Estimating Changes in Planted Acreage in Iowa Throughout the Planting Season

John R. Kruse and Darnell Smith

CARD Working Paper 94-WP 119
February 1994

Center for Agricultural and Rural Development
Iowa State University
Ames, Iowa 50011-1027

John R. Kruse is U.S. crops and livestock analyst with the Food and Agricultural Policy Research Institute (FAPRI), and Darnell Smith is FAPRI managing director.

This report was prepared using Word Perfect 5.1, Harvard Graphics, and Lotus 1-2-3. Production typing and final formatting by Rebecca Olson.

ABSTRACT

An econometric model of acreage planted in Iowa was developed to assess the weekly impacts of changing economic conditions on acreage distribution among crops. The results indicate that the producer takes into account changes in yield expectations and prices in determining final planting decisions and that the "flex" option has increased crop switching.

ESTIMATING CHANGES IN PLANTED ACREAGE IN IOWA THROUGHOUT THE PLANTING SEASON

Traditional econometric modeling approaches to estimating planted acreage hinge on a one-time decision by a producer given the economic conditions at that time. While these approaches may be appropriate for that particular moment, economic conditions are by no means stagnant during the planting season so producers re-evaluate their planting decisions and change their acreage distribution among crops. A comparison of prospective plantings and final planted acreage suggests this is particularly true in years where weather significantly delays planting. For example, in 1991 wet weather caused significant planting delays; only 12.5 million acres of corn were planted in Iowa compared with intentions of 13.0 million acres. However, soybean acreage in 1991 went from 8.0 million acres to 8.7 million acres planted. By comparison, weather in 1992 was relatively "normal." Subsequently, acreage planted to corn in Iowa was only 0.1 million acres lower than planting intentions. Thus, in order to make an accurate estimate of acreage planted it is important to monitor the variables that motivate changes in planting decisions throughout the planting season.

Monitoring the planting decision process throughout the planting season has become more important since the 1990 Farm Act. Among the most important changes in the 1990 Farm Act was the introduction of flex acres. The flex option gave producers the ability to plant virtually any crop, with the exception of some fruits and vegetables, on 15 to 25 percent of their base acres. This option strongly encourages farmers to respond to market conditions on this flex acreage (which may or may not favor the traditional program crop). The increased ability of producers to move acres from one crop to another without concerns about maintaining base acres increases the potential for acreage movement throughout the planting season given changing economic conditions. Thus, the flex option, in effect, gives producers greater freedom to shift acreage among crops during the planting season.

In this study, an econometric model of acreage planted in Iowa was developed to assess the weekly impacts of changing economic conditions on acreage distribution among crops. The results indicate that the farmer does take into account changes in economic conditions in determining final planting decisions. In addition, the results indicate that the flex option has increased the farmer's ability to react to expected yield reductions and changes in relative prices.

Many previous studies have developed theoretical approaches for estimating acreage response equations. However, much of the actual econometric estimation work has occurred since the 1970s. A significant portion of the early development work was done by Houck and Ryan 1972; Labys 1973; Teigen 1977; Gallagher 1978; and Baumes and Meyers 1980. More recently, Westhoff et al. 1990; Bailey and Adams 1990; and Subotnik 1990 have further advanced supply response estimation techniques. This study draws largely on the work of Westhoff and of Bailey and Adams.

Conceptual Model

In order to evaluate the Iowa producer's decision making process throughout the planting season, a weekly econometric model of Iowa planted acreage was developed. In Iowa, five principal crops are grown: corn, soybeans, oats, hay, and wheat. In the context of this analysis, wheat planted acreage is considered exogenous since it is planted in the fall rather than in the spring. Hay is also considered to be exogenous since only a portion of the hay crop is reseeded each year and weekly planting progress and prices are not available for hay. Oats planted acreage is estimated, but oats is not a strong competitor for corn and soybean acreage in Iowa due to its relatively low level of returns. Recent evidence indicates, however, that there is strong competition between corn and soybeans for acreage in Iowa and that the acreage trade-off relative to changes in expected net returns is virtually one-for-one. Changes in economic conditions throughout the planting season can swing the acreage trade-off between corn and soybeans, thus affecting acreage planted in a dynamic manner. Exceptionally good planting conditions and strong prices can stimulate producers to plant more corn than they originally intended. On the other hand, planting delays can make soybeans a very attractive alternative. It is this variability in acreage distribution between corn and soybeans that weekly forecast with the Iowa model seeks to explain.

