Commodity-Specific Effects of the Conservation Reserve Program

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Abstract. *A summary function describing the relationship between output level, conservation reserve program (CRP) acreage, and production costs for major U S field crops indicates that extending the CRP from 40 million to 44 million acres in 1990 could raise the bid price for CRP land by as much as 7 percent. The estimated effect on commodity prices is modest and depends largely on interactions with other farm programs Previous research has probably overstated the commodity price effects of the CRP because of insuffficient treatment of cross-commodity effects*

Keywords. *Conservation reserve, summary function, commodity prices*

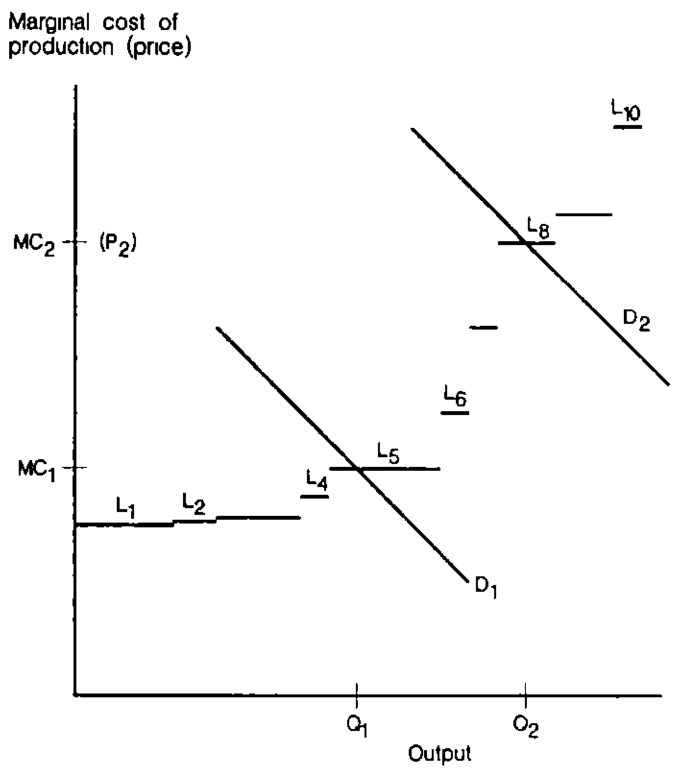
The 1985 Food Security Act introduced a conservation reserve designed to withdraw 40-45 million acres of erodible cropland from production by 1990 A conservation program of this magnitude can be expected to dramatically affect agricultural commodity markets and the cost of other farm programs In addition to reducing erosion, the program will absorb some of the excess capacity of U S agriculture, thereby bolstering farm prices and reducing program payments In a recent ERS report, Webb, Ogg, and Huang have attempted to quantify the magnitude of these effects *(15)* [1] They find that retiring 32 million acres of highly erodible cropland would significantly affect commodity prices and would probably save the Government over $5 billion a year in deficiency and storage payments Our purpose here is to refine their estimates of the likely commodity market effects of the Conservation Reserve Program (CRP) We will focus on marginal, rather than total, effects The major question is What would be the likely effects of enlarging the CRP in 1990?

Figure 1 illustrates the basic problem It shows the marginal cost of production solely as a function of land type and output level (prices and intensities of other factors are held constant) Producers are assumed to use the best land first, resulting in a step-function in which constant returns to scale apply for any given land type and marginal costs rise only as less productive land is brought into production Thus, at the level of demand depicted by D_1, the cost of production on land type L_5 determines marginal cost and thereby commodity price Ricardian rents accrue to land types L_1-L_4, and other land (L_6-L_{10}) is idled

It is easy to see that the impact of the CRP on the marginal cost of production will depend on the productivity of land withdrawn (fig 1) If the erodible land is also the least productive, there may be little effect on prices For example, at the lower level of demand, any land withdrawn from L_6-L_{10} (as well as marginal amounts from L_5) will have no price effects By contrast, the maximum backward shift in the supply curve and, hence, the largest price effect can be achieved by the withdrawal of land type L_1 Next, consider the effect of enlarging the CRP when demand is at the higher level, D_2 in figure 1 At this higher price (P_2), land types

Figure 1

Marginal production costs in a linear programming (LP) model with different land types



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[1] Italicized numbers in parentheses refer to items in the References at the end of this article

L_5 to L_7 are no longer marginal Enrolling more of this land in the CRP now affects the market price Further more, since the Ricardian rents on all land in production will be higher, bid prices for additional CRP land will also rise

