The Profitability of Sustainable Agriculture on a Representative Grain Farm in the Mid-Atlantic Region, 1981-89

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A long-term whole-farm analysis compared conventional and low-input fanning systems. Data from a nine-year agronomic study at the Rodale Research Farm, Kutztown, Pennsylvania, were used to analyze profitability, liquidity, solvency, and risk on a representative commercial grain farm. Conventional and low-input farms participating in government programs are the most profitable scenarios, followed by conventional and tow-input farms not participating in government programs. All farms increased their net worth. The low-input approach is advantageous for risk-averse farmers using a safety-first criterion.

There has been an increased interest in sustainable farming systems nationally. Many advocate reducing purchased inputs, particularly synthetic pesticides and inorganic fertilizers. Environmental concerns, health issues related to chemical residues in foods, and increasing costs of inputs have all contributed to this interest. Research has been conducted for several years to develop various sustainable flow-input) farming systems. Some of these systems have been adopted on commercial farms, but information on these systems is still limited. The effects of low-input systems on the farm organization, farm output, and environment are also uncertain. Even more uncertain is the relative profitability of low-input systems compared to conventional farming systems.

This topic has particular significance for Middle Atlantic agriculture. The close proximity of major population centers and watersheds for the Chesapeake Bay has generated pressure on agriculture to reduce chemical residues in surface and ground waters. If low-input agriculture, which emphasizes chemical reduction, can be shown to be profitable on some farms, then contamination of surface and ground water may be reduced through its adoption. It is equally important to know why low-input agriculture may not be profitable for individual farmers.

In the 1989 publication *Alternative Agriculture,* the authors note several limitations in past efforts to evaluate the profitability of sustainable agriculture. Partial budget studies that have been conducted "focus on short-term net returns, including labor, and generally do not take into account off-farm impact or long-term changes in the productivity of the natural resource base. They also assume no change in farm size, enterprise combinations, prices of commodities or inputs, or other variables. Despite these limitations, this method is practical and easy to understand" (p. 197). Surveys, which compare low-input and conventional farms, also provide useful data but have difficulty delineating management ability among farmers, which can bias the results (p. 198). Whole-farm analyses often take a static approach, ignoring transitional costs that must be paid to move from conventional to sustainable agriculture. The uncertainty caused by weather and prices is often ignored (p. 198). In addition, the assessment of some sustainable systems is complicated by the lack of comparable data for conventional farms (p. 304).

This paper presents a whole-farm analysis of a representative Mid-Atlantic commercial grain farm under conventional and low-input scenarios. This analysis covers a time span of nine years, which

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incorporates the costs of moving from one system to another. Yields and input data are taken from the Farming Systems Experiment conducted by the Rodale Research Center in southern Pennsylvania from 1981 through 1989. In contrast to a "normalized budget" and sensitivity-analysis approach (Dobbs, Leddy, and Smolik), actual yields, prices, and costs for the 1980s were used to develop specific crop budgets for each year. Income taxes and financial considerations such as debt refinancing were also included. In addition, the effects of the government feed grain program on the conventional and low-input systems were evaluated.

Study **Background and Framework**

Rodale Research Center has been conducting a long-term farming systems experiment since 1981 (Peters, Andrews, and Janke). Three farming systems based on multiyear rotations were evaluated. These systems include conventional cash grain, low-input cash grain, and low-input livestock.

Research plots were established so that each system had three different entry points in the rotation, and each of these entry points was replicated eight times. Yields, input records, and other biological data were kept for these research plots. Published agronomic results of this study from 1981 through 1985 are available (Liebhardt et al.).

This study analyzes two of Rodale's systems—the conventional cash grain and the low-input cash grain. These two systems were expanded to four scenarios by looking at each system under the hypothetical situation of participation in the government commodity programs. A representative commercial-sized grain farm was modeled based on information from the Rodale systems. A whole-farm long-term financial analysis was conducted to examine the advantages and disadvantages of each scenario. Factors of profitability, liquidity, risk, and solvency were analyzed in a nine-year trend analysis.