Conceptually the Iowa model is designed to be applicable to any set of economic conditions at any time. With the model specified in a net returns format, the economic variables that determine net returns are the important factors influencing the planting decision. Of course expected net returns are determined by expected prices, expected yields, and expected variable costs. It can be argued that the producer has a very good idea of expected variable cost given that a significant proportion of the cost is incurred at planting time. Therefore, in this study, the producer's expectation of variable cost is assumed to be fixed throughout the planting season. In determining expected prices, this study makes the naive assumption that the producers use an average of the four previous weeks' prices.

Expected yields are based on planting progress and the relationship of yield with planting dates for each specific crop. If planting is delayed, expected yields may fall, but they may fall faster for longer season crops such as corn when compared with shorter season crops such as soybeans. Since planting progress is monitored on a weekly basis, the frequency of monitoring acreage planting decisions throughout the planting season is weekly.

As mentioned earlier, the model generates a different distribution of acreage planted for each distinct set of economic conditions. Therefore, each week a new acreage distribution is projected for Iowa. However, this new acreage distribution may not be applicable to all arable acres in Iowa since some producers may have already planted some or all of their acreage. To account for information on acreage already planted, the amount of acreage that can be redistributed to this new acreage allocation is restricted by planting progress. One simple way to restrict the acreage redistribution would be to allow only the estimated proportion of acreage that remains unplanted to respond to the new allocation. This method of restricting acres assumes, however, that producers are unable to adjust their remaining acreage to be planted to come up with the new allocation. This assumption is probably not too heroic when planting progress is nearly complete; but early in the season, this restriction may be inappropriate. In light of this problem, this study assumes producers can completely shift to the new acreage distribution while planting progress remains below 25 percent complete for all crops considered and then restricts the adjustment by the percentage planted when planting progress is above 25 percent complete. This in not an entirely arbitrary percentage because previous studies have analyzed a range of parameters. An additional simplifying assumption, that planting progress represents a homogenous set of producers, is also made.

One final problem with planting progress is that the number of acres on which percentage completion is based varies throughout the planting season. Planting progress reaches 100 percent by the end of the season, when final acreage planted may be considerably different from planting intentions. This problem suggests that planting intentions throughout the season must be kept in mind when evaluating the number of acres planted implied by planting progress. This is particularly important when week-to-week forecasts of Iowa acreage begin to suggest large shifts in acreage from corn to soybeans. If the March "prospective plantings" report suggests 13 million acres of corn will be planted, but the current week's forecast suggests 12 million acres planted with a reported planting progress of 40 percent, only 4.8 million acres would actually be planted when the "prospective plantings" report would have suggested 5.2 million acres planted. It is particularly important to account for this situation when planting progress advances beyond 25 percent and the restrictions on acreage allocation begin to apply.

Given the model and acreage redistribution assumptions, a new forecast of Iowa planted acreage is generated for each week. The crops considered in this study are corn, soybeans, and oats, the three primary crops in Iowa. Wheat planted acreage is considered to be exogenous since only winter wheat is grown in Iowa. As a check on the weekly acreage redistribution, Iowa's total acreage base is also monitored to determine its stability.

The Econometric Model

Since the Iowa model used to estimate planted acreage is so important in determining the acreage reallocation decision, a brief synopsis is presented here of the equations that are important to this study. All equations were estimated using ordinary least squares. A complete documentation of the FAPRI Iowa model will be available in a CARD Technical Report. In addition, greater detail on the Iowa weekly forecasting model will be documented in a CARD Technical Report. These reports will be announced by CARD/FAPRI when they are available for distribution.

