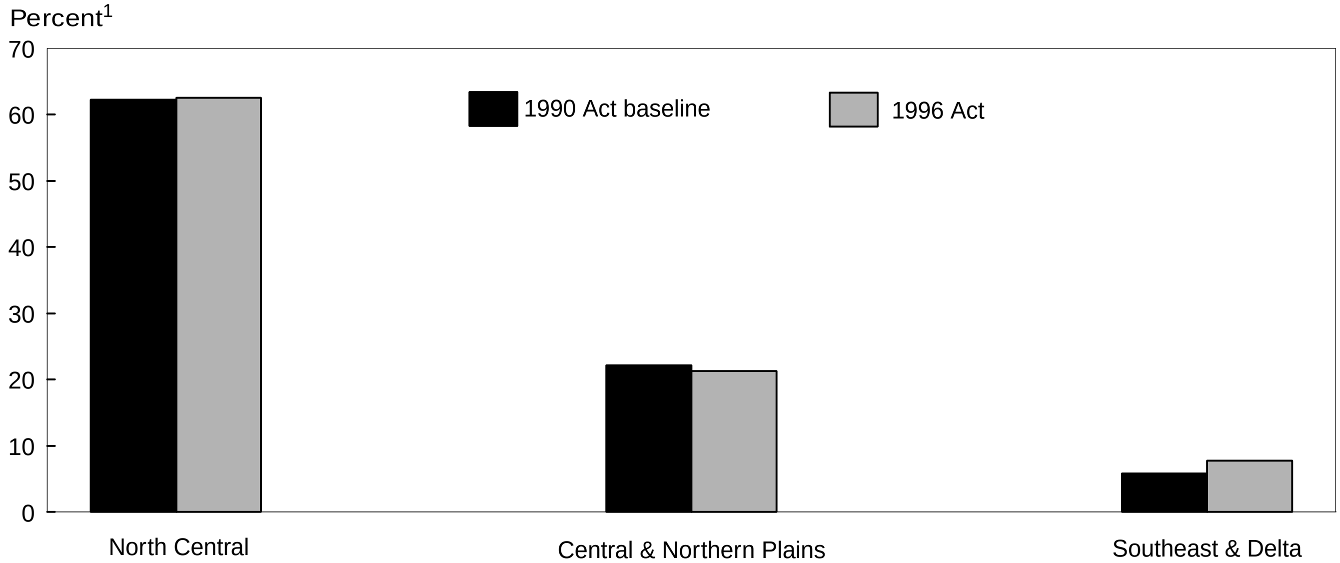
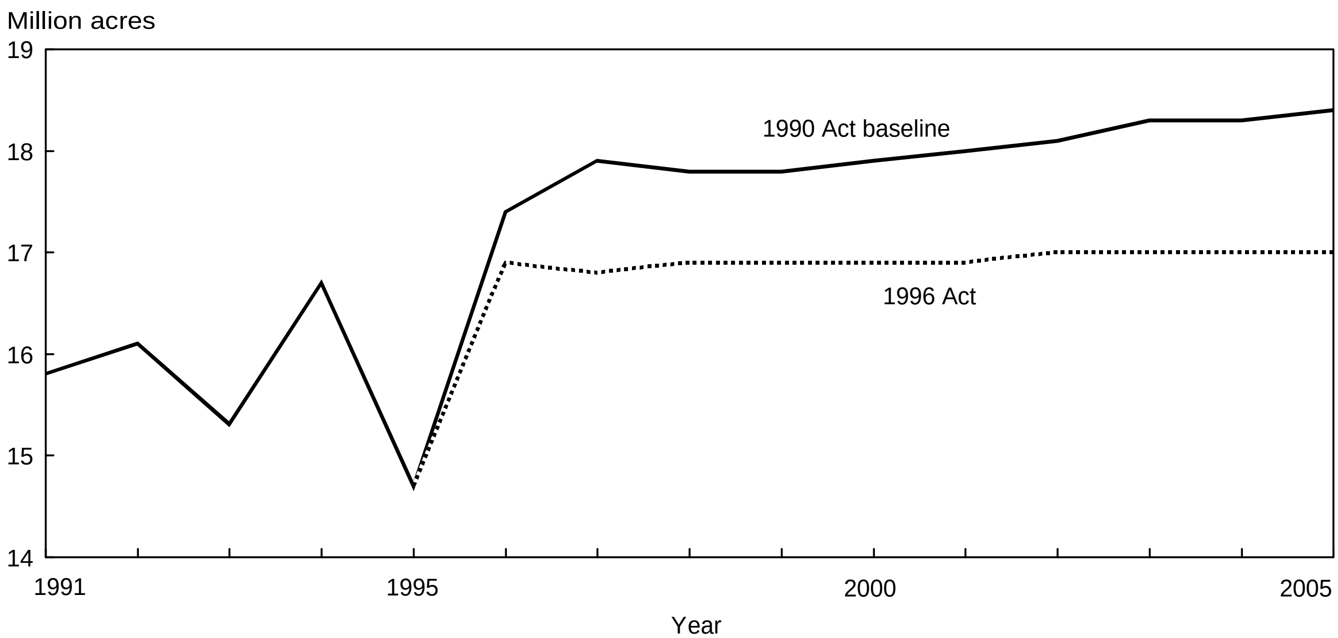


Figure 15
The 1996 Act continues corn production concentration in the North Central region, and the South gains a larger U.S. share



[1]Average percentage of 1996-2005 planted acreage.

Figure 16
The 1996 Act slows corn-acreage expansion in the Central and Northern Plains



beans), if they are more profitable. As a result, corn acreage expansion projected to occur under the 1990 Act baseline would be substantially slowed under the 1996 Act scenario.

Soybeans

The change in farm legislation from the 1990 Act to the 1996 Act will have its biggest acreage impact on soybeans, which shows an increase of over 2 million acres throughout the simulation period under the 1996 Act over the 1990 Act baseline (fig. 17). Nearly full planting flexibility allows corn producers to make a switch from corn to soybeans, which is based primarily on market signals in the simulations. This finding is consistent with the steady rising trend in the soybean share of U.S. soybean-corn acres in recent years, from nearly 44 percent in 1996 to 45.8 percent in 1997, and to nearly 49 percent in 1999.

In contrast to corn prices, soybean prices are projected to be lower under the 1996 Act by about 35 cents per bushel in 2000-05 (fig. 18). During this period, corn prices are projected to be 10-15 cents per bushel higher under the 1996 Act scenario. Soybean prices initially show a decline of about 10-20 cents per bushel during 1996-97. However, the gap is simulated to widen afterwards, reaching a difference of more than 20 cents per bushel in the 1998 crop year. The lower soybean prices reflect the projected increase in soybean acreage under the 1996 Act throughout the simulation period.

The 1996 Act would make soybean production slightly less concentrated in the North Central region. The own-price elasticity shows the largest increase (14 percent) under the 1996 Act when compared with 1991-95 in this region. Since the 1996 Act shows an expansion of soybean acreage and consequently a decline in soybean prices, the largest increase in the own-price elasticity for the North Central region suggests that U.S. soybean plantings would be less concentrated in that region. This region's share of U.S. soybean acreage is projected to be around 66.1 percent to 66.3 percent under the 1990 Act baseline, but would decline to 65.2 percent to 65.4 percent under the 1996 Act (fig. 19).

The 1996 Act would facilitate soybean expansion in the Central and Northern Plains (fig. 20). Under the 1996 Act scenario, soybean plantings in this region are projected to be 0.2-0.4 million acres higher than under the 1990 Act baseline. Planting flexibility would permit producers to switch from corn to soybean plantings, giving the result of lower U.S. corn acreage and larger soybean acreage projected under the 1996 Act scenario.

Cotton

During 1996-2005, upland cotton acreage on average is projected to be 15.2 million acres under the 1996 Act (fig. 21). Relative to the 1990 Act baseline, upland cotton acreage would average 0.7 million acres