The Representative Farm

A representative grain farm typical of those found in the Mid-Atlantic region was modeled. This grain farm had the following characteristics. The farm included 750 acres of tillable cropland. The machinery complement included equipment for tillage, planting, cultivating, and spraying. Grain harvesting and fertilizer/lime applications were custom hired. The farm was managed by an owner-operator with 250 hours of operator and family labor per month. Seasonal hired labor was available on an hourly basis. There was sufficient building space for machinery and hay storage. There was no on-farm grain storage. The farm started with a 22% intermediate and long-term debt-to-asset ratio (current liabilities equal zero). Fifteen years remained on the farm mortgage.

Each of the four scenarios started with the same resources. Therefore, a direct comparison could be made as to which was the most successful over the nine years. The two base scenarios—conventional grain and low-input grain—followed the cultural practices and received the yields of their respective plots in Rodale's Farming Systems Experiment. These data were adapted to the corresponding scenarios enrolled in the government feed grain programs. The four scenarios are characterized as follows (Tables 1 and 2).

1. Conventional grain farm, base scenario. This farm followed Rodale's five-year rotation of corn, corn, soybeans, corn, and soybeans. Three, 250-acre sections were planted in different entry points. Fertilizer and pesticide application rates were made following The Pennsylvania State University's recommendations given the conditions at the experimental plots. This farm did not participate in government commodity programs. The existing machinery and building complements were sufficient to operate this farm.

2. *Conventional grain farm participating in government feed grain programs, adapted scenario.* In this scenario, the conventional base scenario rotation was adapted for the feed grain program for com. The Agricultural Stabilization and Conservation Service (ASCS) base acreage for corn was 500 acres. The farm complied with the acreage-reduction requirements to receive deficiency payments. In 1985, the conventional grain farm, base scenario, planted 500 acres of soybeans and 250 acres of corn. This was changed to fit the government-program scenario of 450 acres of corn, 250 acres of soybeans, and 50 acres of set-aside land in that year. Since there was no on-farm grain storage capacity, it did not receive loan support payments. No other government-program alternatives, such as paid land diversion or 0/92, were selected.

3. Low-input cash grain farm, base scenario. This farm followed Rodale's low-input rotation of small grain/forage legume, corn, small grain/forage legume, corn, and soybeans. Three, 250-acre sections were planted in three different entry points. Pesticides and inorganic fertilizers (except potash in 1989) were not applied to these crops. This farm did not participate in government commodity programs. Besides the basic machinery complement, the farm purchased forage harvesting equipment for $24,505 in 1981. The buildings were sufficient to operate this farm.

Table 1. Crop Acreages, by Year, for the Conventional Grain Farm, Base Scenario, and the Conventional Grain Farm Adapted to Participate in the Government Feed Grain Programs, 1981-89

Year	Field One	Field Two	Field Three	Set-Aside
Conveiitional Cash ti Grain Farm, Base Scenario				
1981	Com (250 A)	Soybeans (250 A)	Corn (250 A)	
1982	Corn (250 A)	Com (250 A)	Soybeans (250 A)	
1983	Soybeans (250 A)	Corn (250 A)	Corn (250 A)	
1984	Corn (250 A)	Soybeans (250 A)	Corn (250 A)	
1985	Soybeans (250 A)	Com (250 A)	Soybeans (250 A)	
1986	Corn (250 A)	Soybeans (250 A)	Com (250 A)	
1987	Corn (250 A)	Corn (250 A)	Soybeans (250 A)	
1988	Soybeans (250 A)	Corn (250 A)	Corn (250 A)	
1989	Corn (250 A)	Soybeans (250 A)	Corn (250 A)	
Conveiitional Cash Grain Farm, Government Programs				
1981	Corn (250 A)	Soybeans (250 A)	Corn (250 A)	(OA)
1982	Corn (250 A)	Corn (200 A)	Soybeans (250 A)	(50 A)
1983	Soybeans (250 A)	Corn (250 A)	Corn (150 A)	(100 A)
1984	Corn (250 A)	Soybeans (250 A)	Corn (200 A)	(50 A)
1985	Soybeans (250 A)	Com (250 A)	Corn (200 A)	(50 A)
1986	Com (250 A)	Soybeans (250 A)	Corn (150 A)	(100 A)
1987	Corn (250 A)	Com (150 A)	Soybeans (250 A)	(100 A)
1988	Soybeans (250 A)	Corn (250 A)	Corn (200 A)	(50 A)
1989	Corn (250 A)	Soybeans (250 A)	Corn (200 A)	(50 A)