The modeling approach in this study follows the basic expected net returns structure developed by Westhoff et al. 1990. Critical to any expected net returns model are the components that determine net returns: expected prices, expected yields, and expected variable costs. As discussed earlier, the expected variable costs are left fixed throughout the planting season.

In this study, a naive approach is used for expected prices where the producer expected price is simply the moving average of the previous four weeks of prices. Since Iowa prices received by farmers are not easily accessible, the relationship between monthly Iowa prices received by farmers and monthly average North Central Illinois prices reported in *The Wall Street Journal* was estimated and applied to weekly North Central Illinois data to establish weekly Iowa prices.

Expected yields are based on the relationship of potential yield with planting date and trend yields, with the planting date for each weekly forecast taken to be the date of the forecast. The relationship of expected yield with planting date for corn and soybeans was derived from data provided by Dr. Garren Benson, Iowa State University Agronomist with University Extension. The data suggest a relationship between the percentage of expected average corn and soybean yield obtainable and specific planting dates. These percentages were made using continuous cubic spline interpolation so that estimates for each day throughout the planting season can be obtained. Thus, to determine the percentage of trend yield obtainable for a given forecast, the forecast date is used as the planting date point of reference. The percentage of yield obtainable is then applied to the trend yield estimate for the crop to establish expected yield.

Once the expected prices and yields have been determined, expected market net returns for each crop and participant net returns are calculated for corn and oats. With these returns, Iowa corn, soybean, and oats planted acreage can be estimated. Iowa corn planted acreage may be broken down into parts as suggested by Figure 1. Since corn and soybeans are so competitive in Iowa it is important to keep total acreage from the combination of these two crops in mind. Corn planted acreage is made up of corn planted on participating corn base excluding flex, corn planted on eligible corn flex, acres not participating in the government program but planted on corn base, and acres not participating in the program and not planted on corn base. Since the data do not allow the division of nonbase, nonparticipating corn acres and base nonparticipating acres, these acreage types are estimated together as nonprogram planted acreage. Note that participating acres are made up of set-aside acres, 0/85 acres, flex acres, and corn program planted acreage. The figure also suggests that soybean acres can be broken down into four parts: soybeans planted on participating farms excluding flex, soybeans planted on eligible corn flex acres, soybeans planted on nonbase, nonparticipating

