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WHOLE FARM ANALYSIS OF LOW-INPUT/SUSTAINABLE FARMING SYSTEMS USING AN EXTENSION FARM FINANCIAL MANAGEMENT PACKAGE

by

Mark G. Leddy, Thomas L. Dobbs, and Burton W. Pflueger

Farmers in recent years have been faced with economic hardships and an increasing awareness of the environmental impacts of conventional farming practices. These factors have led many farmers to consider "alternative" farming methods and practices to replace conventional farming practices. "Alternative" systems include those going by a variety of labels, not all of which always mean the same thing. Terms used include regenerative, sustainable, low-input, and organic, among others. A recently established research and education program of the U.S. Department of Agriculture uses the term "low-input/sustainable agriculture" ("LISA"). The LISA program contrasts conventional and alternative, or low-input/sustainable, farming systems in the following language, which is useful for the purposes of this paper:

> Conventional agriculture involves highly specialized systems which emphasize high yields achieved by inputs of fertilizers, pesticides, and other off-farm purchases. Alternative farming systems, on the other hand, range from systems with only slightly reduced use of these inputs (through soil tests, integrated pest management, and capital inputs) to systems that seek to minimize their use (through appropriate rotations, ridge tillage, integration of livestock with crops, mechanical/biological weed control, and less costly buildings and equipment).
>
> Low-input/sustainable agriculture addresses multiple objectives--from increasing profits to maintaining the environment--and may incorporate and build on multiple systems and practices such as integrated pest management and crop rotations (U.S. Department of Agriculture, 1988).

Analyses comparing conventional and alternative farming systems generally require whole farm, multidisciplinary approaches with strong farm management economics components. Madden and Dobbs (1988) have recently reviewed various whole farm analysis approaches available to agricultural economists involved in LISA research. Approaches range from relatively simple microcomputer

spreadsheet models to quite complex optimization and simulation models of whole farm situations. LISA research at South Dakota State University (SDSU) has thus far emphasized relatively simple and straightforward models that are compatible with available data. This approach has provided many useful farm management and public policy insights on alternative farming systems (Dobbs, et al., 1988). In many cases, insufficient data, time, and research resources cause more complex approaches to be unwarranted and to possibly yield misleading results. Thus, no apologies need be made for the more simple whole farm approaches, so long as the analyses have a sufficiently "holistic" perspectives (Dobbs, 1987; Madden and Dobbs, 1988).

SDSU has also employed a slightly more complex whole farm analysis approach in some of its LISA research. This other approach, used in a portion of Leddy's thesis (Leddy, 1987), utilized the Extension farm financial management package known as FINPACK. FINPACK (standing for Financial Package) was developed by the University of Minnesota Extension Service; it has been adopted by many other State Extension Services during the 1980s, as increased emphasis has been placed on microcomputer-whole farm financial planning. FINPACK constitutes a whole farm analysis approach that is of intermediate complexity--more complex than that reported in Dobbs, et al. (1988) but less complex than many of the mathematical programming and simulation approaches cited by Madden and Dobbs (1988). It allows quantitative evaluation of a substantial number of crop and livestock enterprises, yet its results can be interpreted without excessive difficulty.

Various whole farm analysis approaches are likely to be tried in LISA research over the next several years. FINPACK, a tool thus far used primarily in extension work, may have a place in LISA and other farm management

research. In this paper, descriptions of both application and results of FINPACK for LISA research in South Dakota are given. First, the alternative or low-input/sustainable systems which were analyzed are briefly described. Then, the components of FINPACK used in the analyses are presented. Subsequently, results of the analysis, comparing alternative with more conventional systems, are presented. Some advantages and disadvantages of using FINPACK in LISA research are presented in the concluding section.

Farming Systems Being Studied

South Dakota State University has been conducting research on alternative farming systems in farmers' fields near Madison, S.D. since 1984 and at its Northeast Research Station, near Watertown, S.D., since 1985. The alternative farming systems research is being conducted by a research and extension team covering soil fertility and plant nutrition, plant pathology, reduced tillage, nematology, entomology, weed science, and agricultural economics. Two farming system studies are involved in work at the Northeast Station.