Figure 17
Soybean planted acreage, 1990 Act baseline and 1996 Act

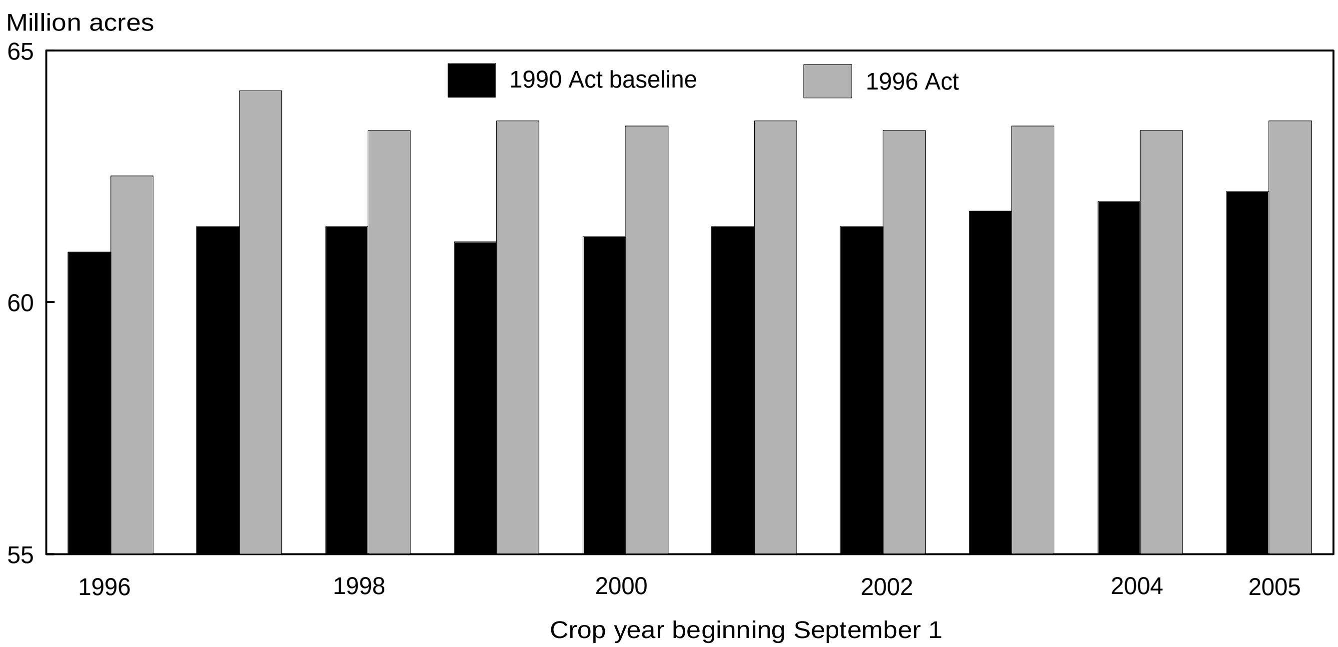


Figure 18
Farm prices of soybeans, 1990 Act baseline and 1996 Act

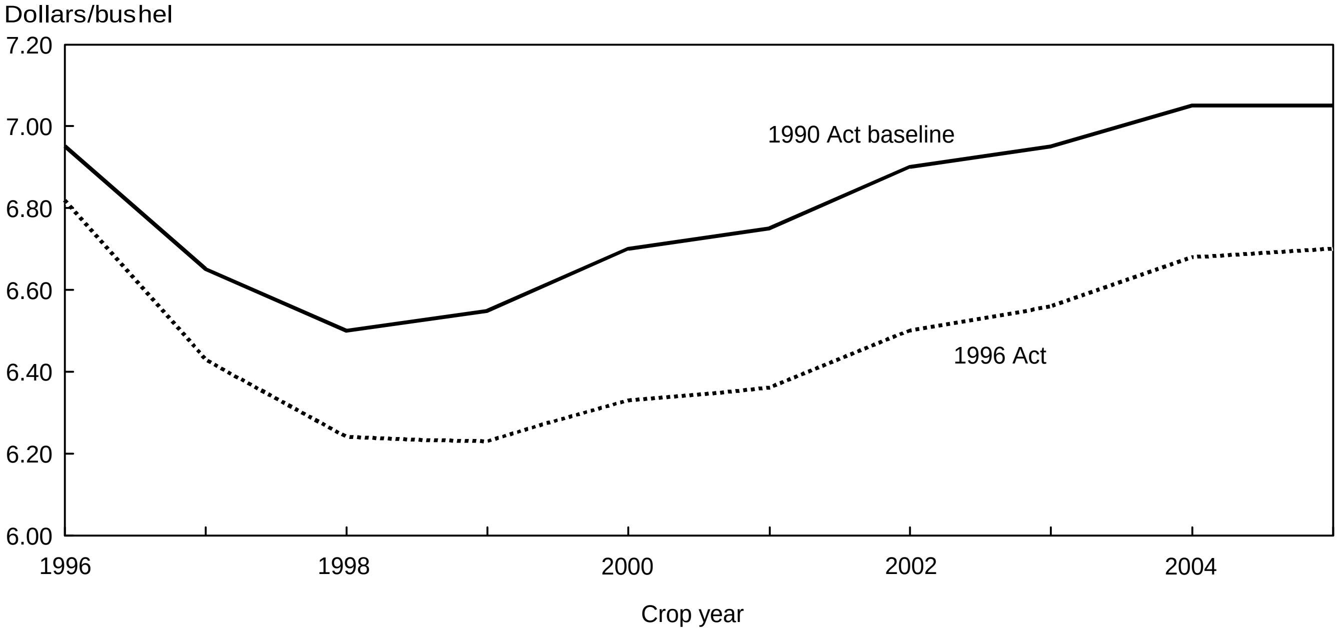
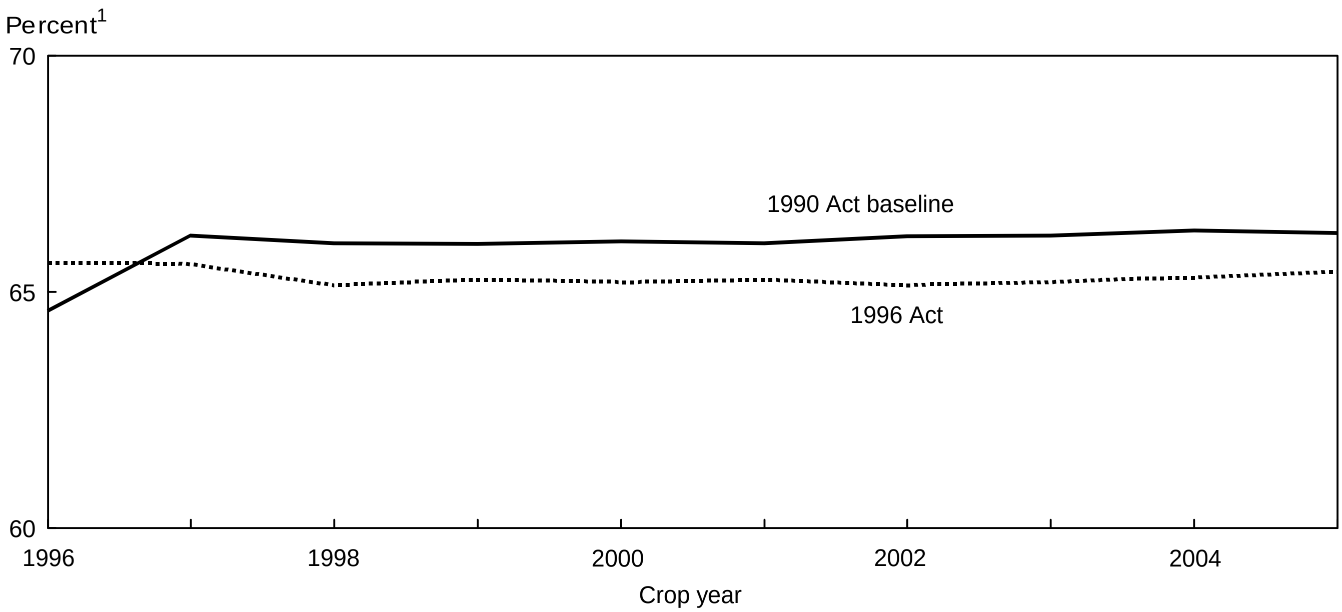


Figure 19
The 1996 Act makes soybean production slightly less concentrated in the North Central region



[1]Percent of soybeans grown in the North Central region.

Figure 20
The 1996 Act facilitates soybean-acreage expansion in the Central and Northern Plains