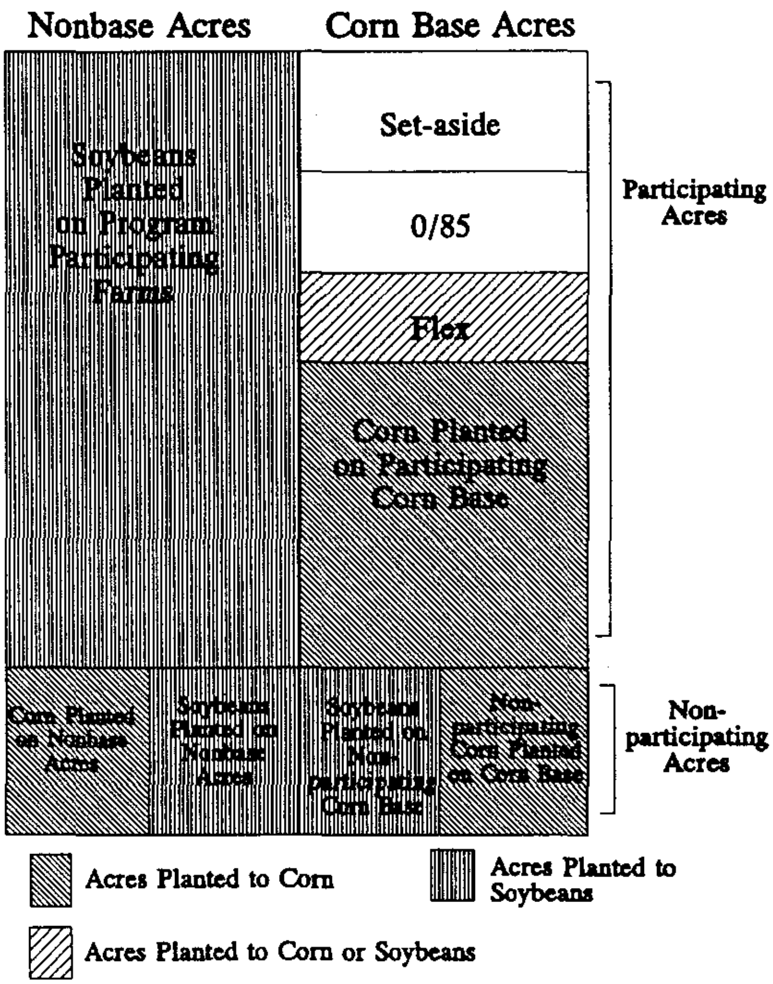

Figure 1. Iowa corn and soybean acreage

acres, and soybeans planted on corn base, non-participation acres. Since data on the breakout of soybeans planted on nonbase, nonparticipating acres and soybeans planted on corn base, nonparticipating acres are not available, these two categories are combined and estimated as soybeans planted on nonparticipating farms. Note that oat acres are not included in the figure because oat acres are not effective competitors with corn or soybeans, nor is the quality of oat acreage particularly attractive for planting corn or soybeans. With this acreage breakout in mind, each part is estimated to determine total acres planted.

Beginning with corn, program participation is estimated to determine participating corn acres. Corn program participation is specified as a function of deflated participant expected net returns for corn, deflated market net returns for corn, and deflated soybean market net returns. Participating acres are then calculated by multiplying participation rate by the number of base acres. Since participating acres are made up of set-aside, 0/85 acres, acres flexed to other crops, and program planted acreage, each of the components is estimated to determine the residual program planted acreage. Set-aside acres are calculated as participating acres multiplied by the set-aside rate. The 0/85 acres are estimated as a function of 0/85 expected net returns and market expected net returns. Flex acres are estimated as a function of the ratio of expected market net returns from soybeans and corn. Program planted acreage is computed by subtracting set-aside, 0/85 acres, and flex acres from program participating acres. Nonparticipating planted acres is the other component of total planted acreage. Nonparticipating planted acreage is estimated as a function of deflated market net returns for corn, deflated market net returns for soybeans, and participating acres.

Iowa soybean planted acres are estimated in three parts: soybeans planted on participating farms, soybeans planted on nonparticipating farms, and corn flexed to soybeans. The first part, soybeans planted on participating farms, encompasses all soybeans planted on participating farms excluding soybeans planted on flex acreage. In Iowa, this acreage is estimated as a residual since historical data indicate that soybeans planted on participating farms is a reasonably constant proportion of participating acreage. The second part, soybeans planted on nonparticipating farms, is estimated as a function of soybeans planted on complying farms, deflated soybean market net returns, and deflated corn market net returns. The third component, corn flexed to soybeans, was already estimated when corn planted acreage was estimated.

Oats planted acreage is estimated similar to corn except that oats in Iowa do not effectively compete with corn or soybeans. Thus, program participation is estimated as a function of deflated program net returns for oats and deflated market net returns for oats. Participating acres are calculated by multiplying participation rate by base acres. Participating oat acres are made up of set-aside acres, 0/85 acres, acres flexed to other crops, and program planted acres. Since the 1990 Farm Bill froze the set-aside rate for oats at 0 percent, set-aside acres are zero. Both 0/85 acres and flex acres are negligible for oats and are not estimated. Thus, participating acreage is program planted acreage for oats. Oats nonprogram planted acres are estimated as a function of deflated market net returns for oats, corn acreage idled, and the number of dairy cows on farms. Note that corn idled acreage is included in the specification to account for oats planted as a cover crop (Brandt, Kruse, and Todd 1992). In addition, notice that program planted acreage is not included in the specification of nonprogram planted acreage. Program planted acreage for oats is not statistically significant when included in the equation. This is probably due to the low level of oats program participation in Iowa.

