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Title: **Evaluating the Sustainability of Alternative Farming Systems: A Case Study**

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Abstract:

The sustainability of farming systems must be assessed in terms of their potential ecologic, economic, and social performance. An approach to assessing relative sustainability, using all three types of performance criteria, is illustrated through a case study. Ecological criteria used in the study were natural resource conservation and environmental protection. Indicators of resource conservation were soil loss and energy use. Indicators of environmental protection were agricultural chemical use and cropping diversity. A single economic indicator, gross farm income, was use to assess economic viability. Social criteria used in the study were employment opportunities and utilization of community resources. Social indicators were numbers of potential viable family farms and the level of economic activity in the local community.

Two alternative scenarios were developed for farming land currently enrolled in the Conservation Reserve Program (CRP) in Putnam County, MO. A conventional scenario reflects farming systems currently typical for North Missouri. The alternative scenario reflects a farming system hypothesized to be more ecologically sound than the current system. Alternative cropping systems made greater use of crop rotations and input management to reduce agricultural chemical use and uses conservation tillage to reduce soil loss. Alternative livestock systems utilize management-intensive grazing to increase the productivity of cattle operations, which are inherently lower input and more resource conserving than typical north Missouri cropping systems. The case study focuses on utilizing selected economic and social

indicators to assess whether the farming systems hypothesized to be more ecologically sound might be at least as economically viable and socially responsible as conventional systems.

The comparison of scenarios indicated that returning CRP land to crop and livestock production could result in a two-fold increase in gross farm income over current CRP payments -- to $2.4 million and $3.4 million for conventional and sustainable systems respectively compared with $1.7 million in CRP payments. Greater gross farm income, in this case reflecting more labor and management applied to a given land resource, indicates a potential to support more farming families in the local community. Estimated total community economic impacts were 25 percent greater for returning CRP land to production under the alternative scenario than for the conventional farming scenario. In summary, the case study indicated land currently in the CRP program could be returned to production by means that could significantly enhance economic and social benefits to the local community, while retaining many of the ecological benefits attributable of the CRP program.

Evaluating the Sustainability of Alternative Farming Systems: A Case Study

The term sustainable agriculture has been defined in many ways (Allen, et.al, Lockeretz, Altieri, Smit and Smithers). However, most definitions seem to agree in defining sustainability as a characteristic of performance of farming systems rather than attempting to define sustainable farming practices, methods, or enterprises. A consensus also seems to be evolving concerning a set of performance criteria for evaluating sustainability (Stockle, et. al.). The Food, Agriculture, Conservation, and Trade Act of 1990 defines sustainable agriculture, for purposes of federally funded research and education programs, as "integrated systems of plant and animal production practices having site specific application that will over the long term: (a) satisfy human food and fiber needs, (b) enhance environmental quality and the natural resource base upon which the agricultural economy depends, (c) make the most efficient use of nonrenewable resources and on-farm resources, and integrate, where appropriate, natural biological cycles and controls, (d) sustain the economic viability of farm operations, and (e) enhance the quality of life for farmers and society as a whole" (U.S. Congress, Title XVI, Subtitle A, Sect. 1603)

Discussions during the legislative process further clarified the intended meaning of quality of life, at least as the concept applies to federally funded research and education. Increased income and employment opportunities, especially self-employment opportunities, in agricultural and rural communities, and a strong family farm based system of agriculture, with small and moderate sized farms, principally owner operated, were identified as indicators of enhanced quality of life (Congressional Record 10/22/90:H11128).

Most definitions and the above legislation seem in agreement that a sustainable agriculture must be ecologically sound, economically viable, and socially responsible. An agriculture that meets all three objectives is logically capable of maintained productivity and value to society over time, and thus, would be perpetually sustainable. Any system failing to meet any one of the three objectives cannot be sustained over time (Ikerd, 1994). One cannot prove empirically that one agricultural system is perpetually sustainable and another is not. One can only ask the question: is a system ecologically sound, economically viable, and socially responsible? All three are necessary and none is sufficient.

Risk and uncertainty are inherent aspects of sustainability. Sustainability is a question concerning the future, and the future is inherently risky and uncertain. One cannot concluded with certainty that a system of farming is or is not sustainable -- only that based on current knowledge a system appears likely or unlikely to be sustainable. Sustainability is a relative concept. One system can be said to be more or less likely than another to be sustainable over time. But, it is impossible to state with certainty that one system is sustainable and another is not.