We have highlighted the importance of identifying which land will be targeted by the CRP and what its potential productivity is Any modeling framework that treats land as a homogeneous input will miss the point of figure 1 entirely Webb and others *(15)* utilize a land capability classification scheme *(7)* that permits identification of both erosion potential and productivity of different land types They proceed by solving a version of the Iowa State/Center for Agriculture and Rural Development (CARD) model *(5, 11)* with the erodible land in the available base acreage The production impact of a CRP-type scheme is then assumed equal to the output produced on the erodible acreage in the base solution Another approach would involve resolving the linear programming (LP) model with the erodible acreage eliminated from the resource endowments The increased marginal cost of producing the base output vector would indicate the backward shift in the supply curve in figure 1

Neither of these approaches, however, provides any information about the shape and local behavior of the marginal cost curves of individual crops Such qualitative information can be extremely useful in evaluating the sensitivity of the results to different levels of both demand and the CRP This type of information is particularly important in light of recent proposals to extend the CRP beyond 40 million acres The summary function developed in this article systematically reveals the marginal cost functions of individual crops that are implicit in the CARD model Thus, it provides useful supplementary information to policymakers concerned about the commodity-specific effects of the CRP

Having created a summary function, we then proceed to conduct a simple multimarket equilibrium analysis for corn, wheat, and soybeans We estimate the commodity price and bid price effects of extending the CRP The results demonstrate why previous analysis *(15)* has probably overstated the commodity price effects of the CRP

Model Description and Base Case

Our study draws on the same general model structure and data base as the report of Webb and others *(15)* We employed a version of the CARD linear program that minimizes costs of crop production subject to exogenous national demands and a variety of resource constraints[2] We utilized the LP model at the 31-market-region level with the same six land groups developed for the earlier study Acreage was further grouped into three irrigation classes dry land, surface-irrigated, and ground-irrigated This grouping gives rise to 558 constraints on land availability by region, land group, and irrigation class Demands for the major crops (barley, corn, cotton, oats, sorghum, soybeans, and wheat) are treated as fixed quantities at the projected (1990) national levels, with lower bounds on commodity acreage in each region (Constraints on hay and summer fallow are set only at the national level) Upper bounds on conservation tillage acreage were set at 50 percent for each region To permit the summary function algorithm to be applied economically, we limited tillage practices to conventional practices with and without conservation tillage and with and without irrigation The resulting LP had 830 constraints, 6,582 variables, and 60,000 nonzero coefficients

A summary function is a local approximation to the LP Hence, the base solution (about which the local approximation is constructed) is important There are two key components to the 1990 baseline data set the land base and the levels of national demands[3] Table 1 details the land base, by six land groups Columns two through four identify the characteristics of each land group by capability classes, erosion potential, and relative yields Groups 1 and 3 exhibit the highest yields, while groups 4-6 have the greatest potential for erosion Group 2 has both low yield and low erosion potential

The next column in table 1 shows total acreage, by land group, as provided in the 1982 National Resources Inventory (NRI) Note that this land base totals roughly 420 million acres, almost half of which is in land group 3 The next column shows set-aside projections by land group The column total (36 3 million acres) was based on U S Department of Agriculture (USDA) projections (as of the summer of 1986) for 1990 After deducting approximately 40 million acres of conservation reserve, we computed the 1990 land base (the final column in table 1) to be 343 4 million acres

[2] The summary function technique described on pp 5 7 produces an approximation to the LP as a function of the objective coefficients In this application we construct a summary that is a function of right-side variables, that is, constraints on land and demand levels Hence, we applied the summary function technique to the dual formulation of the CARD model *(3)*

[3] Relative input prices and yields are left at the 1982 levels used in the recent application of the CARD model to an analysis of the Resources Conservation Act *(5)* Because yields will probably be higher in 1990, the marginal cost associated with projected demands for that year will be exaggerated

Table 1—Land groups, total acreages, and projected distribution across set-aside and conservation reserve

Land group	Capability classes[1]	Erosion potential	Average U S corn yield[2]	1982 NRI	Set-aside[3]	Conservation reserve[4]	1990 land base[5]
			Bushels per acre	*Million acres*			
1	I, IIWA, IIIWA	Low	109	69 4	1 9	0	67 5
2	IIW/S/C, IIIW/S/C, IVW/S/C	Low	67	106 5	14 9	5 4	86 2
3	IIE, IIIE, IVE, RKLS <50	Medium	97	194 6	16 7	17 6	160 3
4	IIE, IIIE, RKLS >50	High	85	22 0	1 5	6 4	14 1
5	IVE, RKLS >50	High	79	9 6	8	2 9	5 9
6	V, VI, VII, VIII	High or low	37	17 3	5	7 4	9 4
Total				419 4	36 3	39 7	343 4