Simulation of the Model Through the Planting Season

Forecasts of acreage planted are from the last week in March until planting is complete. The first Iowa acreage planted forecast is done before the March planting intentions report. This establishes the first benchmark from which the model can be evaluated and also establishes a benchmark from which changes in future forecasts can be evaluated. Note that in the first week of March no planting progress has been reported and expected yields are at trend levels. Thus, no restrictions are applied and acreage is fully allocated. However, as the weeks pass, the model begins to encounter constraints. The first likely constraint is the final program enrollment date. This date is usually set between April 15 and May 1. When the model advances to these dates, program participation is no longer allowed to increase.

Program participation could potentially decrease since some producers may choose not to comply, but participation cannot increase. As the planting season progresses, the model allows acreage to become planted while reductions in expected yields begin to occur. When this happens the model's estimate of acreage allocation between corn and soybeans begins to become restricted. As expected yields decline with later planting dates, net returns begin to fall. In the case of Iowa, since the optimal planting window for corn occurs early in the season when compared with soybeans, corn expected net returns begin to fall more rapidly than soybean expected net returns (see Figure 2). As acreage begins to reallocate from corn to soybeans in early June, only part of that acreage reallocation may be appropriate. Remember that by this time considerable acreage has been planted. However,

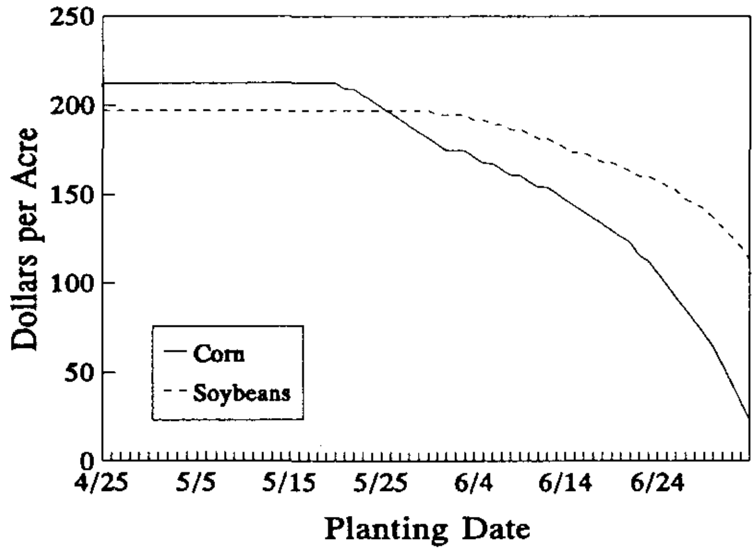

Figure 2. Market net returns over variable cost in Iowa

the model estimates acreage planted as if no acreage has been planted. The changes in acreage allocation begin to become restricted when planting progress exceeds 50 percent complete. For example, if corn acreage was 60 percent planted and the previous week's estimate of corn acreage was 13 million acres but the current week's forecast suggests only 12 million acres of corn would be planted, only 40 percent of the one million acre change would be applied to the previous week's forecast. Thus, the new acreage forecast would be 12.6 million acres of corn planted in this simple example. Of course, once planting progress reaches 100 percent complete, the model will not permit any more acreage shifts and planted acreage becomes final.

Model Simulation Results

Historical simulations of the model for 1991, 1992, and 1993 were conducted to evaluate the performance of the model in explaining the difference between planting intentions and final planted acreage. The planting intentions level for 1991 for corn and soybeans was reported to be 13 million acres and for soybeans 8 million acres in the "prospective plantings" report. With a very wet planting season in early 1991, the final January crop production report indicated that only 12.5 million acres of corn were actually planted. The data also indicated significant shifts of intended corn acreage to soybeans as corn acreage declined 0.5 million acres and soybeans increased 0.7 million.