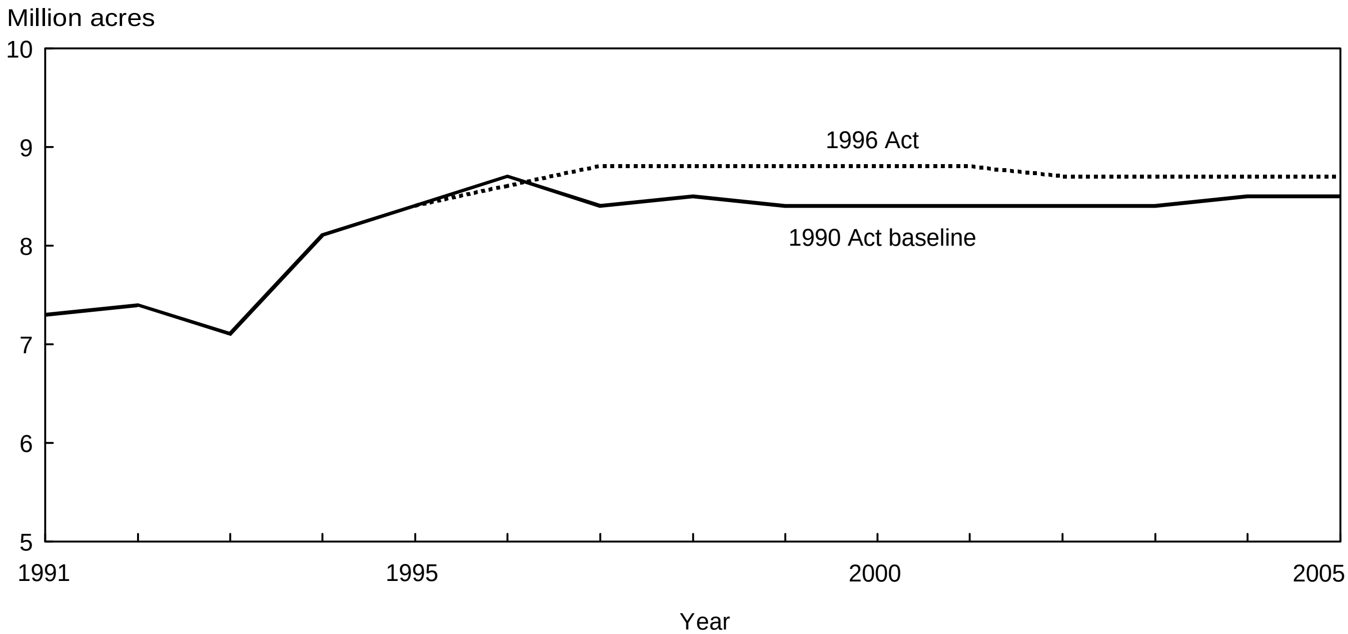
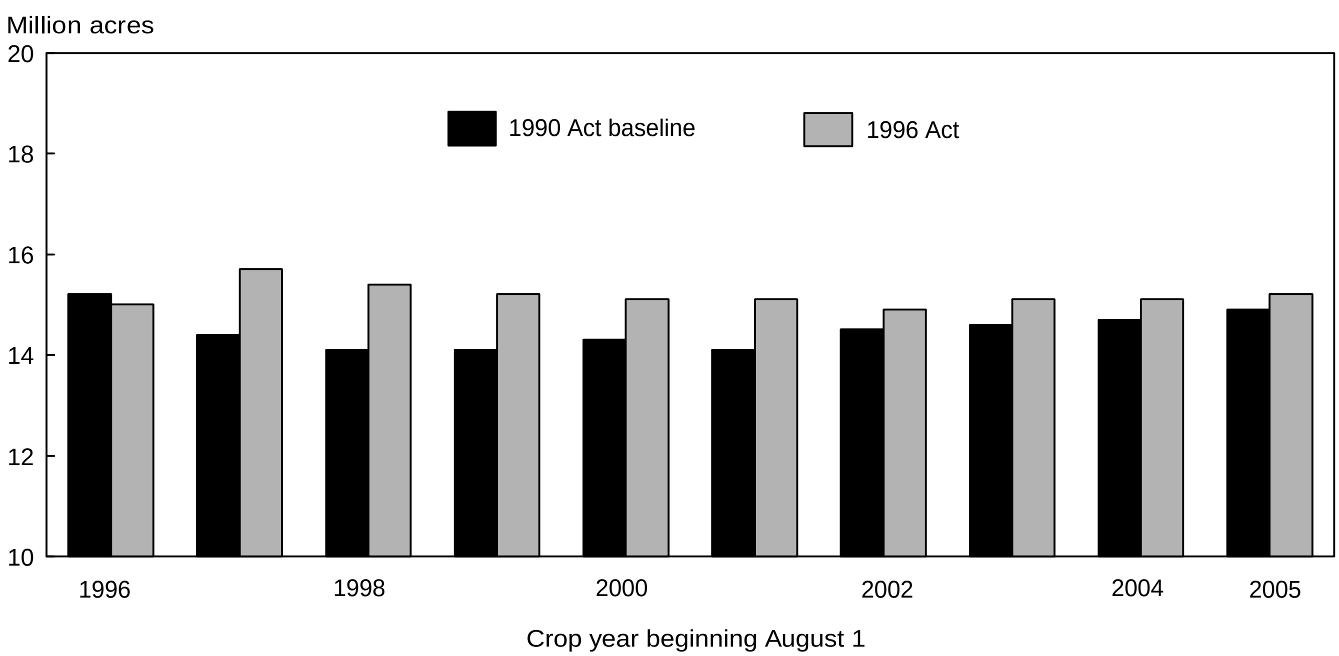


Figure 21
Cotton planted acreage, 1990 Act baseline and 1996 Act



higher under the 1996 Act scenario, largely reflecting the effect of eliminating the ARP, which was projected to account for between 0.3 to 1.0 million acres under the 1990 Act baseline.[20] During the 1996-2005 simulation period, about 0.6 million acres per year are projected to be idled under the ARP in the 1990 Act baseline. These idled acres would most likely return to cotton production under the 1996 Act scenario.

Larger upland cotton acreage under the 1996 Act results in higher stocks-to-use ratios for cotton under the current policy environment. The ratio is simulated to show a rapid upturn before the year 2000—increasing from 26 percent in 1996 to 43 percent in the year 1999—and then to gradually decline to 37 percent by the year 2005. In contrast, the ratio is projected to hover around the range of 27-31 percent under the 1990 Act baseline.

Due to higher stocks-to-use ratios under the 1996 Act scenario, cotton prices are simulated to remain lower than under the 1990 Act baseline. Despite lower prices, cotton acreage under the 1996 Act scenario remains consistently higher than the 1990 Act baseline because of the elimination of the ARP.

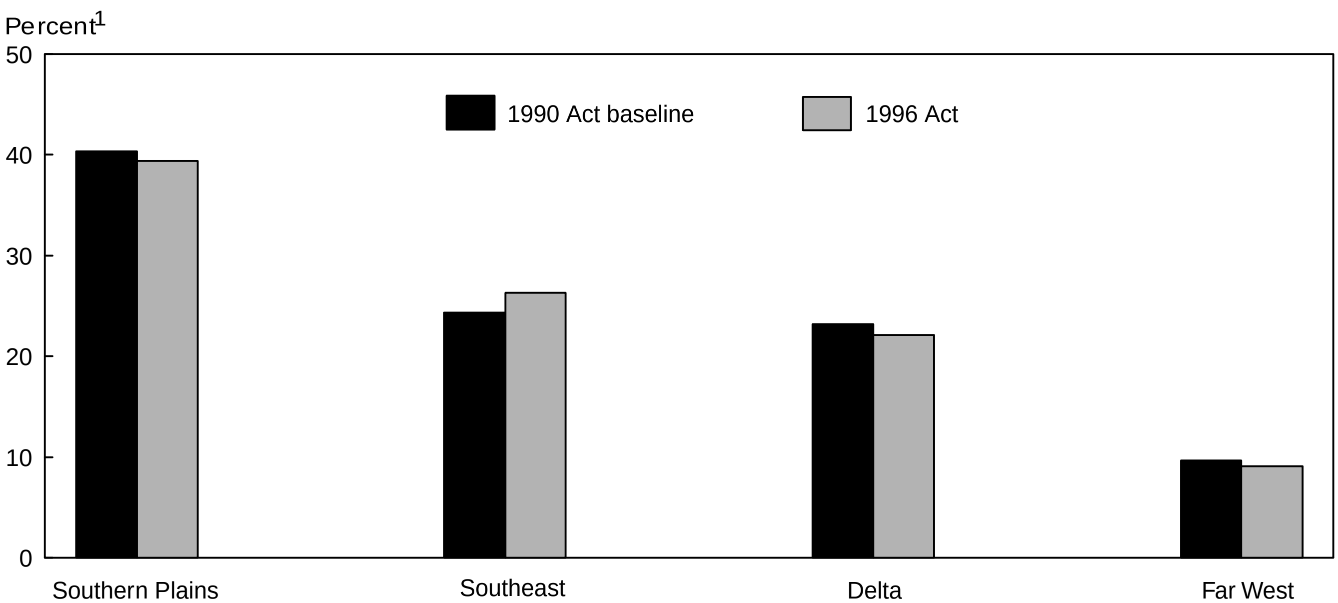
[20]The effect of eliminating the ARP, which permits cotton acreage to return to production, is the key factor that contributes to higher cotton acreage under the 1996 Act scenario. The cross-price effect of competing crops on cotton acreage is relatively modest.

The 1996 Act is found to have a more noticeable impact on regional production patterns for cotton than for other major field crops. The Southeast stands to gain a larger share of U.S. cotton acreage under the 1996 Act—an increase of 2 percentage points over the 1990 Act level—at the expense of the Southern Plains and Delta, whose share is projected to decline by 1 percentage point each (fig. 22).

These changes in regional production patterns are consistent with the changes in cotton's own-price acreage elasticities. The Southeast gains share because the increase in the elasticity—from 0.419 estimated by Adams for 1991-95 under the 1990 Act to 0.435 under the 1996 Act—is smallest in this region (+0.016). This gives a small decline in this region's cotton acreage resulting from lower cotton prices projected under the 1996 Act. In contrast, the Southern Plains is projected to lose share because its own-price elasticity has the greatest increase (+0.217)—from 0.263 estimated by Adams for 1991-95 under the 1990 Act to 0.480 under the 1996 Act, resulting in a larger decline in this region's cotton acreage in response to lower projected cotton prices. In addition, the changes in regional production patterns are consistent with the costs of production—the Southeast is a low-cost region while the Southern Plains and Delta are higher cost regions.

Figure 22

The Southeast gains a larger share of U.S. cotton acreage under the 1996 Act



[1]Average percentage of 1996-2005 planted acreage.

Validation of Acreage Price Elasticities and Simulation Results

The validity of these simulation results would be greatly enhanced if (1) the acreage price elasticities embedded in the 1996 Act scenario accurately "forecast" producers' planting intentions for major field crops in 1997-99, and (2) the effect of change in the farm program (through increased planting flexibility) from the 1990 Act baseline to the 1996 Act scenario, as reported earlier in the simulation analysis section, remains unchanged when market conditions embedded in the February 1996 USDA baseline (high-priced) are replaced with market conditions that actually occurred during 1997/98 and 1998/99 (low-priced).

If the results track reasonably well, we anticipate that the program effects reported in the simulation results section, together with the market effect based on actual market conditions, will explain producers' planting intentions in cases where nonprice factors did not play an important role in affecting producers' planting decisions. In addition, if this is the case, then we have reason to believe that the program effect would remain largely the same despite the change in market conditions from the higher-price 1990 Act baseline (reflected in the February 1996 USDA baseline) to the low-price market situation of the late 1990's.

Comparisons Between Model Acreage Forecasts and March Planting Intentions, 1997-99

To assess the validity of the acreage price elasticities estimated in this study, those elasticities were used to forecast March planting intentions for major field crops under the 1996 Act policy environment. The change from 1995/96 to 1996/97 is difficult to replicate, in part, because the change in policy regime was taking place at the same time that many planting choices were being made. To avoid this difficulty, the comparison is confined to 1997-99. We compared acreage forecasts generated with the new acreage price elasticities and farmers' planting intentions released by USDA at the end of March. Model estimates use new-crop futures prices observed at planting time as the basis for price expectations.