[1]Suffix denotes dominant limitation C = climatic, E = erosion, S = shallow, droughty, or stony soil, W = wetness, WA = wetness, but adequately treated

[2]1977 yields are shown here only to illustrate differences in productivity between land groups U S average corn yield in 1977 was 102 bushels per acre, source *(7)*

[3]Based on estimated distribution in 1983, source *(2)*

[4]Based on 3T criterion (land eroding at more than three times the soil loss tolerance level) for first 2 years (15 million acres), followed by 2T for the last 3 years (25 million acres)

[5]1982 NRI (National Resources Inventory) acreage less set aside and CRP (Conservation Reserve Program)

Table 2—Actual distribution of commodity and set-aside acreage, by production region, 1983 and 1990

Item	Corn	Sorghum	Barley	Oats	Wheat	Cotton
	Percent					
Production region						
Northeast	2 8	0 1	0 3	4 2	0 3	0
Lake States	18 4	1	14 9	15 3	6 3	0
Corn Belt	48 1	8 4	0	9	5 7	1 4
Northern Plains	17 1	45 7	37 6	62 3	39 1	0
Appalachia	5 4	1 4	4	4	3 0	2 7
Southeast	3 4	2 0	2	1 9	2 3	5 2
Delta	1	2 5	0	1	2 7	19 1
Southern Plains	1 8	33 0	5	4 0	20 3	56 7
Mountain	1 4	6 6	33 0	9 0	14 9	5 2
Pacific	1 5	2	13 1	1 9	5 4	9 7
Total	100 0	100 0	100 0	100 0	100 0	100 0
	Million acres set aside					
Year						
1983	32 2	5 7	1 1	0 3	30 0	6 8
1990 (projected)	12 6	2 0	1 6	0 3	17 0	2 8

Source Based on data provided by the Agricultural Stabilization and Conservation Service, U S Department of Agriculture

Distributing Set-Aside and Crop Acreage

The procedures for estimating set-aside and conservation reserve acreage, by land group and by region, are of central importance to our study and deserve further explanation The distribution of set-aside by land group is based on national survey results from 1983 *(2)* The regional distribution of set-aside acres was based on the actual distribution for 1983 (table 2) However, set-aside projections by crop for 1990 differ from 1983 Because different regions produce crops in different proportions, the proportions of total set-aside acres by region will also differ from 1983 [4]

The distribution of conservation reserve acreage by land group and region was based on the following assumptions

(1) During the first 2 years of the conservation reserve (15 million acres), only land with an erosion potential in excess of 3T (three times the soil loss tolerance level) was eligible
(2) During the last 3 years of the CRP (25 million acres), the eligibility criterion was relaxed to 2T
(3) Eligible land is withdrawn proportionally across market regions and eligible land classes [5]

Table 3 shows projected output levels for 1990 by crop They are compatible with the ERS baseline projections as of the summer of 1986 Note that corn output is about 1 billion bushels below its 1986 level Of course, these projections are subject to continual adjustment, and part of our task was to ascertain the effect of unforeseen changes in the level of demand for one or more of these crops

Construction of the Summary Function

The summary function technique produces a local, differentiable approximation to the optimal objective of an LP as a function of the objective coefficients In the case of a cost-minimizing LP, with prices of inputs as

[4] The set aside adjustment scheme proceeds as follows First, we computed the percentage set aside for each crop in each of the 10 USDA production regions for 1983 from table 2 Second, we used projected 1990 set aside by crop to compute the 1990 set aside in the 10 production regions Third, we used the 1983 set aside shares by land type (for 1990) Fourth, we used the land base to distribute proportionally the set-asides in the production regions across the 31 market regions in the model

[5] This assumption of proportionality is problematic Because of the current structure of commodity programs, relatively less than proportionate acreage from the Corn Belt has entered the CRP *(4)* Thus, our analysis here will likely overstate the program's effect on corn prices Of course, any changes in the commodity programs before 1990 could again change the mix of land entering the CRP, possibly reversing this effect Behavioral equations governing the levels of the CRP by land group and region would ideally be used Such complexity is beyond the scope of our study