The weekly forecasts generated by the Iowa model over the planting season are presented in Figure 3. Note how the model initially estimates corn planted acreage at close to 13 million acres of corn and 8.1 million acres of soybeans. However, as planting delays begin to occur in the second and third weeks of May expected yields for corn decline and acreage begins to shift from corn to soybeans. The model ends up with 12.6 million acres of corn planted and 8.5 million acres of soybeans planted.

Clearly, the model does not explain all of the variation in acreage planted but note how it explains the majority of the trade-off between corn and soybeans. The final planted acreage numbers suggest that the total corn and soybean planted base picked up an extra 200,000 acres from some other crop, such as oats, over the planting season. It is also interesting to note that the "preliminary sign-up" report, released May 13, 1991, reported that intended flex to soybeans from corn was 460,000 acres. On May 3, 1991, the model indicated 450,000 acres of flex from corn to soybeans. However, the "final compliance" report suggests that 655,000 acres of corn ended up being flexed to soybeans. The model suggested 634,000 acres had been flexed by the end of the planting season. It is important to note that a model based on early reports would have underestimated soybean planting by more than 200,000 acres. The model did well in explaining the change in flex acres and also reveals an important implication of the flex program. Notice that producers flexed almost an additional 200,000 acres in Iowa due to weather. This suggests that producers can now react to changing economic conditions through flex, allowing them to remain in the program without jeopardizing their program crop bases.

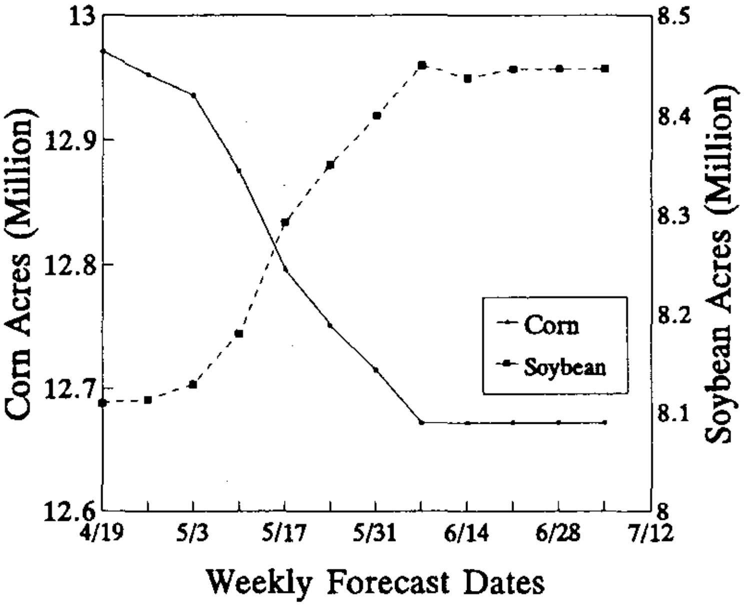

Figure 3. 1991 corn and soybean projected plantings in Iowa

The model performed even better in 1992, although not as much variation was present. The "prospective plantings" report indicated that 13.3 million acres of corn and 8.1 million acres of soybeans were intended to be planted in 1992. There was excellent weather for the 1992 planting season and 13.2 million acres of corn and 8.3 million acres of soybeans were planted. The weekly forecasts generated by the Iowa model are presented in Figure 4. On April 22, 1992, the model suggested 13.3 million acres of corn and 8.1 million acres of soybeans would be planted, identical to