Model acreage forecasts presented here are strictly based on acreage price elasticities estimated in this report, leaving the deviation between March intentions and model forecasts to be explained by nonprice factors and model errors. Comparisons for the 1999 crop are highlighted with illustrations here because they represent the most interesting test of the estimated acreage price elasticities in a low-price environment.

The acreage response model (based on the acreage price elasticities) generally performs well in forecasting (1) aggregate planting intentions for four major field crops and (2) plantings for individual field crops in cases where nonprice factors did not play an important role in producers' planting intentions.

In the aggregate, the acreage response model forecast 229.1 million acres of total plantings for the four major field crops (wheat, corn, soybeans, and cotton) in 1999, compared with the 228.3-million-acre planting intentions, as reported in USDA's March 1999 planting intentions report, a deviation of 0.35 percent (table 5). An important factor that might have contributed to the difference is a net increase of about 1.25 million acres enrolled in the Conservation Reserve Program (CRP) between 1998 and 1999. If the acreage model result is adjusted for the effects of the 1.25-million-acre increase in CRP enrollment on cropland availability, the adjusted model result would be 227.86 million acres, only 0.2 percent different from the March planting intentions. Based on new crop futures prices at planting time, farm prices for the four major field crops were expected to decline by an average of 14.6 percent from 1998 to 1999. The acreage response model indicated an expected decline of 1.7 percent in planting intentions for the four major field crops—to 229.11 million acres.

The model performs equally well for 1998, but the deviation between March intentions and model forecasts is greater for 1997, reaching 2.45 percent. A large portion of the deviation between the model forecasts and the March planting intentions is attributed to nonprice factors not reflected in the model. For example, agronomic practices, weather, and increased yield risk all played an important role in reducing winter wheat plantings in 1997.

Winter Wheat

Winter wheat seeded area in 1999 was estimated by USDA in the March planting intentions report to total 43.4 million acres—the smallest since 1972 and down 7 percent from the 46.6 million estimated for 1998 (USDA, 1999). The most significant factor contributing to the decline was a lower wheat price expected by producers, especially for soft red winter (SRW) wheat. Based on July 1999 new-crop futures prices at Kansas

Table 5—Comparisons between model acreage forecasts and March planting intentions

Crop	March intentions	Model forecast	Deviation
	Million acres		Percent
1997			
Winter wheat	48.23	49.94	+3.55
Spring wheat	20.96	20.23	- .73
Corn	81.42	78.77	- 3.25
Soybeans	68.80	63.60	- 7.56
Cotton	14.48	15.62	+7.87
Subtotal	233.89	228.16	- 2.45
1998			
Winter wheat	46.64	49.38	+2.74
Spring wheat	20.39	21.26	+4.27
Corn	80.78	81.79	+1.25
Soybeans	72.00	67.64	- 6.06
Cotton	13.22	14.19	+7.34
Subtotal	233.03	234.26	+ .61
1999			
Winter wheat	43.40	44.25	+1.96
Spring wheat	19.63	20.02	+1.99
Corn	78.22	79.76	+1.54
Soybeans	73.11	71.63	-2.02
Cotton	13.94	13.45	-3.50
Subtotal	228.30	229.11	+ .35

City in mid-October 1998, the expected harvesttime farm price for 1999-crop hard red winter (HRW) wheat was estimated to decline 13.6 percent from 1998. The expected price for soft red winter (SRW) wheat based on July 1999 new-crop futures at Chicago was projected to decline even more—19.6 percent. Thus, the weighted-average expected price for winter wheat was estimated to decline 15.4 percent. Given the own-price elasticity of 0.383 for winter wheat plantings (Lin, 1999a), the reduction in the expected wheat price implied a decline of about 6 percent in winter wheat seedings from 1998, or about 2.75 million acres (based only on own-price effects).

The decline in expected prices of competing crops partly offsets the effect on winter wheat seedings due to the decline in the expected price for winter wheat itself. For winter wheat producers, the decline in expected prices for competing crops based on new-crop futures prices in mid-October 1998 were 8 percent for sorghum and corn, 6 percent for barley, 13 percent for soybeans, and 2 percent for cotton.[21] The decline in the expected price of these competing crops altogether is estimated to add about 0.36 million acres to winter wheat seedings.

Including both own- and cross-price effects together, the acreage response model suggests a decline of 2.39 (2.75 - 0.36) million acres in winter wheat acreage from 1998, compared with a decline of 3.24 million acres estimated by USDA in March 1999. Thus, the model projected winter wheat acreage to total 44.25 million acres—2.0 percent more than the 43.4 million acres estimated by USDA in March. Because March planting intentions include producers' response to nonprice factors as well, the discrepancy could be attributed to the effect on wheat plantings of poor weather that would have prevented the seeding of some HRW acres and an increase in CRP enrollment from wheat land.

[21]The expected prices for sorghum and barley are linked to the expected price of corn based on historical relationships between sorghum and corn prices, and between barley and corn prices. As a result, the expected sorghum price is estimated to follow 100 percent of the change in the expected corn price, and the expected barley price follows 77.3 percent of the change in the expected corn price.

The deviation between model forecasts and March intentions was greater for 1997 and 1998 winter wheat plantings, reaching 3.6 and 2.7 percent, respectively. HRW wheat area seeded in 1998 declined from 1997 levels due primarily to unfavorable weather conditions and an increase of wheat land in CRP enrollment. Virtually all HRW States planted less 1998-crop wheat than they did in 1997. Poor weather prevented some plantings in Montana, which reduced 1998 winter wheat plantings to 1.4 million acres, down from 2.2 million in 1996 and 1.6 million in 1997. Heavy winterkill during 1995-96 and good returns for corn and soybeans reportedly reduced incentives to plant winter wheat (USDA, 1998a). HRW seeded area in Kansas alone was down 700,000 acres from 1997, reflecting chiefly weather-related effects. Several States "ranging from Arkansas to South Carolina did not get all of the previously intended winter wheat in because of wet weather..." (USDA, 1998b). In addition, wheat acres enrolled in the CRP reached 9.7 million acres, up from 9.1 million in 1997. The effects of these nonprice factors could have reduced winter wheat plantings by as much as 2.3 million acres—a large proportion of the deviation (2.7 million acres) between model forecasts and March intentions for 1998

For 1997-crop winter wheat, agronomic practices, weather, and increased yield risk all played an important role in reducing winter wheat plantings (as shown in the March intentions report) to 48.2 million acres, down from 52.0 million in 1996. Late row crop (soybeans in particular) harvest and wetness presented problems in the Plains States and major SRW wheat States. In addition, high yield risk in years prior to 1997 also discouraged producers from growing SRW wheat. These factors, which are not reflected in the acreage response model, might have explained a large proportion of the deviation between model forecasts and March intentions for 1997-crop winter wheat plantings.

Spring Wheat

Spring wheat (including durum) planting intentions in 1999 were estimated by USDA in March 1999 at 19.6 million acres—a decline of 0.8 million acres from 1998's planting intentions, but only 0.3 million acres less than actual 1998 plantings. This projected decline from 1998 intended acreage reflects a decline in the expected price not only for hard red spring (HRS) wheat but also for durum wheat. The acreage response model helps explain the reduction from the previous year's planting intentions.

As of March 15, 1999, the September futures price for HRS at the Minneapolis Grain Exchange settled at $3.56 per bushel—down 9.2 percent (in farm price equivalent) from the September futures price in March 1998. The farm price expected for durum wheat declined even more, by 17.4 percent. Thus, the weighted average price expected for total spring wheat declined by about 10.83 percent. This price decline implies a 3.15-percent decrease in total spring wheat acreage (about 0.64 million acres) based on the 0.291 own-price elasticity (Lin, 1999a). The 9.2-percent decline in 1999 new-crop futures price for HRS wheat was expected to lower HRS wheat plantings. In contrast, an attractive revenue insurance coverage guarantee for durum wheat in 1999 attracted durum plantings, despite the lower expected market price.

The decline in the expected price for competing crops (such as barley, corn, and soybeans) partly offsets the effect on spring wheat plantings due to the decline in the expected price for spring wheat itself, by adding about 0.28 million acres. Thus, including both own- and cross-price effects together, based on market conditions as of March 15, 1999, the acreage response model suggests a slight decline in 1999's spring wheat planting intentions from 1998, to 20.02 million acres—compared with the March planting intentions estimate of 19.63 million acres.

Corn

Planting intentions for corn were estimated by USDA to total 78.2 million acres in March 1999, down 2.6 million from 1998's intentions. The most significant factor contributing to the decline is the 15.3-percent decline in the expected harvesttime farm price for corn, based on December 1999 new-crop futures prices at Chicago in mid-March 1999. Given the own-price elasticity of 0.301 for corn, the decline in the expected corn price implies a decline of 4.6 percent in corn plantings from 1998, or about 3.73 million acres.

The decline in the expected price of competing crops only partly offsets the effect on corn plantings due to the decline in the expected corn price. For corn producers, the decline in expected prices for competing crops based on new-crop futures prices in mid-March 1999 were 16.5 percent for soybeans (calculated at the $5.26 per bushel loan rate), 13.2 percent for wheat, 15.3 percent for sorghum, and 11.3 percent for cotton. The decline in the expected price of these competing crops together is estimated to add about 2.71 million acres to corn plantings, of which 1.88 million were attributed to the decline in the expected soybean price. Combining own- and cross-price effects suggests a model forecast of 79.8 million acres for 1999 corn planting intentions, compared with the 78.2 million-acre planting intentions estimate.