Table 3—Projected output levels, by crop, 1990

Crop	Quantity
	Million bushels
Corn	7,350
Wheat	2,475
Soybeans	2,113
Oats	532
Barley	627
Sorghum	868
	1,000 bales
Cotton	11,900
	1,000 tons
Corn silage	140,000
Sorghum silage	10,000
Legume hay	100,000
Nonlegume hay	80,000

the objective coefficients, this approximation would be expressed as a function of input prices When evaluated for given levels of input prices, the value of the summary function approximates the minimum level of costs The levels of the inputs associated with the minimum costs are also of interest When one uses a standard envelope result, the first derivative of the summary function with respect to an input price is equal to the optimal level of input use Thus, the summary function may be viewed as an approximate substitute for the LP The method is general and may be applied to any LP

The summary function is constructed by a two-step process (Technical details are found in *(12)*) First, a piecewise linear summary of the true optimal response function is constructed The "base case coefficients" define the point about which the approximation is constructed Although it is difficult to determine the entire surface of optimal objective function values as a function of objective coefficients, it is straightforward to determine the optimal objective values associated with a range of objective coefficients lying on a straight line Hence, the experimental design of a summary function analysis consists of setting the base case coefficients, defining a set of directions for changing those coefficients, and defining limits for the changes for each direction [6] Because a given basis will be optimal for a range of objective function coefficients, each LP evalua-

[6] To illustrate, consider the following example Let the base coefficients for a two-variable LP be (2,3) Let one of the directions be given as (−1,1), and let the limits for change associated with that direction be from −0 1 to 0 1 Then, the LP response would be constructed for the line segment of objective coefficient variables $(2-\alpha, 3+\alpha)$ for values of α between −0 1 and 01

tion yields a line segment of optimal objective function values and activity levels [7]

The second step in the construction of the LP summary involves estimating parameters for the differentiable approximation Once a functional form is chosen, the parameters are selected so as to minimize the square of the difference between the true optimal LP response to the objective coefficients and the differentiable summary Because the LP responses observed are for line segments of data, the estimation problem involves solving a nonlinear programming problem whose objective function is an infinite sample generalization of a least-squares curve-fitting problem

Experimental Design and the Piecewise Linear Function

Our objective is to summarize the LP's responses to variations in national demands as well as to changes in CRP acreage These responses amount to changes in right-hand sides for the CARD model Because the summary function method is designed to build summaries with respect to the objective coefficients, it was necessary to work with the dual formulation of the usual cost-minimization problem *(3)* As a result, the primal right-hand-side coefficients became objective coefficients in the dual problem The summary was then created as a function of these demand and acreage levels

To limit the amount of numerical effort, we restricted the number of variables entering the summary function We chose to make the summary a function of the national demands for corn, wheat, soybeans, and a residual category called "other crops" We also included the level of conservation reserve acreage in the function These variables were each perturbed one at a time over the range from 75 percent to 125 percent of the base values for the national crop demands and the CRP We then constructed the piecewise linear summary using a maximum of five LP evaluations per direction The selection of individual sample points is determined endogenously by the summary function algorithm (see *12* for details)

Estimation and Differentiable Summary Function

We chose the differentiable summary function fitted to the piecewise linear response surface to be translog in form, which is the most popular of the class of flexible functional forms meeting the criteria outlined by Fuss and others *(6)* Rather than estimating the shadow cost function itself, we estimated a set of share equations The individual marginal cost share equations and the associated R^2's (explained variation divided by total variation) follow corn (0 77), soybeans (0 70), wheat (0 76), other crops (0 73), and conservation reserve acreage (0 62) Together with base case costs, these share equations provide the parameters for the translog summary function given in table 4

The translog estimates must be converted into flexibilities before they can be readily interpreted (table 5) These flexibilities describe the effect (*at the base point*) of a 1-percent change in any of the quantities on the marginal cost of supplying more output or CRP acreage Several obvservations are noteworthy First all the flexibilities are positive, indicating that more output requirements or less available land always boost all marginal costs Second, the largest numbers appear in the last row of table 5, which means that the marginal cost of bidding more land into the CRP is extremely sensitive to output levels [8] For example, the

Table 4—Fitted summary function

Functional form

$$\ln Z(Y, CRP) = A_O + A_Y^T \overline{Y} + A_C \overline{CRP}$$
$$+ 1/2\, \overline{Y}^T A_{YY} \overline{Y} + 1/2\, A_{CC} \overline{CRP}^2 + 1/2\, \overline{CRP}\, A_{CY} \overline{Y}$$
$$+ 1/2\, \overline{Y}^T A_{YC} \overline{CRP}$$

where $\overline{Y}^T = (\ln y_C, \ln y_S, \ln y_W, \ln y_O)$
$\overline{CRP} = \ln CRP$, and
y_C, y_S, y_W, and y_O are outputs of corn, soybeans, wheat, and other crops, respectively, Z (Y, CRP) is the total cost, and CRP denotes total acreage in the Conservation Reserve Program