Farming Systems Study 1 (FSS1) is composed of three farming systems: alternative (low-input/sustainable), conventional, and ridge till. The alternative system is a 4-year rotational system composed of oats, alfalfa, soybeans, and corn. It is patterned after a system used by alternative system farmers in the Madison area. No commercial fertilizers or pesticides are applied in this system. Livestock manure is applied on the oats stubble in the fall. The conventional system consists of a 3-year corn, soybeans, and spring wheat rotation. This system is farmed using practices which are consistent with practices typically used by farmers in the vicinity of the research farm. Fertilizers and herbicides are applied using agronomically suggested rates. The ridge till system is also composed of a 3-year rotation

of corn, soybeans, and spring wheat. This system is operated using ridge till farming techniques, with fertilizers and herbicides applied using agronomically suggested rates.

Farming Systems Study 2 (FSS2) is composed of four farming systems: alternative (low-input/sustainable), conventional, and minimum till. The alternative system is composed of a 4-year rotation of oats, sweet clover, soybeans, and spring wheat. This system is operated under the same conditions as its counterpart in FSS1. The conventional system is composed of a 3-year rotation of barley, soybeans, and spring wheat, which utilizes the same practices as the FSS1 conventional system. The minimum till system is composed of a 3-year rotation of barley, soybeans, and spring wheat. Tillage practices are limited to the use of chisel plowing in the fall, with no tillage prior to planting in the spring. Both commercial fertilizers and herbicides are used in this system. A fourth system, continuous no till winter wheat, is being discontinued at the Northeast Farm; it will not be discussed here.

Data from these studies were used during 1987 to develop enterprise budgets for each crop, each differing with the farming system used and the crop's position in the rotation. Initial enterprise budgets used in this analysis were published in SDSU Economics Research Report 87-5 (Dobbs, et al., 1987). This publication contains enterprise budgets which were developed using 1986 yield and tillage practices, as well as budgets with expected long term ("normalized") yields and practices. "Normalized" budgets were developed and used in the analysis of the farming systems because it was assumed that the 1986 results were too restrictive to be used in extensive analyses. The normalized enterprise budgets developed for each system were used as inputs to

the FINPACK model.

One of the objectives of SDSU's research is to determine what effect, if any, inclusion of livestock enterprises might have on the viability of alternative farming systems. The presence of livestock enterprises is often considered crucial to the optimum performance of alternative farming systems. Lockeretz, et al. (1981) found in their western Corn Belt study that nine-tenths of the 363 organic farmers surveyed had a substantial quantity of livestock, most commonly beef cattle, hogs, or dairy cattle. LISA farmers often have livestock to utilize much or all of the forages produced in their rotational systems. Therefore, livestock enterprises were included in our analysis to examine interactions of crop and livestock systems and to determine effects of various livestock enterprises on the economic and financial viability of alternative farming systems.

Although there is no livestock research underway at SDSU's Northeast Station, three livestock enterprises were selected for inclusion (one at a time) in the whole farm analyses. They were: (a) a 50-head beef cow/calf operation; (b) a 150-head wintering steers operation; and (c) a 50-head dairy operation. These enterprises were chosen because they are typical enterprises for this area of South Dakota (Ranek, 1985) and they provide a means to utilize the forages produced by the alternative systems. Costs and returns for the livestock enterprises were derived from FINPACK budgets previously developed for northeast South Dakota. The livestock prices in these budgets were updated to reflect 1987 conditions.

Use of the FINPACK Model

FINPACK is composed of four programs (FINLRB, FINTRAN, FINFLO, and FINAN) designed to be used in whole farm analyses (Hawkins, et al., 1986). The

program utilized in this study was FINLRB (Financial Long Range Budgeting). The FINLRB model projects profitability, liquidity, and solvency for up to three alternative plans (at one time) on a long-run, typical year, basis. Specifically, this program was utilized in the analysis of long range profitability, return on investment, debt repayment capacity, potential net worth growth, and labor hour requirements of a typical farm operated under alternative long-range crop and livestock system plans. These financial measures provided an indication of the performance of each farming system. Following are brief descriptions of the financial measures selected for special attention in the alternative farming systems study.

