A Case Study of Federal Farm Commodity Programs and Sustainable Production Systems

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Abstract

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and Sustainable Production Systems

Federal farm commodity programs have been considered to be less beneficial for sustainable than conventional production systems. This research analyzed the impacts of changes in the 1990 Farm Bill on this issue. These changes increase the benefits of farm commodity program participation for sustainable farmers.

A Case Study of Federal Farm Commodity Programs and Sustainable Production Systems

Federal farm commodity programs are generally perceived as limiting use of sustainable agricultural production methods. Increases in commodity prices combined with land diversion programs are hypothesized to increase use of pesticides and fertilizers. Recently, Ribaudo and Shoemaker reviewed this literature and presented new empirical evidence supporting this hypothesis. Another set of research demonstrates that conventional rotations utilizing pesticides and fertilizer are more profitable than sustainable rotations that minimize these inputs with government program participation while the reverse holds without government program participation. These results were replicated in several production regions including the Pacific Northwest (Goldstein and Young; Young and Painter), Iowa (Duffy) and the Northern Great Plains (Dobbs, Leddy, and Smolik). These studies were completed before 1990.

In 1989, Young argued that federal commodity programs were evolving to have less incentives for use of fertilizers and pesticides; the 1990 Farm Bill continued this evolution. The cross-compliance provision that required participation in commodity programs for all program commodities was eliminated. A 15% mandatory and a 10% optional flex provision allowed participants to forego deficiency payments, plant part of their base to other crops and still maintain their base. These flex provisions allowed protection of program base; loss of program base was an additional disincentive besides current profitability for adoption of sustainable production methods with previous programs. Limited studies subsequent to 1990 showed continued bias against sustainable production systems (Faeth, et al.; Faeth). The 1996 Federal Agricultural Improvement and Reform Act eliminated the relationship between program payments and planted acres and realized prices. However, further analysis of the impact of flex provisions and cross-compliance will assist in understanding the impact of past commodity programs on adoption of sustainable production systems if similar programs are considered in the future.

This paper presents a farm firm simulation of the impact of cross-compliance and flex provisions on the profitability of participation in federal commodity programs for a conventional and sustainable production system in the Mid-Atlantic region. The 1990 Farm Bill is used for the basic parameters for the simulation. Profits from sustainable and conventional production systems are based on experimental data from the Rodale Institute Research Center in Kutztown, Pennsylvania. The simulation emphasizes both annual profits and program base from combinations of different program provisions.

Farm Program Background

For this analysis, profit (π) is defined as returns to family labor and management. Without government program participation, π is

$$(1) \qquad \pi = \sum_{j=i}^{n} A_j(Y_j P_j - C_j)$$

where A_j, Y_j, P_j, and C_j are acres, yield per acre, price, and costs per acre of crop j. Farm firms have a choice of n crops. Rotations involve particular interrelations among A_j for the crops in the rotations. All crops will not have positive A_j's for most production systems. However, sustainable production systems will include more crops in the rotation than conventional farming systems in most cases.

Government program participation results in addition of deficiency payments to (1) and several constraints on A_j for program crops. Under the 1990 Farm Bill, profits ($\bar{\pi}$) equal:

$$\bar{\pi} = \sum_{j=i}^{n} A_j(P_jY_j - C_j) + \sum_{j=1}^{m} (\mathrm{Max}(0,\ P_j^* - P_j))Y_j^*A_j^* \tag{2}$$

where P_j^*, Y_j^*, and A_j^* are the target price, fixed program yield, and acres eligible for deficiency payments, respectively, m is the number of program crops, and Max is the maximum operator. A_j^* is defined as:

ARP normal flex optional flex

$$A_j^* = \mathrm{Min}\ (A_j,\ B_j(1 - \theta_j)(1 - \delta_j)(1 - \gamma_j)) \tag{3}$$

where B_j = the program base acreage for crop j, θ_j = the set-aside for crop j, which is the percent of program base that participants must idle, δ_j = normal flex percentage of B_j, which is not eligible for deficiency payments, γ_j is the percent of optional flex, which can range from zero to a set maximum, and Min is the minimum operator. Normal flex acres can be planted to the program crop or other crops while optional flex acres are planted to other crops. These flex provisions are useful for a sustainable farmer because they allow maintenance of program base. Normally, $A_j^* < A_j$ because of the flex requirements. However, a farmer that has recently adopted sustainable rotations may have a larger base due to higher acreage under previously planted conventional rotations.