Risk may be defined as the probability of an unfavorable outcome, for example, the risk a system is not sustainable. Probably is typically associated with stocastic events with known distributions of possible outcomes. With known distributions, the "probability" of a specific event can be precisely quantified prior to its occurrence. When the distribution of possibilities is not known, an event is said to be uncertain, because the precise level of risk is uncertain.

Many real-life hazards are characterized by uncertainties rather than quantifiable risks. One may estimate probabilities of future events based on observed distributions of past occurrences, but distributions of future possibilities are constantly reshaped by the changing biophysical, economic, and social contexts within which these events occur. In general, future distributions become increasingly difficult to estimate the more distant in the future the event of concern. Thus, our assessments of long run, perpetual sustainability are inherently fraught with uncertainties.

In assessing sustainability, attempts to assign specific probabilities to many events would be futile, even though the fundamental nature of such risks are clear. For example, it may seem obvious that rapid depletion of known fossil fuel reserves represents a significant risk to long run sustainability. However, it is not impossible to accurately assess the probability that total energy supplies will be drop below some critical level at any specific future point in time. One cannot know what alternative fuel sources might be discovered or what alternative technologies, including solar conversion technologies, might be discovered in the interim. Similar assertions can be made regarding sustainability risks associated with the current status or trends in soil erosion, water quality, farm profitability, or viability of family farms and rural communities. Relationships between such indicators and the sustainability of agriculture are neither certain nor probabilistic in nature. Thus, indicators of sustainability must be selected through logical deduction rather than empirical observation.

Assessing Sustainability

Sustainability must be measured in terms of ecological soundness, economic viability, and social responsibility. Environmentally sustainability might be based on indicators or measures of surface and ground water quality, soil and water conservation, energy use, farm safety, and biological diversity. Economic indicators might include measures of economic competitiveness or costs, farm profitability, return on investment, income variability, and financial risks. Social indicators might include measures of availability and cost of food and fiber, farm size and ownership structure, rural landscapes, self esteem of farmers, ethics of farm practices, and self-perceived quality of life of farm families and others who live and work in rural communities.

Obviously no single study can evaluate the full range of possible criteria for, or indicators of, sustainability. However, explicit consideration should be given to criteria and indicators of all three dimensions of sustainability: ecologic, economic, and social in nature. A system judged to be superior in one or more of these three dimensions, and not inferior in any other, may be judged as more likely to be sustainable. In cases where a system is judged superior in one or more dimension, but inferior in one or more of the others, no conclusions can be drawn regarding relative sustainability. Studies may focus on either ecologic, economic, or social sustainability, but any study of sustainability should give specific attention to all three.

Socially responsibility may be less widely recognized than are the ecologic and economic dimensions of sustainability, but is no less important. Social acceptance, social responsibility, and social justice have all be used to describe the social dimension of sustainability. However, the three terms have different meanings. For example, systems that are socially acceptable to one element of society may be viewed as socially unjust by another. Sustainability requires that acceptance and justice ultimately come together. A society will not be sustainable if its socially just systems are not deemed socially acceptable or its socially acceptable systems are not judged socially just (Ikerd, 1994). Social responsibility represents a link between social justice and social acceptability. Social responsibility is viewed as the means by which socially justice and social acceptance are brought together. If a society "accepts" responsibility for others of the current generation and for those of all generations to come, it might be said to be moving toward social "justice," and thus, toward sustainability.

Community Impacts of Sustainability

Few studies have even attempted to address the social or quality of life dimension of agricultural sustainability. Lockeretz compared the economics of high input conventional cropping systems with lower input alternatives in an attempt to draw conclusions regarding their impacts on local communities (1989). The underlying assumption was that lower input systems were more ecologically sound. Thus, lower input systems would contribute more to community sustainability, if they made equal or greater contributions to the economic viability of the local community. The results from five regional comparisons were inconclusive with respect to overall sustainability.

In general, the lower input systems were found to contribute less per acre to the local economy than did the higher input systems, resulting in a conflict between the relative economic and ecologic performance of the two types of cropping systems. This conflict was addressed through questions regarding the long run sustainability of higher input systems of farming. No attempt was made to assess quality of life or social indicators such as farm size, self employment opportunities, or viability of family farms in the local community.