Note: "A" is acres.

Table 2. Crop Acreages, by Year, for the Low-Input Grain Farm, Base Scenario, and the Low-Input Grain Farm Adapted to Participate in the Government Feed Grain Programs, 1981-89

Year	Field One	Field Two	Field Three	Set-Aside
Low-Input Cash Grain Farm, Base Scenario				
1981	Oats/RC (250 A)	Soybeans (250 A)	Corn (250 A)	
1982	Corn (250 A)	Oats/RC (250 A)	Soybeans (250 A)	
1983	Oats/RC (250 A)	Corn (250 A)	Oats/RC (250 A)	
1984	Corn (250 A)	Wheat/RC (250 A)	Corn (250 A)	
1985	Soybeans (250 A)	Com (250 A)	Oats/RC (250 A)	
1986	Oats/RC (250 A)	Barley/SB (250 A)	Corn (250 A)	
1987	Corn (250 A)	Wheat/RC (250 A)	Wheat/SB (250 A)	
1988	Barley/SB (250 A)	Corn (250 A)	Oats/RC (250 A)	
1989	Wheat/RC (250 A)	Soybeans (250 A)	Corn (250 A)	
Low-Iinput Cash Grain Farm, Government Programs				
1981	Oats/RC (250 A)	Soybeans (250 A)	Corn (250 A)	(O A)
1982	Corn (250 A)	Oats/RC (205 A)	Soybeans (250 A)	(45 A)
1983	Oats/RC (250 A)	Corn (250 A)	Oats/RC (168 A)	(82 A)
1984	Corn (250 A)	Wheat/RC (375 A)	Corn (87 A)	(38 A)
1985	Soybeans (250 A)	Corn (250 A)	Oats/RC (2 15 A)	(35 A)
1986	Oats/RC (189 A)	Barley/SB (250 A)	Corn (250 A)	(61 A)
1987	Corn (250 A)	Wheat/RC (186 A)	Wheat/SB (250 A)	(64 A)
1988	Barley/SB (250 A)	Corn (250 A)	Oats/RC (185 A)	(65 A)
1989	Wheat/RC (2 18 A)	Soybeans (250 A)	Corn (250 A)	(32 A)

Note: RC = red clover, SB = soybeans.

4, Low-input cash grain farm participating in government feed grain programs, adapted scenario. In this scenario, the low-input base scenario rotation was adapted for the feed grain program for corn. The beginning ASCS acreage was 500 acres, but that declined in the following years. The farm complied with the acreage-reduction requirements to receive deficiency payments. In the five years when wheat or barley was planted (program crops), cross-compliance requirements were ignored. This is a conflict between participating in government programs and practicing rotational agriculture. In reality, this scenario cannot be adopted. However, it is useful to analyze what would happen if there were no such restrictions. In 1984, 500 acres of corn and 250 acres of wheat/red clover were planted in the low-input cash grain farm, base scenario. This was changed to fit the government-program scenario of 337 acres of corn, 375 acres of wheat/red clover, and 38 acres of set-aside. Since there was no on-farm grain storage capacity, it did not receive loan support payments. No other government-program alternatives, such as paid land diversion or 0/92, were selected. This farm also purchased forage harvesting equipment.