A large proportion of the deviation between the price-based model forecast and March intention for 1999 corn planting intentions might have been attributed to concerns over aflatoxin (a fungus in corn crops) in the South that reportedly could have lowered 1999 corn plantings by about 1 million acres.[22]

Soybeans

U.S. farmers intended to plant a record 73.1 million acres of soybeans in 1999, as reported by USDA's March 1999 *Prospective Plantings,* which reflects a continued steady upward trend in soybean acreage since implementation of the 1996 Act. On March 15, new-crop soybean futures (November contract) settled at $4.90 per bushel, down 25 percent from the March 1998 quote. So why did soybean acreage continue to expand when farmers faced a dramatic price decline? The increase in planting intentions from 72 million acres in 1998 to 73.1 in 1999 can be accounted for by three factors.

The change in the expected farm price for soybeans, including the incentive offered by marketing loan provisions, is the most important factor that affected 1999 soybean plantings (Lin, 1999b). Despite the 25-percent decline in new-crop soybean futures prices between 1998 and 1999, the soybean marketing loan program guaranteed farmers a price of approximately $5.26 per bushel. As a per-unit price guarantee, the program essentially reduces the decline in the expected soybean farm price to producers from 25.3 percent to 16.5 percent. Given the 0.268 own-price elasticity for U.S. soybeans, the change in soybean's own-price expectations means that 1999 soybean plantings would be reduced by 4.38 percent, or 3.15 million acres.

Partially offsetting this decline is the effect of lowered expected prices for competing crops, which encourage soybean plantings. The combined effect of lower prices for corn (down 15.3 percent), wheat (down 15.6 percent), sorghum (down 15.3 percent), and cotton (down 11.3 percent) resulted in a projected model increase of 2.76 million acres in soybean plantings in 1999, offsetting much of the soybean own-price effect. The expected corn price has the biggest impact (nearly 2.5 million acres), with the acreage price elasticity showing that soybean plantings rise 0.23 percent for each 1-percent decline in the price of corn. Combining own- and cross-price effects suggest a model forecast of 71.6 million acres for 1999 soybean planting intentions, compared with the 73.1 million estimated by USDA in the March 1999 intentions report.

Part of the 1.5-million-acre difference between the model forecast and reported planting intentions may reflect the fact that some farmers had greater cost savings in input use for soybeans than other crops, particularly with the recent introduction of herbicide-tolerant varieties.

Cotton

Planting intentions for the 1999 cotton were estimated by USDA in March 1999 to total 13.94 million acres, up 0.72 million from 1998's planting intentions report. The most significant factor contributing to the change in plantings was the lower cotton price expected by producers. As of March 15, 1999, December 1999 new crop futures had settled at 59.15 cents per pound in New York, for a 56.65 cents per pound farm price equivalent. The expected cotton farm price represents a 19.0-percent decline from the expected farm price based on March 1998 futures quotes. However, the 52 cents per pound loan rate plus the fact that domestic cotton prices could be 10 cents per pound higher than the world price suggest an effective price to producers of about 62 cents per pound. Hence, the effective cotton farm price in 1999 suggests only a decline of 11.3 percent in the expected producer price. Given the estimated price elasticity of 0.469, this decline in price implies a 5.3-percent (or 0.7 million acres) drop in cotton plantings.

The decline in the expected price of competing crops more than offsets the effect on cotton plantings due to the decline in expected cotton prices. For cotton producers, the decline in the expected price of competing crops (corn, wheat, sorghum, and soybeans) contributed to an increase of 0.93 million acres in cotton plantings. Combining own- and cross-price effects suggests a model forecast of 13.45 million acres for 1999 cotton planting intentions, compared with the

[22] In early February 1999, agronomists saw large cuts in corn acreage in the Delta, Southeast, and Southern Plains regions due to concerns over aflatoxin. They reported that "... All together production of early harvested corn should be sharply lower, with planted acreage from these southern States near 3.17 million, compared to 4.05 million in 1998" (*Knight-Ridder MoneyCenter,* Feb. 1, 1999).

13.94 million estimated by USDA in the March 1999 intentions report.

A large portion of the 0.5 million-acre deviation between the model forecast and March intention can be attributed to the effect of nonprice factors, such as aflatoxin for corn crops, on 1999 cotton plantings. Concerns over aflatoxin for corn crops in the South appeared to have caused farmers to switch a part of corn land into cotton plantings.

Comparisons of the POLYSYS Simulation Results Between "High-Price" and "Low-Price" Scenarios, 1997-98

The comparison between model acreage forecasts and March planting intentions reported above is intended to examine whether the acreage price elasticities accurately "forecast" planted acreage (in terms of planting intentions) for major field crops in 1997-99. In this section, the focus is shifted to address whether the effects of increased planting flexibility in the 1996 Act scenario (relative to the February 1996 USDA high-price baseline) on planted acreage, remain intact in low-price market conditions.

To address that issue, this section first compares the POLYSYS simulation results between the February 1996 USDA baseline and the 1996 Act scenario (through increased planting flexibility) under higher price market conditions reflected in the February 1996 USDA baseline, as reported earlier in the simulation analysis section of this report. Then, it compares the POLYSYS simulation results between the two policy scenarios under lower prices to analyze the effect of increased planting flexibility under the 1996 Act scenario on planted acreage with those market price conditions. Lower market prices are simulated in these scenarios by replacing projected crop yields and exports from the February 1996 USDA baseline with actual data in 1996 through 1998. Provisions of previous farm programs that could be triggered by lower prices, such as ARPs, are assumed in the simulations to be unchanged from the February 1996 USDA baseline.

Lower market prices in these scenarios are not reduced to levels that result in marketing loan benefits, thus allowing a comparison of planting flexibility impacts across a range of prices where supply response is based on market signals. For example, corn farm prices in 1998/99 are simulated at $2.34 per bushel under the 1990 Act scenario, lower-price conditions, compared with the $2.60 per bushel in the February 1996 USDA baseline (1990 Act baseline, higher-price conditions). Similarly, corn farm prices in 1998/99 are simulated at $2.40 per bushel under the 1996 Act scenario, lower-price conditions, compared with the $2.69 per bushel under the 1996 Act scenario, higher-price conditions.

Except for the wheat results in 1998, virtually all of the POLYSYS simulation results show that the program effect—the change in planted acreage as a result of increased planting flexibility under the 1996 Act scenario (relative to the 1990 Act baseline)—would remain quite similar in high-price and low-price scenarios (table 6). The program effect for wheat under the low-price scenario is estimated to reduce wheat plantings by 0.9 million acres, down from a reduction of 1.7 million acres under the high-price scenario.

Table 6—Comparisons of the POLYSYS simulation results between "high-price"and "low-price" scenarios, 1997-98

Crop (1)	Market condition (2)	1990 Act scenarios (3)	1996 Act scenarios (4)	Difference (5)=(4)-(3)
		Million acres		
1997				
Wheat	High-price	73.5	72.2	-1.3
	Low-price	74.2	72.9	-1.3
Corn	High-price	80.0	78.1	-1.9
	Low-price	79.2	77.4	-1.8
Soybeans	High-price	61.5	64.2	+2.7
	Low-price	62.7	65.1	+2.4
Cotton	High-price	14.4	15.6	+1.2
	Low-price	14.1	15.3	+1.2
1998				
Wheat	High-price	73.7	72.0	-1.7
	Low-price	71.3	70.4	- .9
Corn	High-price	80.0	79.2	- .8
	Low-price	78.7	78.1	- .6
Soybeans	High-price	61.5	63.2	+1.7
	Low-price	63.1	64.5	+1.4
Cotton	High-price	14.1	15.2	+1.1
	Low-price	14.1	15.4	+1.3

Conclusions

Because the 1996 Act allows farmers nearly complete planting flexibility, own- and cross-price acreage elasticities (measures of a producer's production/acreage response to changes in crop prices) for major U.S. field crops are greater, in most cases, under the 1996 Act than those estimated under previous legislation. The increase in acreage price elasticities over previous legislation (especially compared with those estimated for 1986-90) reflects the 1996 Act's removal of both the institutional barriers (including base acreage protection) and the economic barriers (concerns over government payments) to greater planting flexibility for crop producers.

In percentage terms, cross-price acreage elasticities estimated under the 1996 Act generally increase even more than own-price elasticities. This implies that farm commodity programs in the past might have restricted acreage shifts from program crops to other crops.

Simulation results using a U.S. agricultural sector model indicate that the aggregate impact of the 1996 Act on area planted to the eight major field crops (wheat, corn, sorghum, barley, oats, soybeans, cotton, and rice) is small when compared with plantings under a continuation of the 1990 Act. The effect of the 1996 Act on planted acreage for individual crops differs by commodity and has the least impact on U.S. wheat acreage. Due to small changes in acreage price elasticities between the 1996 Act and 1990 Act, U.S. wheat planted acreage under the 1996 Act scenario, on average, differs very little during the 1996-2005 simulation period from the 1990 Act baseline. Corn acreage expansion in the Central and Northern Plains, a long-term trend in this important wheat production region, would contract under the 1996 Act. In contrast, soybean acreage expansion in this region would accelerate under the 1996 Act.

The change in farm legislation is simulated to have its biggest acreage impact on soybeans—an increase of over 2 million acres under the 1996 Act through the 1996-2005 simulation period. Nearly full planting flexibility allows corn producers to make a switch from corn to soybeans. Greater planting flexibility under the 1996 Act would lower corn planted acreage by an average of 1-2 million acres from the 1990 Act baseline but increase upland cotton acreage by 0.7 million acres.