A South Dakota study went beyond the work of Lockeretz in evaluating impacts of alternative farming systems on consumer spending and marketing services in addition to business spending for production inputs (Dobbs and Cole). The study paired five farms classified as "sustainable" with five "conventional" farms representing different regions of South Dakota. Data for the "sustainable" farms were gleaned from on-farm interviews, but four of the five "conventional" farms were "synthesized" from various sources. The "sustainable" farms were virtually "organic" farms in that none used inorganic fertilizer and only one farm reported appreciable use of commercial pesticides.

First-round economic impacts on local input purchases and marketing services were clearly negative for the "sustainable" farms. Not only did the organic farms purchase fewer inputs and market fewer products per acre, but they also purchased more of their inputs and marketed more of their products outside the local community. First-round, farm household income effects clearly depended on whether organic premiums were included or excluded from the analysis. Without organic premiums, four of the five "conventional" farms produced more income per acre, but with premiums included, three of the five "sustainable" farms produced more income per acre. Induced economic impacts, income impacts on consequent consumer spending, tend to magnify differences among farm household effects.

In spite of the stated conclusions, the South Dakota study produced inconclusive results with respect to agricultural "sustainability." The assumption, explicit in this case, was that the "organic" farms included in the study were more ecologically sound than the conventional farms. However, sustainability requires that such farms also be economically viable and socially responsible. Two of the five "organic" farms clearly were not more economically viable than the conventional farms based on the economic data presented. In cases where one farm is more ecologically sound and the other is more economically viable, no conclusions can be drawn regarding relative sustainability.

With organic premiums included, three of the five organic farms appeared to be more economically viable than their conventional counterparts and contributed as much or more than their conventional counterparts to the local community. The authors questioned the sustainability of organic premiums, which would seem also to put in doubt the sustainability of organic farming. However, their more serious problem in drawing conclusions regarding sustainability is that the study omits any consideration of the social or quality of life dimension of sustainability, such as differences in size between conventional and sustainable farms.

A Case Study of Sustainability

The Conservation Reserve Program was initiated by the 1985 farm bill as a means of removing environmentally fragile (i.e., highly erodible) land from degrading land use practices (i.e., cultivation for commercial crop production). The program has been successful in reducing ecological risks, through conserving top soil and reducing water quality risks associated with use of commercial inputs. Land owners were paid to remove land from production according to bids offered and accepted on a voluntary basis. Thus, the program made economic sense, at least from the standpoint of participating land owners. However, the CRP program may or may not be economically viable from the standpoint of program cost to taxpayers. Its societal sustainability is also questionable from the standpoint of its impacts on the people who actually farm the land and others who live and work in rural communities.

The case study presented here represents an attempt to evaluate the implications of returning land currently in the CRP program to agricultural production in Putnam County, Missouri on the sustainability of agriculture in the county. The case study is based on two alternative scenarios for using land currently in the CRP program. A conventional scenario was designed to reflect farming methods currently typical of northern Missouri farms. An alternative scenario was based on assumptions of increased use of crop rotations, more intensive input management strategies, and reduced tillage methods for cropping system. Pasture were utilized through a management intensive grazing systems for beef cattle production. The alternative scenario was designed to achieve a balance of ecologic, economic, and social benefits. An attempt was made to retain as many of the ecological benefits of the CRP program as practical while using the land in ways that would be profitable to local farmers and supportive of the local community. In other words, the alternative scenario was designed to reflect farming systems that might be more sustainable for local farmers and for the local community. All farming systems were "synthesized" using secondary data from a variety of sources and opinions of individuals knowledgeable of farming in the area.

The criteria used for ecological soundness in this study were natural resource conservation and environmental protection. Indicators of resource conservation were soil loss and energy use. Indicators of environmental protection were agricultural chemical use and cropping diversity. Economic criteria were financial costs and returns. Gross farm income was used as an indicator of economic viability. Criteria for social responsibility criteria used in this study were employment opportunities in the community and utilization of community resources. Indicators of social responsibility were potential number of viable family farms and level of economic activity in the local community.