Financial measures

Three profitability measures were examined. The first was "profit or loss". This measure can be viewed as a return to labor, management, and equity capital invested in the farm business. The next profitability measure examined was "labor and management earnings", which represents a return to the farm operator for investing labor and management skills in the farm business. The final profitability measure examined was "rate of return on farm investment". That represents the actual return on the average dollars invested in the farm business.

Two liquidity measures were examined. The first was "cash surplus or deficit". This measure is the projected amount of cash left over after all cash commitments have been accounted for. This provides an indication of the ability of a farm operation to generate sufficient cash to meet its financial commitments. The other liquidity measure examined was "cash farm expense as a percent of income", which shows the percentage of gross income required to meet cash operating requirements.

One solvency measure, "net worth change per year", was examined. This measure projects the amount net worth will change in a typical year.

Another measure used to analyze the farming systems was "annual labor hours required". This measure gives an estimate of the total labor hours required per year for each of the farming systems. This is an important consideration because of the differences in labor requirements between the farming systems.

These measures were determined, with FINLRB, for a hypothetical case farm. Next, some of the assumptions made in specifying the "case" farm are presented.

The case farm

The case farm was "designed" to represent a typical 640-acre farm in the vicinity of the Northeast Station. It was assumed that the farm is comprised of 540 tillable acres, 60 acres of pasture, 20 acres of wasteland (not usable for crops or pasture), and 20 acres for the building site.

Differing initial financial positions were used to account for any differences in investment requirements among farming systems.

Current assets, such as cash, securities, and crop inventory, were assumed to be constant values across all farming systems. Intermediate assets were assumed to be investments in machinery and equipment for each of the farming systems. Intermediate assets varied across farming systems, due to the types of tillage practices utilized and the equipment required. Long term assets were assumed to be the value of farmland and buildings. This included a valuation, not only for the assumed tillable acres, but also for the assumed pasture, untillable acres, and farmstead acres specified in the typical farm.

Current liabilities were derived from the current asset level. A constant current asset to current liability ratio of 1.5 was assumed for all farming systems. Intermediate liabilities were derived from relationships available in the South Dakota Agricultural Statistics handbook (Ranek, 1987). The average ratio of non-real estate debt and Commodity Credit Corporation loans to total assets for South Dakota in 1985 was .193. This ratio was multiplied by total assets for each farming system to determine total current and intermediate liabilities. The value for the current liabilities was then subtracted from this value to derive intermediate liabilities. The value for long term liabilities was also determined in this manner. The ratio of real estate debt to total assets in 1985 was .12. This ratio was then multiplied by total assets to derive the long term liabilities value.

The addition of livestock enterprises to the analysis required adjustment of initial balance sheet levels. In specifying these new levels, it was assumed that any transitional stage involved with the addition of a livestock enterprise had already been completed.

Current assets were assumed to remain constant for each livestock enterprise. Intermediate assets were increased to account for livestock inventories and additional machinery and equipment required for each livestock enterprise. Long term assets were increased to account for additional buildings and facilities required for each livestock enterprise. Liability levels for each livestock enterprise were adjusted to maintain the liability to asset relationships assumed in the baseline situation.

Having determined these values, it was then possible to develop a baseline situation, using the enterprise budgets referred to earlier in this paper.

Application and Results

Baseline "crop systems only" results for FSS1 and FSS2 will be presented using the profitability, liquidity, and solvency measures which were defined previously. These will be followed by the results obtained with the addition of the livestock enterprises. Tables 1 and 2 contain a summary of baseline results for all systems examined.

Crop enterprises only, FSS1

An examination of "profit" for the crop (including hay) enterprises alone in FSS1 (Table 1) showed the ridge till system exhibiting the highest profit ($24,607), followed by the conventional system ($23,402); the alternative system exhibited the lowest profit level ($21,473). This measure showed the ridge till system having a 14.6% higher profit than the alternative system and a 5% higher profit than the conventional system. The conventional system profit was 9% higher than the alternative system.