The Analysis Methodology

This financial analysis simulates what would have happened over the 1981-89 period if a representative farm with the characteristics described had followed each of the four scenarios. The following financial procedures were used for each of the four scenarios:

1. Crop enterprise budgets were developed. Rodale's farming-systems inputs and cultural practices from the different rotations were adapted to fit the 750-acre farm. Between 1982 and 1989, Rodale's replicated plot yields were reduced by 20% to better approximate yields on larger commercial farms. In 1981, 100% of plot yields were used because of the initial problems associated with establishing the trial that year. Budgets were developed that were based on Rodale's input and output quantities each year. For the respective years, actual input and output prices from central Maryland were used. Central Maryland prices are similar to southern Pennsylvania prices,

2. Crop enterprise budgets were summarized in annual income statements.

3. Balance sheets were developed. Assets on the balance sheets were developed based on the farm characteristics discussed earlier. Liabilities were assessed to reflect a typical Mid-Atlantic commercial grain farm operation of this size.

4. A financial trend analysis was developed for 1981 to 1989. The income statements and balance sheets were combined in a yearly financial summary using the FINAN component of FINPACK, a computerized farm financial and analysis program developed at the University of Minnesota. This package provides profitability, solvency, and liquidity analysis. Profits and losses are carried over from year to year on the income statements and balance sheets to provide a trend analysis for the entire time period.

5. Miscellaneous, necessary assumptions were made regarding such issues as machinery and buildings purchases, labor, repairs, income taxes, real estate taxes, and interest computations. The authors presented preliminary results of this study to groups of farmers and researchers (in excess of 500 individuals) in Maryland, Pennsylvania, and New Jersey. Many useful comments and suggestions from these meetings were incorporated into the final design of this analysis so that a typical farm situation is more closely approximated.

Some of the major assumptions are:

a. Labor: Rodale agronomists had recorded all field operations and their dates of application. These field operations were translated into hours per acre by using standard farm management conversion rates. These direct time requirements were increased by 25% to allow for indirect labor requirements. The farmer had 250 available hours per month. If field operations exceeded this quantity, then help was hired to complete the task. It was assumed that part-time, skilled labor was available. Wage rates increased each year.

b. Assets were valued at original cost minus accumulated depreciation (no asset appreciation). The fanner purchased new machinery each year at the rate of 15% of the current year's beginning asset value. The fanner made yearly building improvements at the rate of 6% of the current year's beginning asset value.

c. Federal taxes were paid according to the 1988 Tax Rate Schedule. Straight-line depreciation was used.

The strength of this financial analysis stems from the detailed records of inputs and outputs that were kept by Rodale Research Center during the length of the trial. The analysis gives a clear picture of the good and bad years of the 1980s.

One cautionary note is in order in regards to this analysis. The purpose of Rodale's Conversion Experiment is primarily to enlarge the biological understanding of changes in the soil due to the transition from conventional to low-input agriculture (Harwood). The question arises as to whether or not it is appropriate to evaluate an experiment by farm profitability standards when profitability was never a major objective. In this case, the authors feel that the rotations followed in the experiment approximate what a farmer, had he or she been attempting to maximize profits, might have grown. Therefore, these results are presented with confidence.

Results and Discussion

Profitability

Table 3 shows average profit for different time spans for the four scenarios. Profit is defined as the before-tax return to operator and family labor, management, and equity capital. Between 1981 and 1989, the most-profitable scenario was the conventional grain farm participating in the government feed grain program, which averaged $39,193 per year. This result is not surprising, given the high level of participation by farmers in this program during the 1980s (which indicates the program's financial attractiveness). The National Research Council noted in *Alternative Agriculture* that "when cash grain prices are supported far above the market level, many farmers would reduce their net farm income if they shifted from growing only price-supported crops, such as corn and soybeans, to legume-based rotations . . ." (p. 241). Goldstein and Young found similar advantages for conventional wheat production over the low-input approach when support prices were used.