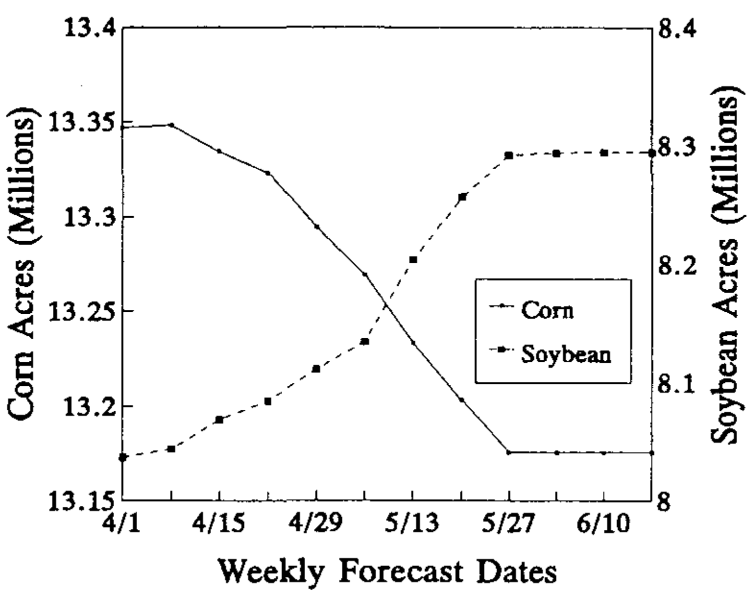

Figure 4. 1992 corn and soybean projected plantings in Iowa

the "planting intentions" report. At the end of the planting season, the model predicted 13.2 million acres of corn and 8.3 million acres of soybeans had been planted, identical to the final planted acreage reported by "crop production." Flex from corn to soybeans in the preliminary report was reported to be 443,000 acres compared with the model's estimate of 434,000 acres. Final flex acreage in the "final compliance" report was 573,000 acres compared with the model's estimate of 525,000 acres. Thus, the question arises, "With no planting delays or adverse weather, what motivated acreage to move through the planting season?" The simple answer is changing economic conditions in the form of relative price changes. Soybean prices increased almost $0.30 per bushel during the planting season while corn prices were relatively flat. Again, producers were able to respond by using their flex acreage without having to worry about maintaining their corn base.

If 1993 will be remembered for anything in the Midwest, it will be the flooding. In the March "planting intentions" report producers indicated they intended to plant 12.6 million acres of corn and 8.5 million acres of soybeans. As implied by the October "crop production" report, plantings actually ended up being 12 million acres of corn and 8.3 million acres of soybeans. Figure 5 present the results of the model simulation through the 1993 planting season. On April 20, 1993, the model suggested 12.4 million acres of corn and 8.3 million acres of soybeans would be planted. By the end of the 1993 planting season the model suggested that 11.8 million acres of corn had been planted and 8.7 million acres of soybeans. Clearly the model did not perform as well in 1993. The most significant reason for this is that the model has no equation designed to idle land when economic conditions suggest it is no longer feasible to plant. The additional soybean acreage that the model suggested was planted actually went two places—idled flex and 0/92 acres. Nearly 352,000 acres were reported enrolled in the 0/92 program and an additional 116,000 acres were reported as idled flex in the "1993 preliminary compliance" report. In addition, 599,000 acres actually flexed from corn into soybeans in Iowa according to the report, compared with the 933,000 acres suggested by the model. Thus, the addition of 334,000 acres that the model allocated as flex to soybeans were actually idled under the 0/92 program. Despite the model's inability to capture idled acreage, the soybean acreage forecast did begin to decline after June 15, 1993. This decline occurred when corn reached 100 percent planted, flex ceased, and soybean net returns began to fall with yield expectations.