The effect of the farm legislation change on regional production patterns of major field crops varies, ranging from the smallest for wheat to a more noticeable change for cotton. Overall, the effect appears to be modest. Due to a small change in wheat acreage price elasticities from the 1996 Act across production regions, regional production patterns for U.S. wheat would remain largely unchanged. Corn production would be slightly more concentrated in the North Central and Southeast and Delta regions. In contrast, soybean production would be slightly less concentrated in the North Central region. In the case of cotton production, the Southeast stands to gain a larger share of U.S. acreage under the 1996 Act at the expense of the Southern Plains.

The effects of the change in 1996 farm legislation on crop acreage were initially estimated under market conditions with relatively high farm commodity prices. However, these program effects remain largely the same under a lower price market conditions. The acreage response model (using acreage price elasticities estimated in this study), in general, performs well in forecasting planted acreage for major field crops. When the deviation between model forecasts and March planting intentions is significant, much of the difference can be attributed to nonprice factors, such as weather, crop fungus, or plant disease. The model does equally well in forecasting acreage response in both high-price and low-price scenarios.

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Appendix table 1—Estimated regression coefficients in wheat acreage response on NFA by production region[1]

Region	Explanatory variable	Model I (lower bound)	Model II (upper bound)
Central and Northern Plains	Wheat net returns	0.147*	0.359*
		(2.29)[2]	(1.90)
	Soybean net returns	-.028	-.005
		(-.90)	(-.17)
	Barley net returns	-.146**	—
		(-2.90)	
	Sorghum net returns	—	-.354*
			(-1.86)
Southern Plains	Wheat net returns	.632**	.749**
		(5.32)	(6.37)
	Cotton net returns	-.060*	-.062*
		(-2.18)	(-2.02)
	Corn net returns	-.072*	-.095
		(-2.44)	(-1.49)
	Sorghum net returns	-.150	-.431*
		(-1.32)	(-1.84)
North Central	Wheat net returns	.095	.169**
		(1.65)	(4.43)
	Corn net returns	-.007	-.120**
		(-.40)	(-6.63)
	Soybean net returns	-.019	-.049
		(-.65)	(-.96)
	Oat net returns	-.418**	—
		(-5.00)	
Southeast and Delta	Wheat net return	.226**	.369**
		(4.03)	(7.28)
	Soybean net returns	.265**	.417**
		(4.65)	(4.28)
	Corn net returns	-.122**	-.199**
		(-2.77)	(-2.72)

[1]Estimates for the Central and Northern Plains and the North Central regions reflect selected theoretical restrictions.
[2]Figures in parentheses are t-ratios.
— = Not applicable.
* = Significant at 5-percent level of significance.
** = Significant at 1-percent level of significance.

Appendix table 2—Estimated regression coefficients in corn acreage response on NFA by production region[1]

Region	Explanatory variable	Model I (lower bound)	Model II (upper bound)[3]
North Central	Corn net returns	0.336**	0.255**
		(4.63)[2]	(4.68)
	Soybean net returns	-.324**	-.215**
		(-4.53)	(-3.65)
	Wheat net returns	-.012	-.040
		(-1.54)	(-1.34)
Central and Northern Plains	Corn net returns	.201*	.370**
		(2.04)	(5.38)
	Wheat net returns	-.092	-.185*
		(-.85)	(-1.86)
	Soybean net returns	-.050	—
		(-1.32)	
	Sorghum net returns	-.059	-.185*
		(-1.51)	(-1.71)
Southeast and Delta	Corn net returns	.024**	.142**
		(3.57)	(7.41)
	Cotton net returns	-.026*	-.311*
		(-1.78)	(-2.13)
	Soybean net returns	-.049	—
		(-1.32)	
	Wheat net returns	-.073**	-.086**
		(-3.07)	(-3.14)
Southern Plains	Corn net returns	.095*	.205**
		(2.33)	(3.14)
	Cotton net returns	-.119**	-.216*
		(-3.54)	(-2.23)
	Sorghum net returns	-.150	-.235**
		(-1.36)	(-2.53)

[1]Estimates for the Central and Northern Plains and North Central regions reflect theoretical restrictions of symmetry and linear homogeneity.
[2]Figures in parentheses are t-ratios.
[3]Regression coefficients in Model II, in a few cases, are smaller than those in Model I; however, acreage price elasticities calculated from Model II remain larger than from Model I.
— = Not applicable.
* = Significant at 5-percent level of significance.
** = Significant at 1-percent level of significance.

Appendix table 3—Estimated regression coefficients in sorghum acreage response on NFA by production region[1]

Region	Explanatory variable	Model I (lower bound)	Model II (upper bound)
Central & Northern Plains	Sorghum net returns	0.086	0.050
		(1.23)[2]	(1.03)
	Wheat net returns	-.689**	-.470**
		(-2.68)	(-2.61)
	Corn net returns	-.088	—
		(-.81)	
Southern Plains	Sorghum net returns	.735**	.759**
		(5.10)	(4.68)
	Cotton net returns	-.048*	-.063**
		(-2.41)	(-2.99)
	Corn net returns	-.057*	-.067**
		(-2.20)	(-2.55)
	Wheat net returns	-.399*	-.419*
		(-2.05)	(-2.17)
Southeast & Delta	Sorghum net returns	.104**	.128*
		(3.07)	(2.07)
	Soybean net returns	-.243**	-.256**
		(-3.32)	(-3.31)

[1]Model I estimates for the Southeast and Delta regions reflect theoretical restriction of symmetry.
[2]Figures in parentheses are t-ratios.
— = Not applicable.
* = Significant at 5-percent level of significance.
** = Significant at 1-percent level of significance.

Appendix table 4—Estimated regression coefficients in barley acreage response on NFA by production region (with restrictions)

Region	Explanatory variable	Model I (lower bound)	Model II (upper bound)
Central and Northern Plains	Barley net returns	0.041	0.071
		(.62)[1]	(1.07)
	Corn net returns	-.101	-.116*
		(-1.68)	(-1.93)
	Sorghum net returns	-.735*	-.679*
		(-2.30)	(-2.12)

[1]Figures in parentheses are t-ratios.
* = Significant at 5-percent level of significance.

Appendix table 5—Estimated regression coefficients in oat acreage response on NFA by production region[1]

Region	Explanatory variable	Model I (lower bound)	Model II (upper bound)
North Central	Oat net returns	0.123*	—
		(2.29)[2]	
	Wheat net returns	-.123*	—
		(-2.30)	

[1]Reflects theoretical restrictions.
[2]Figures in parentheses are t-ratios.
— = Not applicable.
* = Significant at 5-percent level of significance.

Appendix table 6—Estimated regression coefficients in soybean acreage response on NFA (for program crops) by production region[1]

Region	Explanatory variable	Model I (lower bound)	Model II (upper bound)
North Central	Soybean net returns	0.324**	—
		(7.81)[2]	
	Corn net returns	-.324**	—
		(-5.19)	
Central & Northern Plains	Soybean net returns	.103*	—
		(2.18)	
	Corn net returns	-.050	—
		(-1.32)	
	Wheat net returns	-.053	—
		(-.91)	
Southeast & Delta	Soybean net returns	.132**	—
		(9.13)	
	Cotton net returns	-.234**	—
		(-2.92)	
	Corn net returns	-.054*	—
		(-2.44)	
	Wheat net returns	-.072**	—
		(-2.87)	

[1]Model estimates for the North Central and the Central and Northern Plains regions reflect theoretical restrictions of symmetry and linear homogeneity; estimates for the Southeast and Delta region reflect symmetry restriction.
[2]Figures in parentheses are t-ratios.
— = Not applicable.
* = Significant at 5-percent level of significance.
** = significant at 1-percent level of significance.

Appendix table 7—Estimated regression coefficients in cotton acreage response on NFA by production region

Region	Explanatory variable	Model I (lower bound)	Model II (upper bound)
Southern Plains	Cotton net returns	0.152**	0.277**
		(2.98)[1]	(5.38)
	Sorghum net returns	-.200**	-.306**
		(-3.73)	(-3.26)
Southeast and Delta	Cotton net returns	.032	.142**
		(1.37)	(5.38)
	Soybean net returns	—	-.370**
			(-3.19)
	Corn net returns	-.101	-.232**
		(-1.44)	(-2.91)
	Wheat net returns	-.160**	-.223**
		(-2.87)	(-2.55)

[1]Figures in parentheses are t-ratios.
— = Not applicable.
* = Significant at 5-percent level of significance.
** = Significant at 1-percent level of significance.

Appendix table 8—Acreage price elasticities for corn, soybeans, wheat, and oats in the North Central region, without theoretical restrictions

Item	1986-90	NFA acreage price elasticity		Whole-farm under 1996 Act	
		This study[1]	Adams	This study[1]	Adams
		Corn acreage elasticities			
Corn price	0.159	1.465	0.673	0.293	0.372
Soybean price	-0.088	-1.258	-0.364	-0.203	-0.213
Wheat price	-0.004	-0.149	-0.044	-0.018	—
		Soybean acreage elasticities			
Soybean price	0.254	2.440	0.835 .	0.348	0.323
Corn price	-0.213	-1.272	-0.900	-0.261	-0.273
Wheat price	-0.007	0.191	-0.088	0.004	—
		Wheat acreage elasticities			
Wheat price	0.553	0.523	0.901	0.586	0.670
Soybean price	-0.109	-0.517	-0.229	-0.149	-0.209
Oat price	—	-0.113	—	-0.098	—
		Oat acreage elasticities			
Oat price	0.430	0.041	2.199	0.460	0.546
Wheat price	-0.013	-0.527	-0.823	-0.017	—

[1]Average of Model I (lower bound) and Model II (upper bound) results.
— = Not applicable.