The next most profitable scenario was the low-input grain farmer who participated in the government programs. As mentioned earlier, this scenario is not possible. The problem is cross-compliance regulations. This fanner raised wheat and barley several years for which the farm did not have a base. Low-input agriculture requires many different crops to be grown so that pests can be controlled and nutrients regenerated in the soil. Cross-compliance regulations can seriously hamper the farmer's ability to select crops to accomplish these goals. Since the farmer had a corn base of 500 acres, there was not any problem staying within that limitation for corn acreage. The base acreage was reduced each year, but it leveled out at 250 acres. Increasing the corn-acreage base to its previous level would be difficult.

A more-flexible farm program, as regards cross-compliance, may benefit low-input farmers in the future. In addition, while the farmer cannot hay the set-aside acres, this land can be planted to crops that maintain the biological integrity of the low-input rotation.

The conventional grain farm, base scenario, averaged $29,891, or approximately $2,300 more than the low-input farm, base scenario, which averaged $27,614.

One criticism of the research that analyzes the profitability of low-input versus conventional systems is that the research is biased in favor of the low-input approach (Marten). To avoid such criticism, the assumptions associated with this case study assumed a difficult transition for the low-input farm operator. For example, the low-input farmer had to purchase hay equipment for $25,000 in 1981. Also, hay prices were calculated at 75% of the lowest-priced hay category quoted by the Maryland Department of Agriculture. Straw prices were equally devalued. These devaluations may reflect lower-quality hay or a decline in prices if forage production increases as the low-input approach is more widely adapted. A low-input farmer who has resources or opportunities which mitigate the above assumptions would likely achieve higher profits.

As mentioned in other literature, there is a cost of converting to the low-input approach (Dabbert and Madden). It takes time for the soil to develop the positive attributes associated with the low-input approach. Table 3 lists the average profit for 1981-84 and 1985-89. These particular time spans were chosen to reflect a biological transition period of four years. A U.S. Department of Agriculture (USDA) study report suggests that four years of transition should be expected when converting from

Table 3. Measurements of Profitability, Liquidity, and Solvency for Low-Input and Conventional Scenarios (Dollars)

	Average Annual Profit			Current	Increase in
Scenarios	1981-89	1981-84	1985-89	Liabilities (12/31/89)	Net Worth (1981-89)
Low-Input, base scenario	27,614	22,027	32,083	144,448	17,124
Low-Input, govt. programs	32,464	17,790	44,202	1 10,039	50,533
Conventional, base scenario	29,891	39,769	21,990	124,118	15,444
Conventional, govt. programs	39,193	36,125	34,738	54,315	83,247

conventional to low-input practices. While weather and grain prices can dramatically affect these averages, the low-input base scenario averaged $10,000 more per year in profit after the transition period, for an increase of 46%. This suggests that its average profit may equal or surpass the conventional base scenario's profit in future years as the transitional cost is amortized over more years. It is important to note that while the biological transition period might only be four years, this study shows that it will take more than five additional years to recoup those lost profits so that the farmer will be as well off as if no change had been made. In other words, the economic transition for this case study is at least twice as long as the biological transition.

This increase in profit for the low-input farmer was directly related to the increase in average corn yields from 58.8 bushels per acre (1981-84) to 104.4 bushels per acre (1985-89). By comparison, the conventional farm averaged 88.45 and 104.8 bushels, respectively, for those time periods.

The drop in average profits for both conventional scenarios during these periods is not indicative of a declining profitability for the conventional approach. Rather, the two conventional scenarios had relatively high yields in 1983 and 1984 and benefited from the high prices of that period. Low grain prices in 1985, 1986, and 1987 seriously hurt the conventional base scenario. The conventional farmer in government programs was helped by large deficiency payments during those years.

Liquidity

The liquidity of the farm is reflected in the changing level of current liabilities. All scenarios increased their current liabilities from zero on December 31, 1980, to those numbers listed in Table 3. Problems with liquidity are directly related to the profit rankings just discussed.