Besides introducing A_j^*, program participation places an upper constraint on A_j:

$$A_j \leq B_j(1 - \theta_j). \tag{4}$$

B_j is a simple average of crop acreage during the past five years and therefore must be given a time subscript t. B_{jt} is defined with t subscripts on other variables as follows:

current base

$$B_{jt} = \frac{1}{5} \sum_{i=t-1}^{t-5} (A_{ji} + \theta_{ji}B_{ji} + F_{ji}) \tag{5}$$

where F_{ji} = flex acres for program crop j not planted to crop j. F_{ji} and A_{ji} are related as follows:

$$F_{ji} = \mathrm{Min}(B_{ji}(1 - \theta_{ji}) - A_{ji};\ B_{ji}(1 - \theta_{ji})(\delta_{ji} + \gamma_{ji})). \tag{6}$$

$F_{ji} \leq B_j(\delta_j + \gamma_j)$

$F_{ji} \geq B_j\delta_j$

F_{ji} can be either the residual of B_{ji} and $\theta_{ji}B_{ji}$ and A_j or the maximum flex acres for the base. Flex acres allow sustainable farmers to maintain B_j. As shows in (5) and (6), other crops can be partially used to maintain B_j if A_j drops with the adoption of sustainable cropping systems. Recent research has documented that B_j does has rental and asset values (Herriges, Barickman, and Shogren; Duffy and Taylor). While estimation of similar values are beyond the scope of this research, it is recognized that program base is valued for flexibility to facilitate renewed use of conventional production methods or for sale of land to others.

The other major change in the 1990 Farm Bill was the elimination of cross-compliance among program crops. Cross-compliance required participating for all or none of the program crops. Sustainable cropping systems generally have more diverse rotations than conventional methods. If sustainable rotations include a crop such as wheat or other small grains that was not grown in the conventional rotation and is a program crop, the farm would not have a program base for the crop. Thus, program participation for even the crops historically produced was impossible. This provision in pre-1990 farm programs precluded program participation in some analyses of sustainable agriculture (e.g., Hanson, Johnson, Peters, and Janke). However, program base can be created with production during non-participation (Duffy and Taylor). Thus, cross-compliance requirements can be modeled as non-participation until a base is created.

Model Farm Situation

This research used production data from a long-term Farming Systems Trial (FST) at the Rodale Institute Research Center in Southeastern Pennsylvania. FST was originally designed to study the conversion from a conventional farming system to an organic one. FST includes three multi-year rotations for conventional cash grain, low-input cash grain, and low-input livestock. Yields, input records, and other biological data have been kept for the three FST rotations. This study utilizes data from the conventional cash grain and the sustainable cash grain systems. The sustainable cash grain rotation is nearly an organic rotation. This system uses a particular set of cultural practices which are consistent with the guidelines of most organic certification programs in the U.S.; the one exception is the use of potassium sulfate in some years. Production methods have evolved over time. In this study, yield and cultural practice data from the period 1991-94 were used. The conventional rotation was corn, corn, soybeans, corn, and soybeans. The sustainable rotation was hairy vetch winter cover and corn, winter rye cover and soybeans, and winter wheat for grain, which was initiated in 1991.

Two representative cash grain farms were used in the simulation. The two farms had similar assets with 600 acres of cropland, a 360 acre corn base, a machinery compliment, and family labor. The conventional farm planted 360 acres of corn and 240 acres of soybeans. The sustainable farm planted 200 acres each of corn, soybeans, and winter wheat (with their associated winter cover crops). Per acre returns were developed by valuing all outputs and inputs (except for on-farm labor). After 10 years of crop growth and soil investment, the average per acre return of the sustainable rotation for the period 1991-1994 was $68, $11, and $77 per acre for corn, wheat, and soybeans. Over the same period for the conventional rotation, the per acre returns were $43 and $63 for corn and soybeans, respectively. When onfarm labor is valued and the cost of the investment in the biological transition is prorated, then the per acre returns are approximately equal. Hanson et al. (1995) has a detailed discussion of these results.

Using the above data, the effects of current commodity programs on a conventional and a sustainable farm was simulated for 20 years assuming the 1991-94 profits were repeated for this period. The actual level of flex mandated by the 1990 farm bill, 15 percent normal flex and 10 percent optional flex, was used. The set-aside or ARP was 6.5% for corn and 5% for wheat which represents the average percentage over the period, 1990-1995. The ARP acres were assumed to be planted to wheat, which was not harvested, to maintain the rotation. Wheat was used here because it had the smallest annual returns of the three crops. A deficiency payment of 50 cents per bushel and $1.00 (1990-94 average) and an ASCS program yield of 97.1 bushels/acre and 41.2 bushels per acre were assumed for corn and wheat, respectively. The effects of the commodity programs were isolated by assuming that an economic, agronomic and management equilibrium has already been reached in the first year of the change to the sustainable rotation. Because program base changes over time, the net present value of income from the various alternatives was calculated and converted to an equivalent annual profits using a real discount rate of 5%. Because both farms had no initial wheat base, alternative scenarios of non-participation in both corn and wheat programs for varying time periods were simulated. The optimal action was determined as the one that had maximum equivalent annual profits.