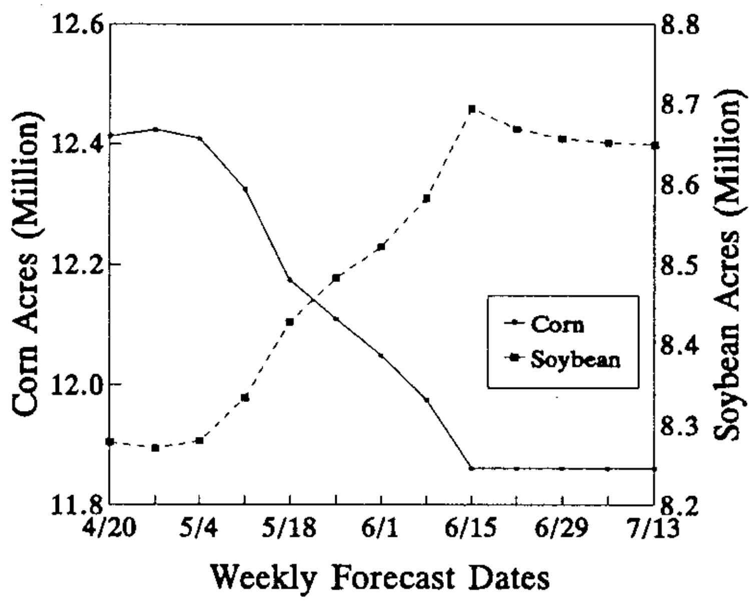

Figure 5. 1993 corn and soybean projected plantings in Iowa

Conclusions

The results indicate that the producer does take into account changes in economic conditions during the planting season in determining the final mix of acreage planted. In addition, through greater flexibility in government programs, producers have the ability to switch acreage between crops on their flex acres without having to drop out of the program and potentially lose base. The attractiveness of trading off acreage grows significantly in years with delayed plantings or significant changes in other economic conditions. The increased ease of reallocating acreage within the planting season increases the potential for error in traditional models that provide one-time acreage forecasts that do not account for changing economic conditions throughout the planting season. The methodology presented in this paper models the dynamic decision making process and illustrates the importance of incorporating current and cumulative information in applied acreage forecasting.

REFERENCES

Baily, Kenneth, and Gary Adams. 1990. "Acreage-Inducing Variables for Wheat Under Government Farm Programs, 1962-88." CNFAP Staff Report #4-90, FAPRI, University of Missouri-Columbia.

Baumes, H. S., and W. H. Meyers. 1980. "The Crops Model: Structural Equations, Definitions and Selected Impact Multipliers." NED Staff Report. Washington, D.C.: ESCS,USDA.

Benson, Garren. 1993. Personal communication. Extension Agronomist, Iowa State University, Ames.

Brandt, Jon A., John R. Kruse, and Jackie Todd. 1992. "Supply, Demand, and the Effects of Alternative Policies on the U.S. Oats Industry." *Amer. J. Agr. Econ.* 74(1992):318-328.

Gallagher, Paul. 1978. "The Effectiveness of Price Support Policy—Some Evidence for U.S. Corn Acreage Response." *Agr. Econ. Res.* 30(1978):8-14.

Houck, S. P., and Mary E. Ryan. 1972. "Supply Analysis for Corn in the United States: The Impact of Changing Government Programs." *Amer. J. Agr. Econ.* 54(1972):184-91.

Labys, W. C. 1973. *Dynamic Commodity Models: Specification, Estimation, and Simulation.* Lexington, MA: D. C. Heath and Company.

Subotnik, Abraham. 1990. "The Participation Functions and Program and Non-Program Acreage Response Functions in U.S. Feedgrains and Wheat." CNFAP Staff Report #15-90. Food and Agricultural Policy Research Institute, University of Missouri-Columbia.

Teigen, L. D. 1977. "Linked Model for Wheat, Feed Grain and Livestock Sectors of the U.S." Commodity Economics Division, Economics Research Service, USDA.

U. S. Department of Agriculture (USDA), National Agricultural Statistics Service (NASS). 1993. *Prospective Plantings*. Cr Pr 2-4 (3-93). Washington, D.C.: Government Printing Office.

__________. 1993. *Crop Production 1992 Summary*. Cr Pr 2-1 (93). Washington, D.C.: Government Printing Office.

Wall Street Journal. 1991, 1992, 1993. "Cash Prices." Wednesdays, March 1 through 2nd week July. Money and Investing, Commodities page.

Westhoff, Patrick, Robert Baur, Deborah Stephens, and William Meyers. 1990. *FAPRI U.S. Crops Model Documentation*. Center for Agricultural and Rural Development, Technical Report No. 90-TR 17. Ames: Iowa State University.