The assumptions in this analysis required that all land, machinery, and building principal payments be honored. In addition, new machinery purchases and building improvements were purchased annually at the rate of 15% and 6% of beginning inventories, respectively. While these rates could be high, it was felt that many whole-farm analyses ignore necessary capital replacement. It is conceivable that these rates could be lowered by timely repairs and maintenance.

As a result, current liabilities had to be increased in many years. This essentially amounted to trading long-term debt for short-term debt. In reality, fanners refinance their short-term debt into long-term debt to alleviate cash-flow problems. However, it was felt that for purposes of comparison, any increase in liabilities should be reflected in only one category.

As mentioned, the problems with liquidity are largely a function of the study's assumptions and of the relative profits during this period. Another possible explanation is the farm crisis of the 1980s. The farm crisis was especially hard on the average-sized family farm which these four scenarios closely approximate.

Solvency

Despite liquidity problems, Table 3 shows that all scenarios increased net worth over the nine years. The largest increase in net worth was achieved by the conventional farmer in the government program. Income taxes, which affect net worth, were incorporated in this analysis to give a better picture of the financial situation. Because of changing tax laws and the considerable flexibility and variation in farmer tax practices, no attempt was made to maximize after-tax income by shifting expenses or revenues, income averaging, taking investment credit, using accelerated depreciation rates, and carrying back or over net operating losses. As a result, the rankings of net-worth increases are not the same as average profit rankings. The lower variability of profits on the low-input farms improved their after-tax income relative to that of the conventional farms.

The debt-to-asset ratios give another perspective on solvency. All scenarios began 1981 with a 22% debt-to-asset ratio. At the end of 1989, the low-input and conventional scenarios participating in government programs had decreased their debt-to-asset ratio to 21% and 18%, respectively. The conventional base scenario's ratio remained the same and the low-input base scenario's ratio increased to 24%. None of these ratios are in the problem range.

Risk

Table 4 lists average annual profit, standard deviations of profit, and lower confidence limits of profits for the three scenarios (the low-input in government programs scenario is not included because of cross-compliance restrictions). The variation in profits is far greater for the two conventional scenarios than for the low-input base scenario. The two conventional farms had much higher and much lower annual profits than the low-input base scenario. A risk-averse farmer might not choose the

Table 4. Average Annual Profits, Standard Deviations of Profits, and 75% Lower Confidence Limit of Profits for Three Scenarios, 1981-89 (Dollars)

Scenarios	Average Annual Profit	Standard Deviation	Lower Limit
Low-Input, base scenario	27,614	16,985	16,166
Conventional. base scenario	29.891	37.811	4.406
Conventional, government programs	39,193	24,416	12,777

conventional grain farm in the government program alternative, which a simple ranking of average annual profits might indicate he or she would.

Musser, Ohannesian, and Benson suggested a safety-first criterion to incorporate risk in farm management extension programs. In this method, the lower confidence limit of profit is equal to: L_t = EJ — *KSj,* where £(is the lower confidence limit of profits for activity i; E_{-t} is the average mean of profits for activity i; 5, is the standard deviation of profits for activity i; and *K* is the number of standard deviations required to satisfy the farmer that average profit in a given year will exceed Z„ (given a level of probability). If a fanner desires that average profit exceed L_f in three of four years (75% lower confidence limit), then $K = 0.674$ if a normal distribution is assumed.

A farmer with this risk preference would choose the low-input scenario over the conventional alternatives. In three of four years, profit would exceed $16,166 (Table 4). The next-best alternative is the conventional government program scenario where profits would exceed $12,777 in three of four years. Because of the large differences in standard deviations between the low-input and the two conventional scenarios, increased risk avoidance only confirms the choice of the low-input alternative using this criterion.