Appendix table 9—Acreage price elasticities for corn, soybeans, wheat, and oats in the North Central region, with theoretical restrictions[1]

Item	1986-90	NFA acreage price elasticity		Whole-farm under 1996 Act	
		This study[2]	Adams	This study[2]	Adams
		Corn acreage elasticities			
Corn price	0.159	0.995	0.673	0.248	0.372
Soybean price	-0.088	-0.843	-0.364	-0.164	-0.213
Wheat price	—	-0.113	-0.044	-0.056	—
		Soybean acreage elasticities			
Soybean price	0.254	1.286	0.835	0.298	0.323
Corn price	-0.213	-1.533	-0.900	-0.274	-0.273
Wheat price	—	—	-0.088	—	—
		Wheat acreage elasticities			
Wheat price	0.553	0.283	0.901	0.567	0.670
Soybean price	-0.109	-0.143	-0.229	-0.117	-0.209
Oat price	—	-0.090	—	-0.096	—
Corn price	-0.133	-0.228	-0.635	-0.138	-0.280
		Oat acreage elasticities			
Oat price	0.430	0.065	2.199	0.461	0.546
Wheat price	—	-0.525	-0.823	-0.030	—
Corn price	-0.181	—	-0.144	—	-0.304
Soybean price	-0.149	—	-2.625	—	-0.227

[1]Estimates from this study reflect theoretical restrictions as indicated in appendix tables 1, 2, 5, and 6.
[2]Average of Model I (lower bound) and Model II (upper bound) results.
— = Not applicable.

Appendix table 10—Acreage price elasticities for wheat, corn, soybeans, sorghum, and barley in the Central & Northern Plains

Item	1986-90	NFA acreage price elasticity		Whole-farm under 1996 Act	
		This study[1]	Adams	This study[1]	Adams
		Wheat acreage elasticities			
Wheat price	0.201	0.508	0.811	0.240	0.356
Soybean price	—-	-0.058	-0.048	-0.010	—
Sorghum price	-0.112	-0.560	-0.109	-0.072	-0.159
Barley price	-0.090	-0.652	-0.112	-0.080	-0.118
		Corn acreage elasticities			
Corn price	0.101	1.711	0.986	0.242	0.381
Wheat price	—	-0.289	-0.207	-0.041	—
Soybean price	-0.021	-0.099	-0.463	-0.027	-0.138
Sorghum price	-0.015	-0.291	-0.036	-0.040	-0.094
		Soybean acreage elasticities			
Soybean price	0.174	1.022	1.223	0.198	0.371
Wheat price	—	-0.484	-0.265	-0.042	—
Corn price	-0.197	-1.075	-0.748	-0.221	-0.321
		Sorghum acreage elasticities			
Sorghum price	0.462	0.157	1.770	0.446	-0.637
Corn price	-0.382	-0.746	-0.790	-0.401	-0.604
Wheat price	-0.157	-1.927	-0.567	-0.251	-0.220
		Barley acreage elasticities			
Barley price	0.201	0.328	2.841	0.206	0.570
Corn price	—	-1.048	-0.615	-0.062	—
Sorghum price	—	-1.258	—	-0.070	—
Wheat price	-0.098	—	-1.131	—	-0.351

[1]Average of Model I (lower bound) and Model II (upper bound) results; reflect theoretical restrictions as indicated in appendix tables 1, 2, and 6.
— = Not applicable.

Appendix table 11—Acreage price elasticities for cotton, corn, wheat, sorghum, and soybeans in the Southeast and Delta regions

Item	1986-90	NFA acreage price elasticity		Whole-farm under 1996 Act	
		This study[1]	Adams	This study[1]	Adams
		Cotton acreage elasticities			
Cotton price	0.424	0.586	0.900	0.435	0.731
Soybean price	-0.130	-0.710	-0.490	-0.183	-0.223
Corn price	—-	-0.404	—-	-0.154	—
Wheat price	-0.113	-0.335	-0.080	-0.136	-0.211
		Corn acreage elasticities			
Corn price	0.785	1.034	0.474	0.794	0.907
Cotton price	-0.360	-0.467	-0.107	-0.364	-0.642
Soybean price	-0.334	-0.180	-0.178	-0.326	-0.393
Wheat price	-0.281	-0.378	-0.024	-0.285	-0.366
		Wheat acreage elasticities			
Wheat price	0.216	1.462	2.226	0.267	0.546
Soybean price	0.136	1.611	-1.012	0.164	0.272
Corn price	-0.161	-0.942	-0.607	-0.193	-0.428
Sorghum price	—-	—	-0.092	—	-0.126
Cotton price	-0.316	—-	-1.017	—	-0.659
		Sorghum acreage elasticities			
Sorghum price	0.372	1.694	2.179	0.406	0.742
Soybean price-	-0.515	-2.288	-0.646	-0.525	-0.673
Corn price	—-	—	-0.907	—	—
		Soybean acreage elasticities			
Soybean price	0.199	0.658	0.598	0.221	0.411
Cotton price	-0.080	-1.178	-0.149	-0.095	-0.144
Corn price	-0.051	-1.127	—	-0.088	-0.144
Wheat price	—-	-0.769	-0.414	-0.008	—
Sorghum price	-0.028	—	-0.102	—	-0.055

[1]Average of Model I (lower bound) and Model II (upper bound) results; reflect theoretical restrictions as indicated in appendix tables 3 and 6.
— = Not applicable.

Appendix table 12—Acreage price elasticities for cotton, corn, wheat, and sorghum in the Southern Plains region

Item	1986-90	NFA acreage price elasticity		Whole-farm under 1996 Act	
		This study[1]	Adams	This study[1]	Adams
		Cotton acreage elasticities			
Cotton price	0.345	2.282	0.797	0.480	0.564
Sorghum price	-0.193	-0.727	-0.450	-0.231	-0.361
		Corn acreage elasticities			
Corn price	0.311	1.789	0.499	0.402	0.398
Cotton price	—	-0.363	-0.023	-0.049	-0.043
Sorghum price	—	-0.743	-0.015	-0.047	-0.021
Soybean price	-0.123	—	-0.220	—	-0.245
		Wheat acreage elasticities			
Wheat price	0.336	1.319	0.960	0.393	0.443
Cotton price	—	-0.815	-0.088	-0.073	-0.089
Corn price	—	-1.009	-0.104	-0.087	-0.064
Sorghum price	—-	-1.102	-0.109	-0.166	-0.159
		Sorghum acreage elasticities			
Sorghum price	0.604	3.034	1.314	0.728	0.766
Cotton price	-0.423	-0.952	-0.454	-0.450	-0.500
Corn price	—-	-0.845	-0.763	-0.247	-0.298
Wheat price	—-	-0.877	-0.478	-0.121	-0.171

[1]Average of Model I (lower bound) and Model II (upper bound) results.
— = Not applicable.

Appendix table 13—Acreage price elasticities for wheat in major production regions under the 1996 Act vs. previous legislation

Item	1986-90[1] (1)	1991-95[1] (2)	1996 Act[2] (3)	Percent difference (4)=(3) vs. (1)	Percent difference (5)=(3) vs. (2)
Central and Northern Plains					
Wheat price	0.201	0.271	0.240	+19.4	-11.4
Barley price	-0.090	-0.086	-0.072	- 20.0	-16.3
Sorghum price	-0.112	-0.118	-0.080	- 28.6	-32.2
Soybean price	—	-0.005	-0.010	—	+100.0
Southern Plains					
Wheat price	0.336	0.398	0.393	+17.0	- 1.3
Sorghum price	—	-0.009	-0.166	—	+1,744.4
Corn price	—	—	-0.087	—	—
Cotton price	—	-0.001	-0.073	—	+7,200.0
Soybean price	—	-0.002	—	—	—
North Central					
Wheat price	0.553	0.594	0.567	+2.5	- 4.5
Corn price	-0.133	-0.186	-0.138	+3.8	-25.8
Soybean price	-0.109	-0.118	-0.117	+7.3	-0.8
Oat price	—	—	-0.096	—	—
Southeast and Delta					
Wheat price	0.216	0.404	0.267	+23.6	-23.9
Corn price	-0.161	-0.225	-0.193	+19.9	-14.2
Soybean price	0.136	0.117	0.164	+20.6	+40.2
Cotton price	-0.316	-0.345	—	—	—

— = Not applicable.
[1]Estimates obtained by Adams.
[2]Estimates obtained from this study (average of Model I and Model II results); estimates for the Central and Northern Plains and the North Central regions reflect selected theoretical restrictions.

Appendix table 14—Acreage price elasticities for corn in major production regions under the 1996 Act vs. previous legislation

Item	1986-90[1] (1)	1991-95[1] (2)	1996 Act[2] (3)	Percent difference (4)=(3) vs. (1)	(5)=(3) vs. (2)
North Central					
Corn price	0.159	0.173	0.248	+56.0	+43.4
Soybean price	-0.088	-0.104	-0.164	+86.4	+57.7
Wheat price	—	-0.004	-0.056	—	+1,300.0
Central and Northern Plains					
Corn price	0.101	0.179	0.242	+139.6	+35.2
Wheat price	—	-0.017	-0.041	—	+141.2
Soybean price	-0.021	-0.052	-0.027	+28.6	-48.1
Sorghum price	-0.015	-0.008	-0.040	+166.7	+400.0
Southeast and Delta					
Corn price	0.785	0.837	0.794	+1.1	-5.1
Cotton price	-0.360	-0.343	-0.364	+1.1	+6.1
Soybean price	-0.334	-0.312	-0.326	-2.4	+4.5
Wheat price	-0.281	-0.253	-0.285	+1.4	+12.6
Southern Plains					
Corn price	0.311	0.311	0.402	+29.3	+29.3
Cotton price	—	-0.001	-0.049	—	+4,800.0
Sorghum price	—	-0.003	-0.047	—	+1,466.7
Soybean price	-0.123	-0.111	—	—	—

— = Not applicable.