"Labor and management earnings" in FSS1 showed the same ranking of systems. The ridge till system had the highest return with this measure ($11,218), followed by the conventional system ($9,622) and then the alternative system ($7,386). The returns were lower with this measure than with the "profit" measure for all systems, because of the inclusion of the opportunity charge for equity capital used in the farm operation.

The final profitability measure examined was "rate of return on investment" (ROI). The ridge till system exhibited the highest ROI (8.9%), followed by the conventional system (8.3%); the alternative system exhibited the lowest ROI (7.1%). Differences in ROI are caused by differences in the amount of return and the amount of total investment in each farming system.

The first liquidity measure examined, "cash surplus or deficit", showed

Table 1. Summary of selected FINLRB measures for the systems analyzed in FSSI.

Measures	Crops Only Conv.	Crops Only Alt.	Crops Only Ridge.	Beef Cow/calf Conv.	Beef Cow/calf Alt.	Beef Cow/calf Ridge.	W. Steers Conv.	W. Steers Alt.	W. Steers Ridge.	Dairy Cow Conv.	Dairy Cow Alt.	Dairy Cow Ridge.
Profit($)	23402	21473	24607	27145	25787	28356	29062	27516	30267	43754	42820	44959
Labor & Mgt Earnings($)	9622	7386	11218	11782	10116	13383	14847	12993	16442	26090	24848	27685
ROI	8.3%	7.2%	8.9%	8.4%	7.6%	9.0%	10.0%	9.0%	10.6%	10.5%	10.2%	10.9%
Cash Surplus Or Deficit($)	2610	1181	3514	5796	4785	6703	6729	5580	7633	18171	17470	19048
Cash Farm Exp. As % of Inc.	60.5%	54.6%	60.7%	61.0%	53.6%	61.1%	75.8%	73.6%	75.8%	63.5%	58.7%	63.5%
Net Worth Change /Year($)	3380	1968	4262	6613	5619	7500	7523	6391	8405	19158	18474	20013
Annual Labor Hours Required(hrs)	821	1169	725	1221	1569	1125	1271	1619	1175	4071	4419	3975

Source: Leddy (1987).

all systems exhibiting cash surpluses. The ridge till system had the largest surplus ($3,514), followed by the conventional system ($2,610) and then the alternative system ($1,181).

The other liquidity measure examined, "cash farm expense as a percent of income", showed the alternative system having the lowest percentage (54.6%). The conventional and ridge till systems had nearly identical percentages, 60.5% and 60.7%, respectively. Since the cost of labor is not included as a cash expense in this analysis, the use of labor intensive methods will result in a lower cash expense as a percentage of income for the alternative farming systems.

The solvency measure which was examined, "net worth change per year", showed all systems exhibiting positive net worth changes. The ridge till system had the highest change ($4,262), followed by the conventional system ($3,380) and then the alternative system ($1,968).

Total labor hour requirements for each system varied by a large amount. The alternative system was the most labor intensive farming system, requiring 1,169 hours. This was 348 hours more than the conventional system requirement of 821 hours and 444 hours more than the ridge till system requirement of 725 hours. A charge for operator and/or family labor required was only included in the "rate of return on investment" analyses with the FINLRB model.

<u>Crop enterprises only, FSS2</u>

An examination of FSS2 results (Table 2) showed the <u>alternative</u> system having the highest profit ($16,737), with the <u>conventional</u> system being only slightly lower ($16,294); the <u>minimum</u> <u>till</u> system had the lowest profit ($14,331). Alternative system profit was 3% higher than the profit of the conventional system and 17% higher than the profit of the minimum till system.

Table 2. Summary of selected FINLRB measures for the systems analyzed in FSS2.