For those farmers who would use a relative-variability criterion (coefficient of variation) to reduce risk, the low-input scenario is still the best choice; however, it is only slightly better than the conventional scenario in government programs. The coefficients of variation for the low-input base scenario, conventional scenario participating in government programs, and conventional base scenario are 62%, 67%, and 126%, respectively.

There are three major explanations for these differences in profit variation. On average, one-third of gross farm income on the low-input farm came from sources other than the sale of corn or 'soybeans. Farms practicing rotations are generally considered less susceptible to profit variation (Helmers, Langemeier, and Atwood). In addition, the conventional scenarios purchased approximately $35,500 more in fertilizers and pesticides each year. This cost exacerbated financial problems by reducing profits significantly during dry years when yields were low. On the other hand, the conventional scenarios had large profits during 1983 and 1984 because of high grain prices and good yields. Finally, farmers in government programs receive deficiency payments which help support profits in years of low prices.

Analysis of Revenues and Expenses

The following section compares revenues and expenses for the low-input and conventional base scenarios. These differences result directly from the cultural practices outlined in this case study which are regional specific. For example, the farmers in the Mid-Atlantic region have access to hay and straw markets that other farmers might not have. However, comparisons can still be made with low-input rotations in other regions.

Table 5 lists several items that compare the operations of the low-input base scenario with the conventional base scenario. The low-input's gross income was on average 19% lower each year than the conventional^ gross income. This reduction is due to lower corn and soybean acreages and because of the lower corn yields during the years of transition. The returns per acre of corn are high on the low-input farm, especially in the later years, but not all acres can be planted to corn as with the conventional farm. For example, in some years there were only 250 acres of corn to sell and other years 500 acres of corn and soybeans. While the hay or straw crops provided income, there was only one cutting, and under these cultural practices, yields were low. Also, while red clover/oat straw is an acceptable hay, it does not command high prices.

Cash operating expenses were 26% lower for the low-input scenario. This is primarily due to the 95% reduction in inorganic fertilizers and chemical pesticides for the low-input scenario. The low-input scenario did not apply any pesticides over the nine years. Both the low-input and conventional scenarios received potash applications in 1989. Other than this potash addition, no other inorganic fertilizers were added to the low-input scenario. The soils at the Rodale Research Center are high in phosphorus. While legumes can supply sufficient nitrogen, inorganic potash and phosphorus fertilizers might still be needed under a low-input regime.

Machinery costs for the low-input farm were higher than for the conventional farm. It was as-

Table 5. A Comparison of Gross Income, Profit, and Factors of Production for the Low-Input and Conventional Base Scenarios, 1981-89

	Average/Yr. (1981-89)		% Difference, Low-Input to
Item	Low- Input	Conventional	Conventional
Gross income	$140,765	$174,433	-19
Cash operating expense	99,715	133,922	-26
Depreciation	13,436	10,620	+26
Profit	27,614	29,891	o o
Fertilizer & crop chemicals	1,875	37,371	-95
Hired labor costs	3,096	2,426	+28
Machinery purchases	17,770	11,719	+52
Machinery repairs, fuel, and lubrication	12,862	10,081	+28
Cash expense as a % of income	71.8%	80.9%	-11
Interest (excluding land mortgage interest)	$10,745	$9,625	+12
Interest on land mortgage	$25,200	$25,200	0
Total interest as a % of income			

sumed that on December 31, 1980, there was not any hay equipment. As a result, the low-input farm had to purchase hay equipment costing approximately $25,000 in 1981. In addition, the low-input farmer had to make additional machinery purchases each year to maintain this hay equipment. Further, there were additional repairs, fuel, and lubrication costs associated with this machinery. A farmer considering this low-input rotation and who has existing hay equipment on the farm would make the transition easier. However, the assumptions in this analysis were made to dramatize additional machinery purchases that might have to be made when cultural practices are changed significantly.