Fitted parameter values

A_O = 17 269, A_C = 034, and

A_Y^T = [0 379 0 257 0 223 0 476]

$\begin{bmatrix} A_{YY} & A_{YC} \\ A_{CY} & A_{CC} \end{bmatrix}$ =	C	S	W	O	CRP
	454	033	– 018	075	054
		367	– 002	100	054
			270	029	026
	Symmetric			801	110
					057

C = corn, S = soybeans, W = wheat, O = other crops, and CRP = Conservation Reserve Program

[7]This aspect of the problem is similar to LP "cost ranging"

[8]The estimated change in CRP bid prices is based purely on the scarcity value of the land, which in turn is based on the potential productivity of the new CRP land In early rounds of bidding for CRP contracts, the multicounty bid "caps" tended to determine the average bid levels They have often exceeded cash rents by a considerable margin *(4)* However, as more land enters the CRP, the scarcity value of the remaining land will rise (see fig 1 and table 5), and bid caps may have to be raised to enroll additional acreage Thus, the change in CRP bid prices reported here may be interpreted as the speed at which bid caps must be raised, once cash rents on remaining acreage have caught up with them

Table 5—Marginal cost flexibilities[1]

Item	Change in marginal cost due to				
	1-percent change in demand for—				1 percent increase in CRP
	Corn	Soybeans	Wheat	Other crops	
	Percent				
Marginal cost commodity production					
Corn	0 58	0 34	0 17	0 67	0 18
Soybeans	51	68	21	87	25
Wheat	30	25	44	61	15
Other crops	54	47	28	1 16	27
Marginal cost bidding for CRP land	1 96	1 84	97	3 70	0 70

[1]Percentage increase in marginal cost due to increased demand or Conservation Reserve Program (CRP) land

first number in the last row indicates that a 1-percent increase in the projected level of corn demand raises the marginal cost of CRP land by 1 96 percent The last entry in this row predicts that a 1-percent increase in conservation reserve acreage raises the expected cost of bidding in the next CRP acre by 0 7 percent Thus, at 40 million acres, the marginal cost of extending the CRP begins to increase sharply [9]

The difference in the size of flexibilities across the first four columns of table 5 is a function of the absolute magnitude of output at the base point Thus, they are largest in the "other crop" and corn columns, since a 1-percent increase in these demands places the greatest pressure on the land base Although soybean and wheat acreages are similar in the base solution, an increase in the former has a greater impact on marginal costs because soybeans compete more intensely for acreage with the other three crop categories

The final column in the flexibility matrix describes the shift in supply curves as more land is brought into the conservation reserve The upward shift in marginal costs is considerably larger for soybeans than for corn or wheat *If the effect of varying output levels on marginal costs is ignored,* this coefficient may be translated directly into a supply price change That is, a 10-percent increase in the CRP, beyond 40 million acres, will cause supply price increases of 1 8 percent for corn, 2 5 percent for soybeans, 1 5 percent for wheat, and 2 7 percent for other crops

[9]The scarcity value of additional CRP land is a function of the institutional constraints imposed on new enrollments The results reported here do not impose the 25 percent maximum on land enrolled in any given county Doing so would cut eligible acreage from 101 million to 70 million acres Adding this constraint would make the rate of increase in CRP bid prices (as output and/or CRP acreage are increased (bottom row in table 5)) even higher