Measures	Crops Only			Beef Cow/calf			W. Steers			Dairy Cow		
	Conv.	Alt.	Min.	Conv.	Alt.	Min.	Conv.	Alt.	Min.	Conv.	Alt.	Min.
Profit($)	16294	16737	14331	20270	20713	18308	21954	22397	19991	39432	39875	37469
Labor & Mgt Earnings($)	2402	3165	857	4795	5557	3250	7626	8389	6082	21655	22417	20110
R.O.I.	6.1%	6.2%	5.9%	6.4%	6.5%	6.2%	7.8%	7.9%	7.6%	9.5%	9.7%	9.2%
Cash Surplus Or Deficit($)	-2599	-2257	-4113	623	965	-790	1520	1862	107	14962	15305	13549
Cash Farm Exp. As % of Inc.	64.7%	55.2%	68.5%	64.1%	56.8%	67.2%	78.9%	76.7%	80.8%	63.6%	59.8%	65.4%
Net Worth Change /Year($)	-1823	-1499	-3360	1488	1812	51	2320	2645	884	15956	16280	14519
Annual Labor Hours Required(hrs)	979	1048	758	1379	1448	1158	1429	1498	1208	4229	4298	4008

Source: Leddy (1987).

"Labor and management earnings" in FSS2 showed the same ranking of systems. The alternative system had the highest return with this measure ($3,165), followed by the conventional system ($2,402) and then the minimum till system ($857). The lower return shown by this measure was due to the inclusion of opportunity costs for equity capital used in each farming system.

"Rate of return on farm investment" was similar across systems. The alternative system had the highest ROI (6.2%), followed closely by the conventional system (6.1%); the minimum till system had the lowest (5.9%).

"Cash surplus or deficit" showed all systems having a cash deficit. The alternative system had the lowest deficit (-$2,257). The conventional system had a deficit of -$2,599 and the minimum till system had the highest cash deficit (-$4,113). These results suggest that these systems may have difficulties meeting all of the cash commitments required for operation and family living.

"Cash farm expense as a percent of income" showed the alternative system to have a lower percentage (55.2%) than the conventional system (64.7%) and the minimum till system (68.5%). Differences in this measure are partially due to the use of more labor intensive methods in the alternative system.

"Net worth change per year" was negative for all systems in FSS2. The alternative system had the smallest decline (-$1,499), followed by the conventional system (-$1,823). The minimum till system had the largest decrease in net worth (-$3,360). This indicates that in a typical year the owner's equity in the farm business will decrease in the process of farming with any of these systems and trying to fully cover living expenses out of the farm operation.

The alternative system had the largest labor hour requirement (1,048),

which was 69 hours more than the requirement of 979 hours for the conventional system and 290 hours more than the requirement of 758 hours for the minimum till system.

Livestock enterprises also included

Livestock enterprises were included in the analysis to determine what effect they might have on the economic and financial viability of the farming systems. The emphasis in this discussion of livestock enterprises will be on relative changes in profitability of the farming systems due to the addition of each livestock system, and not on the resulting absolute profit levels. The discussion will center around the results obtained for FSS1. Baseline results for the addition of each livestock enterprise to both FSS1 and FSS2 are contained in Tables 1 and 2, however.

In addition, we examined the forage requirements and manure production associated with each livestock enterprise. These values were then compared to the manure required for fertilizer and hay produced in the FSS1 alternative system.

Beef cow/calf enterprise: The addition of a 50-head beef cow/calf enterprise to FSS1 crop systems resulted in the alternative system's profit increasing by a larger amount than did the profit of the conventional and ridge till systems. The profit increase for the alternative system was $4,314, while the conventional and ridge till systems' profits increased by $3,743 and $3,749, respectively. The profit increase was 15% greater for the alternative system than for the conventional and ridge till systems.

Differences in increases in profit were due to the alternative system producing the required forage, while the convention and ridge till systems were forced to purchase hay to meet the forage requirements of the beef

cow/calf operation. The purchase price of hay was assumed to be $5 per ton greater than the sale price, to reflect a transportation charge.