The same acreage of the same crops were assumed to be produced under both scenarios, using recent cropping history for the county, to simplify the comparison. However, continuous corn and soybean systems, conventionally used on about half of Putnam County's crop land, were replaced with crop rotations, mostly corn-soybean rotations, under the alternative scenario. The alternative scenario utilized a ridge-till system to replace conventional tillage on more highly erodible lands. The ridge tillage system utilized banded input application and cultivation to cut herbicide use in half and reduce nitrogen application, while maintaining yields and achieving more effective erosion control than with conventional tillage.

Conventional fertilizer application was set at levels so as to not limit yields under the most favorable growing conditions. Fertilizer use for the alternative scenario was adjusted for realistic yield goals. Allowances were made for peak yield reductions in the most favorable growing years. A detailed description of the two scenarios and methods of analysis and the research base supporting assumptions regarding crop yields and cattle stocking rates may be found in a 1994 masters thesis by Traiyongwanich.

The alternative farming scenario represents a modest departure from conventional systems of farming in north Missouri. For example, many sustainable agriculture advocates may view a 50 percent reduction in commercial herbicide use in corn-soybean rotations as little more than fine tuning of conventional farming. However, the objective of this study was to evaluate alternatives that would be viewed as reasonable, not radical, departures from farming practices common in the area. No claim is made that the alternative systems are sustainable, only that such systems might be expected to move farming in the direction of sustainability.

The alternative system of cattle production was represented by a management intensive grazing system with 24 paddocks based on data from the Forage Systems Research Center in North Missouri (Moore). Conventional livestock production was represented by a three paddock grazing system, which likely overestimates the intensity of management of typical Putnam County livestock operations. The alternative system would allow farmers to stock more than 50 percent more cows on the same number of acres than would the conventional grazing system.

Differences in Gross Farm Income

Estimated costs and returns per acre were multiplied by the numbers of acres of CRP land to be returned to crop and livestock production in Putnam County, assuming the CRP program was allowed to expire. A survey of post-CRP intentions of Putnam County CRP contract holders indicated that 50 percent of current CRP land would be used for crop and 41 percent for livestock production (Traiyongwanich).

The results indicate an increase in total input purchases of $946,000, if CRP land were returned to conventional crop production compared with $707,000 for input purchases if the alternative cropping systems were used (Table 1). However, input costs for the conventional livestock system were lower, totaling $1,031,000, in comparison with the alternative system, totaling $1,401,000, due to higher stocking rates. Thus, combined total input purchases were actually higher for alternative systems, $2,108,000, than for the conventional systems, $1,977,000. In addition, combined returns over direct costs were nearly $1 million higher for the alternative system, $3,404,000, as compared with the conventional system, $2,421,000.

Table 1. Costs and Returns for Farming Scenarios

	Crops	Livestock	Total
Input Costs			
Conventional	946,000	1,031,000	1,977,000
Alternative	707,000	1,401,000	2,108,000
Gross Revenues			
Conventional	2,630,000	1,768,000	3,398,000
Alternative	2,831,000	2,681,000	5,512,000
Gross Income			
Conventional	1,684,000	737,000	2,421,000
Alternative	2,124,000	1,280,000	3,404,000

Gross farm income was used as a single indicator of economic viability. Gross farm income reflects returns to the farmer's land, labor, capital, and management. The land resource in this case study was the same for both scenarios, land currently in the CRP program in Putnam County. Interest on livestock were included in direct costs. Under actual farming conditions, farmers vary widely in the type and cost of equipment they have available or choose to buy to carry out the same basic farming practices. Thus, interest on investment and depreciation of equipment were not included in the study. In general, differences in gross farm income probably reflects differences in returns to the farmers owned resources as accurately as any single indicator. In addition, gross farm income represents a buffer between costs and returns that allows farmers to continue to operate during those times when they cannot cover total costs. Thus, gross farm income is an indicator of the resilience of a farm business, or its ability to bear risks, as well as its profitability.

Local Opportunities in Farming

This analysis of the first round, direct impacts indicates that returning CRP land to production under an alternative scenario for crop and livestock production could increase economic opportunities for farming in the local community without being exposed to the environmental risks of bringing CRP land back into conventional production. Gross farm income could be expected to rise to $2.4 million and $3.4 million respectively for conventional and sustainable systems compared with $1.7 million in total CRP payments for the county. The 26,000 acres enrolled in the CRP program theoretically could support twice as many farm families as were supported by CRP payments, assuming that a dollar in net cash farm income will support as many people as a dollar in CRP payments. In addition, nearly 40 percent of current CRP payments made to Putnam County landowners were going to persons living outside of Putnam or any adjoining county, whereas most returns to labor and management would be expected to accrue to local farm operators.