[1]Estimates obtained by Adams.

[2]Estimates obtained from this study (average of Model I and Model II results); estimates for the Central and Northern Plains and North Central regions reflect theoretical restrictions of symmetry and linear homogeneity.

Appendix table 15—Acreage price elasticities for sorghum in major production regions under the 1996 Act vs. previous legislation

Item	1986-90[1] (1)	1991-95[1] (2)	1996 Act[2] (3)	Percent difference (4)=(3) vs. (1)	(5)=(3) vs. (2)
			Central and Northern Plains		
Sorghum price	0.462	0.642	0.446	-3.5	-30.5
Corn price	-0.382	-0.470	-0.401	+5.0	-14.7
Wheat price	-0.157	-0.196	-0.251	+59.9	+28.1
Soybean price	—	-0.026	—	—	—
			Southern Plains		
Sorghum price	0.604	0.666	0.728	+20.5	+9.3
Cotton price	-0.423	-0.344	-0.450	+6.4	+30.8
Corn price	—	-0.042	-0.247	—	+416.7
Wheat price	—	-0.021	-0.121	—	+476.2
			Southeast and Delta		
Sorghum price	0.372	0.398	0.406	+9.1	+2.0
Cotton price	—	-0.019	—	—	—
Corn price	—	-0.022	—	—	—
Soybean price	-0.515	-0.345	-0.525	+1.9	+50.7

— = Not applicable.
[1]Estimates obtained by Adams.
[2]Estimates obtained from this study (average of Model I and Model II results); Model I results for the Southeast and Delta regions reflect theoretical restriction of symmetry.

Appendix table 16—Acreage price elasticities for barley in major production regions under the 1996 Act vs. previous legislation

Item	1986-90[1] (1)	1991-95[1] (2)	1996 Act[2] (3)	Percent difference (4)=(3) vs. (1)	(5)=(3) vs. (2)
			Central and Northern Plains		
Barley price	0.201	0.645	0.206	+2.5	-68.1
Corn price	—	—	-0.062	—	—
Sorghum price	—	—	-0.070	—	—
Soybean price	—	-0.024	—	—	—
Wheat price	-0.098	-0.147	—	—	—

— = Not applicable.
[1]Estimates obtained by Adams.
[2]Estimates obtained from this study (average of Model I and Model II results).

Appendix table 17—Acreage price elasticities for oats in major production regions under the 1996 Act vs. previous legislation

Item	1986-90[1] (1)	1991-95[1] (2)	1996 Act[2] (3)	Percent difference (4)=(3) vs. (1)	Percent difference (5)=(3) vs. (2)
North Central					
Oat price	0.430	0.599	0.461	+7.2	-23.0
Wheat price	—	-0.013	-0.030	—	+130.8
Corn price	-0.181	-0.297	—	—	—
Soybean price	-0.149	-0.270	—	—	—

— = Not applicable.
[1]Estimates obtained by FAPRI (Adams).
[2]Estimates obtained from this study (Model I results); reflect theoretical restrictions.

Appendix table 18—Acreage price elasticities for soybeans in major production regions under the 1996 Act vs. previous legislation

Item	1986-90[1] (1)	1991-95[1] (2)	1996 Act[2] (3)	Percent difference (4)=(3) vs. (1)	Percent difference (5)=(3) vs. (2)
North Central					
Soybean price	0.254	0.262	0.298	+17.3	+13.7
Corn price	-0.213	-0.265	-0.274	+28.6	+3.4
Barley price	—	-0.001	—	—	—
Oat price	—	-0.002	—	—	—
Sorghum price	—	-0.002	—	—	—
Wheat price	—	-0.007	—	—	—
Central and Northern Plains					
Soybean price	0 .174	0.263	0.198	+13.8	-24.7
Wheat price	—	-0.030	-0.042	—	+40.0
Corn price	-0.197	-0.259	-0.221	+12.2	-14.7
Barley price	—	-0.010	—	—	—
Oat price	—	-0.005	—	—	—
Sorghum price	—	-0.024	—	—	—
Southeast and Delta					
Soybean price	0.199	0 .217	0.221	+11.1	+1.8
Cotton price	-0.080	-0.086	-0.095	+18.8	+10.5
Corn price	-0.051	-0.057	-0.088	+72.5	+54.4
Wheat price	—	-0.028	-0.008	—	-71.4
Sorghum price	-0.028	-0.040	—	—	—
Rice price	—	-0.015	—	—	—

— = Not applicable.
[1]Estimates obtained by Adams.
[2]Estimates obtained from this study (Model I results); estimates for the North Central and the Central and Northern Plains regions reflect theoretical restrictions of symmetry and linear homogeneity; estimates for the Southeast and Delta region reflect symmetry restriction.

Appendix table 19—Acreage price elasticities for cotton in major production regions under the 1996 Act vs. previous legislation

Item	1986-90[1] (1)	1991-95[1] (2)	1996 Act[2] (3)	Percent difference (4)=(3) vs. (1)	Percent difference (5)=(3) vs. (2)
Southeast and Delta					
Cotton price	0.424	0.419	0.435	+6.1	+3.8
Soybean price	-0.130	-0.085	-0.183	+40.8	+115.3
Corn price	—	—	-0.154	—	—
Wheat price	-0.113	-0.095	-0.136	+20.4	+43.2
Sorghum price	—	-0.002	—	—	—
Southern Plains					
Cotton price	0.345	0.263	0.480	+39.1	+82.5
Sorghum price	-0.193	-0.171	-0.231	+19.7	+35.1

— = Not applicable.
[1]Estimates obtained by Adams.
[2]Estimates obtained from this study (average of Model I and Model II results).

Appendix table 20—Acreage price elasticities for rice in major production regions under the 1996 Act vs. previous legislation

Item	1986-90[1] (1)	1991-95[1] (2)	1996 Act[1] (3)	Percent difference (4)=(3) vs. (1)	Percent difference (5)=(3) vs. (2)
Delta					
Rice price	0.373	0.418	0.733	+96.5	+75.4
Sorghum price	-0.211	-0.178	-0.466	+120.9	+161.8
Soybean price	-0.229	-0.146	-0.500	+118.3	+242.5
Southern Plains					
Rice price	0.227	0.605	0.615	+88.9	+1.7
Far West					
Rice price	0.434	1.693	0.785	+80.9	-67.6

[1]Source: Estimates obtained by Adams.

Appendix table 21—National acreage price elasticities for major field crops in the United States[1]

	Acreage price elasticity with respect to a 1-percent change in price of						
Commodity	Wheat	Corn	Sorghum	Barley	Oats	Soybeans	Cotton
Wheat	0.340	-0.046	-0.075	-0.076	-0.011	-0.010	-0.014
Corn	-0.065	0.293	-0.010			-0.145	-0.028
Sorghum	-0.168	-0.303	0.550			-0.070	-0.161
Barley	-0.075	-0.038	-0.043	0.282		-0.005	
Oats	-0.082	-0.041		-0.060	0.442		
Soybeans	-0.007	-0.229				0.269	-0.020
Cotton	-0.058	-0.072	-0.103			-0.081	0.466

[1]U.S. acreage price elasticities are weighted averages of acreage price elasticities in major production regions based on regional shares of U.S. planted acreage for each crop in 1991-95.

Appendix table 22—Price flexibility functions for the POLYSYS-ERS model by crop

Crop	Price flexibility at various stocks-to-use levels-- 0.05-0.066	0.066-0.10	0.10-0.15	0.15-0.20	0.20-0.25	0.25-0.30	0.30-0.35	0.35-0.50	0.50-0.55	0.55 -0.60	>0.60
Corn	-5.5	-4.0	-2.8	-2.0	-1.6	-1.4	-1.0	-0.8	-0.8	-0.8	-0.7
Wheat	-6.7	-3.9	-2.7	-2.0	-1.6	-1.4	-1.3	-1.1	-1.1	-1.0	-1.0
Soybeans	-2.6	-1.4	-1.1	-0.8	-0.8	-0.8	-0.8	-0.8	-0.8	-0.8	-0.8
Cotton	—	-4.0	-2.9	-2.1	-1.7	-1.6	-1.2	-1.0	-0.9	-0.9	-0.9
Rice	-3.0	-2.8	-2.2	-1.6	-1.2	-1.2	-1.1	-1.1	-1.0	-1.0	-1.0

— = Not available.

Note: These price flexibilities are derived from ERS in-house work on the price and stocks relationship for major program crops.
Price flexibilities for sorghum, barley, and oats are primarily related to corn prices based on the following relationships:

$LnPsg = -0.01748 + 0.97813\ LnPcn - 0.01760\ Ln(S/U)sg$

$LnPbr = 0.12468 + 0.77268\ LnPcn$

$LnPot = 1.43659 + 0.57235\ LnPcn - 0.44132\ Ln(S/U)ot$

where Psg, Pbr, Pot, and Pcn refer to the price of sorghum, barley, oats, and corn, respectively, and (S/U) refers to the stocks-to-use ratio.