Wintering steers enterprise: The addition of a 150-head wintering steers enterprise to FSS1 crop systems had a greater effect on profits of the alternative system than it did on profits of the conventional and ridge till systems. However, the increase in relative profitability of the alternative system was not as great with this system as it was with the addition of the cow/calf system. This difference was caused by there being less hay required for the wintering steers enterprise; thus, the conventional and ridge till systems were not required to purchase as much hay to meet forage requirements. The alternative system profit increased by $6,043, while the conventional and ridge till systems' profit each increased by $5,660. The profit increase was 6.7% greater for the alternative system than for the conventional and ridge till systems.

Dairy cow enterprise: The addition of a 50-head dairy cow operation to FSS1 crop systems increased labor hour requirements by a large amount (3,250 hours). In order to bring operator labor required in line with requirements of the other systems, a labor charge for 2,500 hours of hired labor was included in this analysis.

Profit for the alternative system increased relatively more than it did for the conventional and ridge till systems when a dairy enterprise was added. Profit increased by $21,347 in the alternative system, while the profit increase for both the conventional and the ridge till system was $20,352. The absolute increase in profit for the alternative system compared to that for the conventional and ridge till systems was greatest with this livestock enterprise. However, because of the larger absolute values involved, the

increase in profit for the alternative system was only 4.9% greater than for the conventional and ridge till systems. This is the smallest percentage advantage in profit increase for the alternative system of the three livestock enterprises examined.

Balancing forage and manure requirements: The addition of livestock enterprises to crop farming systems allows for on-farm utilization of forages produced and results in the production of an often overlooked resource, manure. Analyses were conducted to determine the ability of each of these livestock enterprises to meet the requirement for manure as fertilizer in the FSS1 alternative system and to utilize the hay produced by that system.

The amount of economically recoverable manure produced for each livestock species was obtained from Van Dyne and Gilbertson (1978). Coefficients which were obtained from this publication appear in Leddy (1987).

Results of this analysis (Table 3) showed that none of the livestock enterprises, with the initial assumptions, met the manure requirement of 240 tons dry matter per year for the FSS1 alternative system. An analysis was then conducted to see the effect of increased livestock numbers. The dairy operation met the manure requirement when the number of cows was increased to 125 head (from 50 head). The wintering steers enterprise met the manure requirement when the number of steers increased to 400 head (from 150 head). The majority (90%) of manure produced by the cow/calf system was assumed to be economically unrecoverable; therefore, the cow/calf operation did not approach the requirement for manure production when realistic assumptions were made.

Also contained in Table 3 are results of analysis comparing alfalfa hay production per year in the FSS1 alternative system and the amount of hay required per year for each livestock enterprise. The amount of forage

Table 3. Forage and Manure Resource Balancing Comparison.

	Livestock Enterprise								
	Cow/calf (head)			W. steers (head)			Dairy cow (head)		
	50*	100	200	150*	300	400	50*	100	125
Manure (tons dry matter).									
(a) produced	4	8	16	92	183	244	98	196	245
(b) required	240	240	240	240	240	240	240	240	240
(c) surplus or deficit	-236	-232	-224	-148	- 57	4	-142	- 44	5
Hay (tons)									
(a) produced	432	432	432	432	432	432	432	432	432
(b) required	115	230	460	76	153	204	199	398	498
(c) surplus or deficit	317	202	- 28	356	279	228	233	34	- 66

*Baseline situation

Source: Leddy (1987).

required by each livestock enterprise is expressed as an "alfalfa hay equivalent" value in the FINPACK livestock budgets. Thus, the actual comparison is between the alfalfa hay produced and the forage requirements of the livestock expressed in alfalfa hay equivalents. This forage requirement does not include the pasture grazing which is required.

When the dairy numbers were increased to 125 head, the level which effectively balanced manure required and produced, the hay required exceeded hay produced by 66 tons. With 400 head of steers, which effectively balanced manure produced and required, the amount of hay produced exceeded the amount used by 228 tons. An increase to 200 head in the cow/calf operation resulted in the hay required exceeding the amount produced by 28 tons; however, even at this level, manure required still far exceed the amount produced.