Results

Program Base Acreage

Terminal program bases for various program alternatives are presented in Table 1. Because crop choices in the conventional rotation are unchanging, the program base acres for corn is a constant 360 acres for all alternatives. The flex provision in the farm program does not affect crop acreage in the conventional rotation but just reduces acreage for deficiency payments by 15%.

Program bases for the sustainable rotation varies with alternative program provisions. With no cross-compliance and with flex, wheat program participation had lower income than non-participation. Therefore, wheat base remained at zero. The sustainable rotation grows 200 acres of corn. The corn base begins to decline in year two and then levels off at 292 acres. It is interesting to note that the corn base reaches an equilibrium at a level that is significantly higher than the actual acres planted by the farmer. This phenomenon is attributed to the flex and ARP provisions in this alternative. In particular, 6.5% of 292 corn base acres (19 acres) is allocated to the ARP requirement and planted in winter wheat as a cover crop, which is not harvested. For the flex provisions, 25% (15% mandatory and 10% optional flex) or 73 acres is planted to soybeans (non-program crop). Consequently, with 200 acres of corn, 73 acres of soybeans planted on corn flex acres, and 19 acres of winter wheat planted as a cover crop on the corn ARP, the farmer is able to maintain a 292 acre corn base. The farmer still raises a total of 200 acres of soybeans — 73 on the corn flex and 127 on non-program acres. The farmer also raises 200 acres of wheat, but can only harvest 181 acres because 19 acres is a cover crop for ARP requirements. Without a flex provision, the base acreage reaches a lower equilibrium of 214 acres. Fourteen acres, or 6.5% of the base acreage, are planted to cover crop winter wheat. On the remaining 200 acres, the farmer raises corn. The farmer still raises 200 acres of soybeans; all 200 acres of soybeans are planted on non-program acres. The farmer raises 200 acres of wheat though only 186 can be harvested for grain. With flex plus ARP equal to 100% of base, a 360 acre base was maintained. The ARP is 23 acres of cover wheat, and 54 acres of mandatory flex and 83 acres of optional flex are planted to soybeans.

With cross-compliance, the maximum annual equivalent income is obtained with non-participation in the corn program for a few years in order to build a wheat base. A wheat base allows harvesting of wheat, which cannot be done without a base. With 200 acres of corn, the corn base is reduced each subsequent year and would be 200 acres after five years of non-participation. However, then participation and maintenance of the rotation would be impossible as a positive ARP would preclude 200 acres of corn. Therefore, non-participation for one year resulted in maximum annual equivalent income with no flex and three years with flex. Flex allowed a rebuilding of base after participation began. The terminal corn base without flex was 214 acres as with no cross-compliance.

With flex, the corn base was again higher at 232 acres. This value is lower than without cross-compliance because the base was 264 acres when program participation began rather than 360 acres. Therefore, a small ARP and flex acreage could be added to the 200 acreage corn. Terminal wheat bases were 160 and 67 with and without flex, respectively, because flex allowed three years to build wheat base compared to one for the other case.

Farm Income

Table 1 reports equivalent annual income for the sustainable and conventional farmer with different farm commodity programs provisions. In the absence of commodity program participation, the sustainable rotation had an approximate $800 advantage over the conventional — a farm income of $31,240 compared to $30,426. This difference was attributable to lower purchased production costs and comparable yields for the sustainable system (Hanson et al., 1995). The conventional farm benefited more from participation in the 1990 farm program than the sustainable farm. Income increased to $41,272 for the conventional compared to $39,109 for the sustainable. This increase was due to a deficiency payment of $13,720 compared to $9,710 for the sustainable system. Cover crop wheat cost reflects maintaining a winter cover crop on those acres satisfying the ARP requirement. The conventional farmer has a higher base acreage and therefore more expenses associated with ARP cover crops. Even though the 1990 farm program gave more benefits to the conventional farmer, it generally did not preclude the sustainable farmer from participating and receiving significant benefits. Increasing the optional flex provisions had no effect on the conventional income. For the sustainable farmer, higher flex reduced income slightly because of the increased wheat cover crop acres (and related loss of market wheat sales). In contrast, the 1990 program without flex increased farm income for both the conventional and sustainable farmers due to the increase in government payments.