Commodity Price Effects

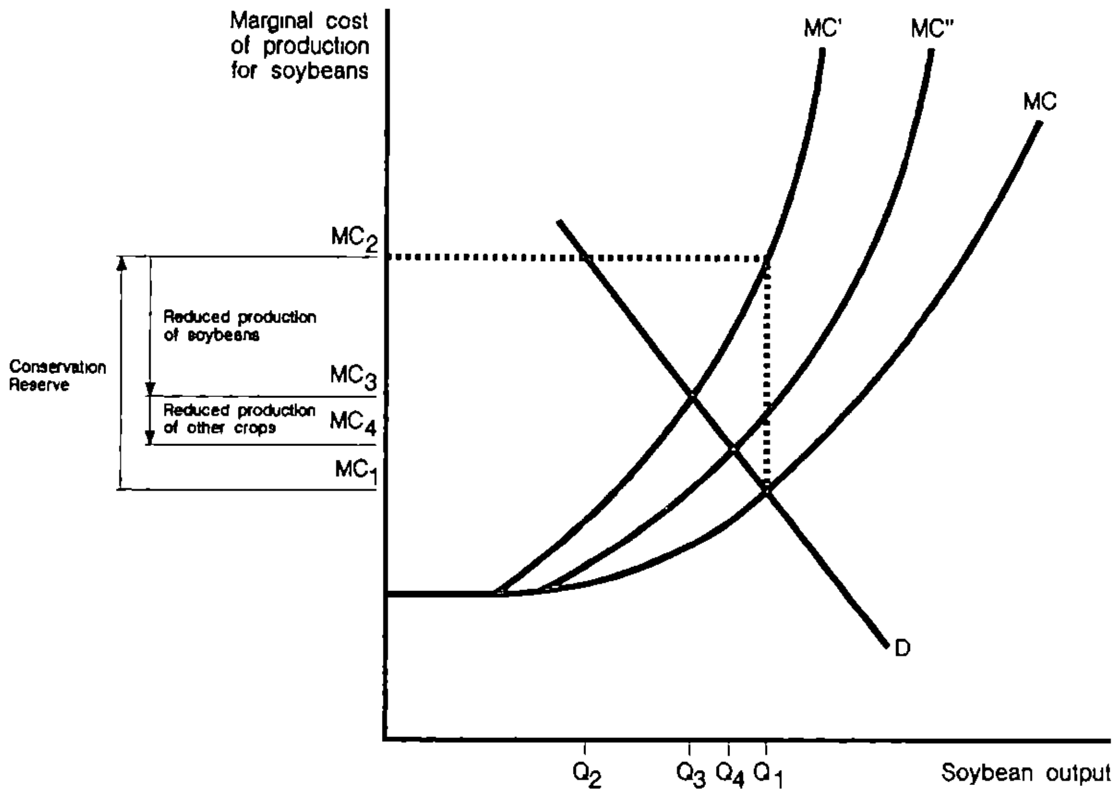
To project the likely consequences of extending the CRP in 1990, we must combine the marginal cost flexibilities already developed with information on commodity demands

Figure 2 illustrates the relevant market interactions for soybeans Here the discontinuous marginal cost relationships in figure 1 have been smoothed to reflect a continuous distribution of land types The marginal cost of producing soybeans increases along MC as output moves onto less productive land The initial equilibrium (the 1990 base case) is given by (Q_1, MC_1)

When we place additional acres under the CRP, the marginal cost curve shifts to MC′ (As noted above, the nature of this shift depends crucially on the productivity of the land withdrawn) If the quantity demanded were unchanged, the projected increase in soybean's marginal cost (due to lower yields) would be $MC_2 - MC_1$ This difference is the measure obtained by solving the CARD LP model both with and without the CRP acreage available However, since demand is not perfectly inelastic, the resulting market price for soybeans will not represent an equilibrium outcome The quantity demanded will drop to Q_3, which in turn relaxes the pressure on the land base and lowers the marginal cost of production (MC_3)

Because the CRP raises prices and reduces the output of other crops as well, the curves in figure 2 will shift In particular, the reduced competition for soybean land will shift MC′ out to MC″, further dampening the soybean price effect of the CRP (now only $MC_4 - MC_1$) (The demand curve will also shift with changes in the prices of competing commodities) This type of cross-commodity interaction can be quite important, as shown in the estimates below

Figure 2
Illustrating the feedback effect on yields and marginal costs



A Simple Equilibrium Model

Taking the partial derivatives of the shadow cost summary function (with respect to the output vector) yields a set of marginal cost equations

$$\nabla_Y Z(Y^S, CRP, \overline{W}) = MC(Y^S, CRP, \overline{W}) = P^S \qquad (1)$$

where P^S is the vector of supply prices for the four commodity groups, assuming competitive behavior. Note that these inverse supply functions explicitly incorporate information on all output levels (Y^S) and the level of the CRP, as well as input prices ($\overline{W}$ assumed here to be exogenously fixed). These functions provide a convenient summary of the supply side of the problem.[10] Furthermore, their continuously differentiable form makes them ideal for incorporation into an econometric model such as FAPSIM (*13*), thus permitting simultaneous solution of supply and demand conditions.[11]

[10] See (*10*) for a discussion of how the LP itself may be combined with an econometric demand system.

[11] Some further steps are desirable before this summary function is incorporated into a model such as FAPSIM. By summarizing the LP response with respect to feed grain and food grain set aside acreage, one can vary the marginal cost of production as a function of program participation, which is endogenous to the FAPSIM framework.