Summary and Conclusions

The baseline "crop enterprises only" results showed all systems for FSS1 to be financially viable in a typical year in a long run setting. The ridge till system consistently had the highest ranking in the profitability measures; however, there were not large differences between systems. When comparisons between systems are made, keep in mind that the only profitability measure which accounts for differences in labor requirements is "rate of return on farm investment". Differences in labor requirements between farming systems were shown to be substantial in some cases. The liquidity and solvency measures also indicated that all systems would be feasible in an average or typical year, once established.

The results were influenced by initial assumptions about debt and asset levels, of course. More detailed analyses with actual LISA and conventional farms could employ less rigid assumptions about debt/asset ratios, costs of

financing, and so forth. Analyses which entail greater variation between particular crop and livestock systems in debt/asset ratios and other financial variables may result in changes in how systems rank--in terms of liquidity and solvency--as one adds different livestock enterprises to the whole farm systems.

In FSS2, the profitability measures indicated positive returns for all systems. The alternative system exhibited the highest return, but the differences between systems were small. However, the liquidity and solvency measures indicated that farm operators using any of these systems may have difficulty maintaining financially viable operations over the long run--given the size of farm assumed.

The addition of livestock enterprises to the FSS1 analyses resulted in the profitability of the alternative system increasing relatively more than the profitability of the conventional and ridge till systems. Differences in profit increases were due to the alternative system producing all hay required for the baseline livestock enterprises, while the conventional and ridge till systems involved purchase of hay to meet livestock requirements. Hay purchase prices were assumed to be $5 per ton greater than farm sale prices, to reflect local transportation and other marketing costs.

Generally similar results on relative profitability of these various farming systems have been reported in Dobbs, et al. (1988)--drawing on analyses with relatively simple microcomputer spreadsheet models. What are some advantages and disadvantages of moving to the somewhat more complex FINPACK models, however?

Advantages

While FINPACK requires more data and assumptions than does the kind of

model reported in Dobbs, et al. (1988), it does constitute a well-accepted whole farm financial analysis tool that is not overly difficult to use. Extension staff and farmers in many states are familiar with this tool. It draws on relatively standard enterprise budget and farm balance sheet information. If used by LISA researchers, the analytical results should be relatively easy to transfer to extension staff and farmers. In fact, if LISA research results are appropriately packaged, extension staff should be able to work with farmers in determining which of various low-input sustainable practices best fit individual farm situations.

FINPACK lends itself well to explicit inclusion of livestock enterprises in the analysis of LISA practices. Feed, labor, and capital requirements can be accounted for, and implications for profitability, liquidity, and solvency can be determined. Although FINPACK is an elaborate accounting tool--not an optimization tool--quantification of crop-livestock enterprise linkages is facilitated by its use. Use of FINPACK does force the researcher to be explicit about all relevant financial costs and assumptions.

Flexibility is another FINPACK characteristic. Alternative crop and livestock systems can be specified for analyses in just about any conceivable combination. The FINPACK format permits simultaneous comparison of three sets of alternative farm plans. In our LISA analysis of FSS1, for example, we specified those sets to be the conventional, alternative, and ridge till systems. However, new combinations including different livestock enterprises were analyzed by respecifying the enterprise mix and related coefficients.

Once data and assumptions have been specified, analyses are quick and inexpensive to carry out with FINPACK. Sensitivity analyses--with such parameters as crop and livestock prices--are also relatively easy to conduct.

Since FINPACK is a complete farm financial package, liquidity and solvency measures can be obtained for the farming systems being compared. Only profitability measures were explicitly included in our spreadsheet analyses.

Disadvantages

Using FINPACK for LISA research also entails some disadvantages, however. For one, complete balance sheet data or assumptions are required. This adds a good deal of required time and effort in specifying the whole farm models--compared to that required for the whole farm models in which profitability is analyzed only with spreadsheets. Although the enterprise budget data is largely similar for FINPACK and spreadsheet analyses, explicit assumptions about machinery inventories, sources of financing, etc. do not have to be made with the kind of spreadsheet analyses we employed. For each change in a farming system analyzed, balance sheet data need to be reexamined and respecified in FINPACK analyses; that is a somewhat tedious and time-consuming process.