These results are similar to those of a companion Nebraska study compared detailed economic data provided by 28 farmers, half of which were classified as "conventional" and the other half as "sustainable" based on current farming methods (Kleinschmit, et. al.). The farms identified as "sustainable" were only about one-half as large; in terms of acres farmed, head of livestock, and total sales; as those called conventional. However, the sustainable farmers actually reported a higher average farm income, or return over direct costs per farm, in spite of their smaller size. A total of 169 people were supported by the 28 farms included in the Nebraska survey. It was estimated that an additional 44 people could have been employed on the same number of acres with at least as high a per capita income if all farms in the survey area had been of the same average size as the sustainable farms.

Whether the "potential" for one farming system to support more families that another would actually be realized depends on many factors. The farming systems in both the Putnam County, Missouri and Nebraska studies were more labor and management intensive, in that both systems would require more people per acre of land or per dollar of capital invested. These people might not be families living and working on smaller independently owned farms. However, the social indicator of "potential" farm size or ownership structure is not fundamentally different from "potential" soil loss or "potential" water quality risks associated with use of particular cultural practices or use of specific inputs on particular soil types. All such measures represent "potential" problems or "potential" benefits that may or may be realized under actual farming conditions over any particular period of time.

Measuring Community Economic Impacts

Total local economic activity, which includes personal income and returns to other local factors of production, was used as an indicator of returns to community resources. Farming activities have direct, indirect, and induced impacts on the local economy. Direct impacts are the first round impacts associated with purchases of production inputs, sales of farm commodities, and the resulting net cash farm income. Indirect effects result when local input suppliers or marketing firms buy raw materials, products, or business services from local sources.

Substantial leakages typically occur between direct and indirect economic impacts. A large portion of total production inputs may be purchased from sources outside the local community. Even when inputs are purchased locally, only a small proportion of the total sale price may go to local manufacturers, local service providers. Additional indirect effects occur when local manufacturers or service providers buy their raw materials or services from other local sources. However, additional leakages occur with each round of activity until additional impacts from a given initial transaction eventually becomes negligible.

Sales of farm commodities may also create indirect effects on the marketing, processing, or value-added sector of the local economy. Commodities sold locally generate sales commissions and other types of income for local marketing firms. Marketing firms may purchase supplies or employ local residents, resulting in indirect economic impacts similar to those associated with input purchases. As in the case of purchases, leakages occur at each round of activity, and eventually any additional impact from a given marketing transaction becomes negligible.

Total indirect effects represent the sum of all local economic activity occurring "after," but in response to, the initial direct transactions associated with input procurement and commodity sales. Indirect impacts are associated with the local business sector, including manufacturing, wholesaling, and business services. Induced impacts, on the other hand, are associated with local consumptive activities.

Induced impacts occur when people spend money they earn from participating in the local economy. Obviously, those earning income from agricultural transactions include farmers and farm workers. However, employees of local input suppliers, marketing firms, and other service providers also earn income from local agricultural transactions. As in the case of indirect impacts, initial consumption expenditures have second, third, and higher round impacts. Those who work for local retailers spend part of their incomes for local goods and services, which in turn generates income for local residents who provide those goods and services. And as in the case of indirect impacts, leakages at each round of consumption spending eventually reduce additional impacts from a given retail transaction until they become negligible.

Economic impacts of input purchases and consumption expenditures for the case study were based on production costs and gross farm income estimates shown in Table 1. Marketing impacts were estimated separately. Allowances were made for differences in sales between conventional and alternative systems and for the amount of grain fed to livestock. Total marketing margins were estimated at $110,400 for CRP land returned to conventional farming systems and $138,770 for the same land returned under the alternative farming scenario.

Indirect and induced economic impacts for the Putnam County case study utilized an input/output model (Implan software and 1991 data base). The Implan model was used to generate indirect economic impacts of production and marketing activities. However, refinements in the basic Implan procedure were required to capture the induced effects related to differences in gross income between the two system of farming.