We use a simplified model of commodity markets to capture the feedback effects from output to marginal costs shown in figure 2. The following three equations are added.

$$Y^D = G(P^D, \overline{P}^O) \qquad (2)$$

$$p_i^S = p_i^D \text{ when } p_i^D > p_i^{TP}, \text{ and } p_i^S = p_i^{TP} \qquad (3)$$

Otherwise (for all commodities i)

$$Y^D = Y^S \qquad (4)$$

Equation 2 describes a vector of commodity demands as a function of a vector of endogenous prices (P^D) and any other relevant prices ($\overline{P}^O$ assumed fixed). Equation 3 describes pricing rules in the presence of target prices (p_i^{TP}). (Per-bushel deficiency payments for commodity i equal ($p_i^{TP} - p_i^D$).) Finally, commodity markets are assumed to clear. Thus, the results refer to a medium-run scenario over which no net stock accumulation occurs. Equations 1-4 may be solved for equilibrium quantities, prices, and deficiency payments, based on alternative levels of the CRP acreage.

In keeping with the local nature of the summary function approximation, the model is solved for percentage changes from the base (1990) values Totally differentiating equations 1-4 and solving for the equilibrium percentage change in commodity market prices yields

$$P^D = \{ [J - N * E]^{-1} M \} \text{ CRP} \qquad (5)$$

where N is a matrix of marginal cost-output flexibilities, E is a matrix of demand elasticities, and M is the vector of marginal cost-CRP flexibilities J is the identity matrix when $p_i^D > p_i^{TP}$ for all i, and its j^th^ diagonal element becomes zero when $p_j^{TP} > p_j^D$ CRP denotes the specified percentage change in conservation reserve acreage

The matrices N and M are generated by our summary function and have been provided in table 5 However, we have not yet specified the matrix of farm-level demand elasticities Although individual elements are available in the literature, there is little consensus about the nature of the matrix E (Brandow's work in the late fifties is an exception (*1*)) We have focused our efforts on corn, soybeans, and wheat The 3×3 matrix of demand elasticities in table 6 is based on the model presented by Hertel and Tsigas (*9*), using the methodology developed by Hertel, Ball, Huang, and Tsigas (*8*) These elasticities incorporate estimated price responsiveness in livestock, prepared feeds, and export and consumer demands Export demand elasticities are taken from (*14*) They may be viewed as medium-term elasticities, and they reflect adjustment in *all* factor and product markets Individual crops compete for crop capital and farm labor, but competition for land has not been permitted (This aspect is already captured by the flexibility matrix) Note that the own-price elasticities in table 6 range from −0 69 to −0 86 and that significant cross-price effects are present The cross-price elasticities derive from competition among crops in domestic feed use as well as in export markets (see (*14*) for a discussion of the latter effect)

Table 6—Aggregated demand elasticities[1]

Commodity	Corn	Soybeans	Wheat
		Elasticity	
Corn	−0 858	0 092	0 080
Soybeans	189	− 701	038
Wheat	381	077	− 688

[1]The following correspondence between commodity groups has been assumed feed grains=corn, oilseeds=soybeans, and food grains=wheat These farm level demand elasticities are computed from the 39-sector general equilibrium model of the U S economy presented in (*9*)

Results

Table 7 summarizes projected commodity market effects of increasing the conservation reserve by 10 percent beyond the 40-million-acre base Two alternative assumptions regarding demand-supply interactions are explored Potential interactions with commodity programs are also examined in this table In the first two columns of table 7, target prices are assumed to be nonbinding Thus, supply price equals demand price By setting the marginal cost-output flexibility matrix equal to zero, we can eliminate the feedback from output to yields This procedure is roughly equivalent to solving the LP model once with a given level of demand, using the resulting yield (marginal cost) information to predict commodity supply prices (It is analogous to the method employed in (*15*)) When the feedback effect from output to yields is ignored, prices increase by 1 8 percent for corn, 2 5 percent for soybeans, and 1 5 percent for wheat Equilibrium quantities of corn and soybeans drop by 1 2 and 1 4 percent Output of wheat drops by only 0 2 percent because of strong cross-price effects in demand This output information may be used to predict the cost effect of bringing the next acre of land into the conservation reserve The last number in the first column of table 7 shows that this increase will be relatively small (2 percent) when feedback effects are ignored

The next column of table 7 introduces the feedback effects (but not target prices) By comparing these results with those presented in the first column, we can see that ignoring the feedback from output to yields leads to an overstating of the commodity price effects