In spite of the greater effort and detail involved in the FINPACK models, the profitability comparisons of the crop systems did not add very much to what had already been learned with the spreadsheet models. Although the FINPACK models provided liquidity and solvency information not provided by the spreadsheet models, that information is highly specific to each actual or assumed farm and its related size, balance sheet, and family economic profile. It is questionable whether that additional information is really essential for many of the problems likely to be addressed in LISA research over the next several years.

The fact that FINPACK lends itself well to explicit inclusion of

livestock in the analyses was listed as an advantage. However, one must be careful not to overstate that advantage. Even our crops-only spreadsheet models implicitly accounted for livestock. Alfalfa hay prices, for example, depend on the supplies of and demands for livestock feed. Moreover, data for the forage and manure resource balancing comparison shown in Table 3 could have been derived from the spreadsheet models and side calculations, had the FINPACK results not been available. Thus, while provision of detailed perspectives on crop-livestock enterprise interactions is a advantage of FINPACK, some reasonable perspectives on the livestock aspect can also be obtained with more simple approaches.

Finally, it must be recognized that both the spreadsheet models and the FINPACK models entail iterative, trial-and-error approaches. Neither embody the self-contained analytics of mathematical programming. For some kinds of LISA research, it will be appropriate to gather the additional data and expend the additional time and effort required to develop mathematical optimization models. However, when decisions are faced about whether or not to employ mathematical programming or other more "sophisticated" approaches, models should be viewed as means, not ends. During the next several years, while data bases are being built, much of the LISA whole farm research might better be based on simpler spreadsheet and FINPACK-type models.

References

Dobbs, T.L. 1987. Toward more effective involvement of agricultural economists in multidisciplinary research and extension programs. Western J. of Agr. Econ. 12(1):8-16.

________, M.G. Leddy, and J.D. Smolik. 1988. Factors influencing the economic potential for alternative farming systems: case analyses in South Dakota. Am. J. of Alt. Ag. 3(1):26-34.

________, L.A. Weiss, and M.G. Leddy. 1987. Costs of production and net returns for alternative farming systems in northeastern South Dakota: 1986 and "normalized" situations. Research Rpt. 87-5. Economics Dept., S. Dak. State Univ. 79 pp.

Hawkins, R.O., D.W. Nordquist, R.H. Craven, and D.A. Judd. 1986. FINPACK: a computerized farm financial planning and analysis package. Center for Farm Financial Management, Dept. of Agr. and Applied Economics, Minn. Extension Service, Univ. of Minn.

Leddy, M.G. 1987. An economic analysis of alternative farming systems in northeastern South Dakota. M.S. Thesis, Economics Dept., S. Dak. State Univ. 141 pp.

Lockeretz, W., G. Shearer, and D.H. Kohl. 1981. Organic farming in the corn belt. Science. 211:540-546.

Madden, P., and T.L. Dobbs. 1988. The role of economics in achieving low-input/sustainable farming systems. To appear in Proceedings of International Conference on Sustainable Agricultural Systems, Columbus, Ohio.

Ranek, John E. 1985. South Dakota agricultural statistics, 1979-1985. South Dakota Crop and Livestock Reporting Service, U.S. Dept. of Agr., Sioux Falls, SD.

________. 1987. South Dakota agricultural statistics, 1986-1987. South Dakota Crop and Livestock Reporting Service, U.S. Dept. of Agr., Sioux Falls, SD.

U.S. Department of Agriculture. 1988. Low-input/sustainable agriculture: research and education program. Cooperative State Research Service and Extension Service, U.S. Dept. of Agr. 7 pp.

Van Dyne, D.L., and C.B. Gilbertson. 1978. Estimating U.S. livestock and poultry manure and nutrient production. Economics, Statistics, and Cooperative Service, U.S. Dept. of Agr., Washington, DC.