Hired labor costs were 28% higher for the low-input scenario. This is not surprising because, for example, mechanical tillage requires more labor than spraying, and hay crops require more labor than corn. However, there is a mitigating factor against the notion that the low-input approach always requires more labor. The conventional farmer has extremely high labor requirements during certain times of the year because the cultural practices of corn and soybeans are similar. The low-input farmer, with more crops and less acreage of each, spreads these labor requirements over the growing season. For example, hay harvest comes at a time when the labor requirements for corn and soybeans are low. In other studies, Lockeretz reported that there were 15% higher labor requirements on biological farms.

Interest payments, excluding the interest on the land mortgage, were 12% higher for the low-input farmer. The low-input farmer does not pay as much interest on the production loan because less is borrowed. However, the low-input farmer has higher interest payments for machinery. In addition, because there were lower profits in the transition years, more interest was paid on carry-over current liabilities.

Total interest paid as a percent of gross income was 25.5% and 20.0% for the low-input and conventional farmers, respectively. Ferguson suggests that when this ratio exceeds 16%, there could be financial problems. The relatively high level of this ratio for the low-input farmer accents the liquidity problems associated with the transitional costs (biological and resource adjustments) associated with the conversion from conventional methods. Overall, cash expenses as a percent of gross income were lower for the low-input farmer as compared to the conventional fanner (71.8% compared to 80.9%).

Conclusions

1. The conventional grain farm in the government program is the most profitable scenario. The next most profitable scenario is the low-input in the government program (ignoring cross-compliance restrictions). The base scenarios for conventional and low-input are ranked third and fourth.

2. Government programs reward the conventional farmer with a good base acreage and yield. Unless the low-input farmer can plant rotational crops not covered by cross-compliance regulations, he or she is^not eligible to participate. It is likely that when moving from a conventional to a low-input system, a farmer will plant less than the farm's base acreage for a particular program crop because of the inclusion of other crops in the rotation. Consequently, if cross-compliance restrictions were relaxed, the benefits of government programs would be available to the low-input farmer to aid in the

transition. If current restrictions are kept in place, however, the loss of revenue from government programs is a tremendous disincentive for conventional farmers who are considering switching to a low-input approach.

3. The low-input approach is advantageous for risk-averse farmers who use the safety-first criterion. When average annual profits are adjusted to reflect risk avoidance, the low-input approach is the best choice. For those farmers who use a relative-variability criterion, the low-input approach is still advantageous, but only slightly so. Both approaches ignore the financial risk of cash-flow problems associated with the transition from a conventional to a low-input system.

4. Profits trend upward for the low-input scenario. This confirms the existence of transitional costs that must be paid. Even though recent profit averages (1985-89) are now higher for the low-input base scenario, overall averages (1981-89) are still less than the conventional base scenario. This indicates that the economic transitional period exceeds the biological transition period. If current trends continue (an admittedly difficult assumption to justify), overall average annual profits for the conventional and low-input base scenarios will be equal after eleven years.

5. Without restructuring current debt, all scenarios faced cash-flow problems. All four scenarios increased their net worth; however, the largest increase was achieved by the conventional farmer in the government program.

6. The quality of the soil will determine, to a large extent, the future productivity of these agricultural systems. This analysis does not directly factor in any differences in soil properties that may have occurred between the low-input and conventional fields after nine years. For example, rapid water infiltration was observed in the low-input corn fields largely as a result of including legume green manure crops in this rotation (Rodale Research Center). However, the increased profits of the low-input systems in the later years presumably reflect this investment in soil improvement.

7. Profitability studies that focus on only a few years of data to compare conventional and low-input systems significantly understate the potential profitability of the low-input approach.

8. This study highlights the extreme cases of applying conventional (normal) amounts of pesticides and inorganic chemicals versus their absence. It is likely that some intermediate level could achieve a higher level of profitability while still significantly reducing chemical pollution. More research is needed to verify this proposition.

9. The results of this study are regional and farm-system specific. Additional research is needed to compare the relative profitability of conventional and low-input farming systems in other regions of the United States.

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