Table 7—Impact of adding 4 million acres to the conservation reserve in 1990

Item	$P^S = P^D > P^{TP}$		$p_i^{TO} > p_i^D$ Corn and wheat[1]	
	No feedback effect on yields	Complete feedback effect	Complete feedback effect	
			P^S	P^D
		Percent		
Prices				
Corn	1 8	1 1	0	3 7
Soybeans	2 5	1 5	9	9
Wheat	1 5	1 0	0	4 6
Quantities				
Corn	−1 2	− 7	−2 7	
Soybeans	−1 4	− 8	2	
Wheat	− 2	− 2	−1 6	
Marginal cost CRP	2 0	3 9	4	

[1]Change in deficiency payments corn=8 1 cents/bu (assuming p_C^{TP}=$2 75/bu, p_C^D=$2 20/bu), wheat=14 1 cents/bu (assuming p_W^{TP}=$4 00/bu, p_W^D=$3 20/bu) Output changes assume no change in set-aside acreage

of enlarging the CRP [12] This error may in turn be decomposed into that associated with movement ($MC_2 - MC_3$) down the marginal cost curve (MC′) in figure 2 and with the outward shift ($MC_3 - MC_4$) of this curve to MC″ For example, for soybeans, the 2 5-percent price hike under the no-feedback assumption is reduced in turn by -0 7 percent (own-output effect) and -0 3 percent (cross-output effect), causing prices to rise by only 1 5 percent Finally, note that incorporating these feedback effects also increases projected output, which doubles the rate of change in the marginal cost of adding to the CRP In this case, moving from 40 million to 44 million acres increases estimated bid prices by 3 9 percent

The final column in table 7 illustrates the effect of binding target prices for wheat and corn under the extreme assumption that program participation rates do not respond to increases in market prices Thus, set-aside acreage remains at the levels shown in table 1 In this case rising marginal production costs, combined with fixed target prices, cause much larger reductions in corn and wheat output As a result, market prices must rise more than they would in the absence of target prices, and deficiency payments shrink by 8 1 cents/bushel for corn and 14 1 cents/bushel for wheat These larger output reductions further shift the soybean supply curve to the right (that is, beyond MC″) Because the market prices of corn and wheat rise by so much more than the market prices of soybeans, there is a strong rightward shift in the farm-level demand for the latter Therefore, equilibrium output of soybeans actually rises, despite the increased conservation reserve acreage ($Q_4 > Q_1$ in fig 2)

Of course, participation rates in the corn and wheat programs are expected to drop in response to higher market prices, reducing set-aside acreage and further shifting these program crops' marginal cost curves to the right In effect, the Government is substituting one form of program payment for another The degree to which these two effects offset each other depends on the responsiveness of program participation rates to market prices, as well as the relative productivity of set-aside acreage

Conclusions

We have presented some estimates of the expected effects on marginal costs of production of extending the CRP beyond the minimum of 40 million acres mandated for 1990 We have also examined the likely effect on CRP bid prices A 10-percent increase in program acreage could raise the marginal cost of adding to the CRP by as much as 7 percent Thus, as attempts are made to extend the CRP, it is important to take into account the fact that per-acre rental costs will rise sharply at the margin Both types of marginal costs are shown to be extremely sensitive to the level of demand projected for 1990 A 10-percent higher corn demand would raise the marginal cost of corn production 5 8 percent, while the marginal cost of renting CRP land would increase by almost 20 percent

We combine this supply information with a set of farm-level demand elasticities to estimate the likely changes in corn, soybean, and wheat prices if the CRP is increased by another 10 percent If 1990 market prices exceed target prices, soybeans are affected most, their price rises 1 5 percent This estimate is much lower than would have been obtained in the absence of multicommodity feedback effects As a result, previous studies ignoring the feedback from output to yields have overstated the degree of price support, which in turn understates the rate of increase in bid prices as acreage is added to the CRP

Estimating the interaction effects between the CRP and traditional price and income support programs is more difficult As CRP acreage is withdrawn, marginal costs and, hence, market prices tend to rise If set-aside acreage is held constant, the output of program crops is lowered considerably However, the supply-restraining features of the program will be blunted to the extent that adding to the CRP reduces program participation and, hence, set-aside acreage Estimation of these program interactions should be a high priority for future research

[12]These numerical results use only a portion of the flexibility matrix in table 4 The row and column relating to "other crops" are omitted because a comparable demand matrix is not available If the full (4×4) output flexibility matrix were utilized, the cross-output effects would be even greater, which would further dampen the price increases

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