Cross-compliance had no effect on the conventional farm as corn was the only program crop but does have an effect on the sustainable farmer. The relationship of this provision with flex provisions is particularly interesting and is the opposite of the cases without cross-compliance. With cross-compliance, flex allows development of a higher wheat base as discussed above. Net income actually increases slightly from the case without wheat program participation. Corn and soybean incomes are the same but the government program benefits for wheat of $7,588 more than compensate for the reduction in income from market wheat and increase in cover wheat costs. Without flex, income drops to $29,429, which is less than the non-participation case. The small feasible wheat base of 67 acres means that wheat program payments and market wheat profits are much lower, and costs of cover wheat is much higher. As these latter provisions are similar to the pre-1990 Farm Bill, government program participation was not feasible from an income perspective.

Conclusions

The 1990 Farm Bill did include provisions that benefit sustainable farmers — the flex provisions and the termination of cross-compliance. This research demonstrated that a Mid-Atlantic sustainable form with a sustainable rotation of corn, soybeans, and wheat with associated cover crops can increase income from participation in the corn but not the wheat program. However, benefits are not as much as for a conventional farmer with a corn and soybeans rotation. The ARP acreage for the corn program is planted to wheat cover crop and flex acres to soybeans so that program payments are received on all planted corn acres and the rotation can be maintained. This analysis presumes that the sustainable farmer has an initial corn base from previous conventional production that is greater than the sustainable corn acreage. Flex provisions allow the farm to maintain a corn base greater than sustainable corn production, which has future potential value. Without cross-compliance, flex provisions are not necessary to benefit from program participation — simulated income is actually higher without flex but the terminal corn base is lower. Similarly, participation is feasible with cross-compliance if flex exists. The farm can build a wheat base with non-participation for a few years and then participate in both programs. Again, income is higher than with the 1990 program, but the terminal corn base is lower. However, a simulation of pre-1990 farm programs with out flex and with cross-compliance found that participation lowered net income which replicated earlier research on this topic.

This research definitely supports the perspective of Young that farm programs were evolving to accommodate sustainable production. While farm program benefits were still greater with the conventional rotation, participation increased income for the sustainable rotation and allowed maintenance of a corn base. Elimination of cross-compliance and inclusion of flex in the 1990 Farm Bill changed the results from earlier programs. Actually, either change allowed participation and had income as high as both changes. However, one change results in a lower corn base than both. Flex seems to be marginally the most importance — increasing flex so that the ARP and flex percentages equal 100 allow maintenance of a corn base from conventional production. If commodity programs similar to the 1990 program are reinstated in the future, including flex and not including cross-compliance are beneficial for sustainable farmers at least in situations similar to those simulated in this research.

Table 1. Simulated Terminal Base Acres and Annual Equivalent Farm Incomes for a Sustainable and Conventional Rotation with Various Farm Program Provisions

	Terminal Corn Base (acres)	Terminal Wheat Base (acres)	Market Corn ($)	Corn Government Payments ($)	Market Wheat ($)	Wheat Government Payment	Market Soybeans ($)	Cover Crop Wheat ($)	Farm Income ($)	Farm Income % of 1990 Program
Organic Rotation										
Non-Program	--	--	13,662	0	2,148	--	15,430	0	31,240	79.9
1990 Program ARP (.065), Flex (.15, .10)	292	--	13,662	9,710	1,930	--	15,430	-1,623	39,109	100.0
1990 No Flex ARP (.065), Flex (0, 0)	214	--	13,662	9,710	1,975	--	15,430	-1,286	39,492	100.7
1990 High Flex ARP (.065), Flex (.15, .785)	360	--	13,662	9,710	1,897	--	15,430	-1,872	38,827	99.3
1990 Program — Cross-compliance ARP (.065), .05), Flex (.15, .10)	232	160	13,662	7,588	1,717	4,113	15,430	-3,205	39,307	100.5
1990 Program — Cross-compliance ARP (.065, .05), Flex (0, 0)	214	67	13,662	8,968	760	2,663	15,430	-10,341	30,808	78.0
Conventional Rotation										
Non-Program ARP (.065), Flex (.15, .10)	--	--	15,426	0	0	--	15,000	0	30,426	73.7
1990 Program ARP (.065), Flex (.15, .10)	360	--	14,423	13,720	0	--	15,000	-1,872	41,272	100.0
1990 No Flex ARP (.065), Flex (0, 0)	360	--	14,423	16,342	0	--	15,000	-1,872	43,893	106.4
1990 High Flex ARP (.065), Flex (.15, .785)	360	--	14,423	13,720	0	0	15,000	-1,872	41,272	100.0

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