The Implan model utilizes default relationships between total consumptive transactions and income of hired workers based on the total local economy. In this case, default values for induced impacts associated with farm income, or gross profits, were replaced with direct estimates, reflecting significant differences in estimated returns over direct costs between the two farming scenarios. Differences in induced impacts, arising from differences in personal income, accounted for most of the difference in total economic activity between the two scenarios.

In summary, the total economic impact from returning land presently in the CRP program to production under the alternative scenario was projected to total $7,860,000: $2,368,200 direct effects (excluding farm income), $925,700 indirect effects, and $4,565,000 induced effect (including farm income). This compares with $6,269,400 under the conventional farming scenario: $2,087,500 direct effects (excluding farm income), $776,000 indirect effects, and $3,406,000 induced effects (including farm income).

The economic impacts of crop production under both scenarios were very similar, even though their conservation and environmental quality impacts would be quite different. Most of the difference in economic impact arises from the livestock sector. The production and profit potential is significantly higher from the management intensive grazing system. The alternative system generated an estimated 25 percent higher level of local economic activity than did the conventional system. Most of the $1,590,600 advantage for the sustainable system is associated with the higher level of gross farm income and the associated consumption spending in the local community.

Conclusion

Returning CRP land to production under the alternative farming scenario appears to be more likely to be sustainable over time than returning it to production under the conventional system. There is reason to believe the alternative farming systems would be more ecologically sound than conventional systems because they would require fewer commercial inputs and would result in less loss of top soil. The alternative systems appears to be more economically viable, in terms of increased gross farm income, and may be more socially responsible, as indicated by greater local employment opportunities and economic activity in the local community.

The question of whether the alternative system would be considered more economically viable than the CRP by current CRP land owners is beyond the scope of this study. Also, current CRP land use practices are quite likely more environmentally sound and resource conserving than are those under either the conventional or alternative land use scenarios. Returning land to production under the alternative scenario would retain more of the ecological benefits than would returning the land to conventional production. However, significant trade offs among environmental, economic, and social benefits remain when the alternative scenario is compared with the CRP program. Sustainability is a question to which the answer is seldom either definite or clear.

REFERENCES

Allen, P., D. Van Dusen, J. Lundy, and S. Gliessman. 1991. Integrating social, environmental, and economic issues in sustainable agriculture, American Journal of Alternative Agriculture, 6(1):34-19.

Dobbs, T. and J. Cole. 1992. Potential effects on rural economies of conversion to sustainable farming systems, American Journal of Alternative Agriculture, 7(1&2):70-80.

Ikerd, J. 1994. "Assessing the health of agroecosystems from a socioeconomic perspective," paper presented at 1st International Symposium on Ecosystem Health and Medicine, Ottawa, Ontario, Canada, June 19-23, 1994.

Kleinschmit, L. D. Ralston, and N. Thompson. 1994. Community impacts of sustainable agriculture in northern Cedar County, Nebraska. Special report of Center for Rural Affairs, Walthill, NE.

Lockeretz, W. 1988. "Open questions in sustainable agriculture. American Journal of Alternative Agriculture. 3:174-181.

Lockeretz, W. 1989. "Comparative local economic benefits of conventional and alternative cropping systems," American Journal of Alternative Agriculture, 4:75-83.

National Research Council/National Academy of Science. 1989. Alternative Agriculture, National Academy Press, Washington, DC.

Smit, B. and J. Smithers. 1993. Sustainable agriculture: interpretations, analyses and prospects. Canadian Journal of Regional Science/Revue. 16(3):499-524.

Stockle, C.O., R.I. Papendick, K.E. Saxton, G.S, Campbell, and F.K. van Evert, "A framework for evaluating the sustainability of agricultural production systems," American Journal of Alternative Agriculture, 9:45-51.

Traiyongwanich, S. 1994. Post-CRP land use alternatives for Putnam County, Missouri, Unpublished Masters Thesis, Dept. of Agricultural Economics, University of Missouri.

GOAL (aspiration or target) Long Run Sustainability

OBJECTIVE (desired outcome, state, or direction of change)

CRITERIA (Evaluation Characteristic -- Standard, yardstick)

INDICATORS (Measure of Achievement -- evidence, mark)

OBJECTIVES	CRITERIA	INDICATORS
Economic viability:	returns:	gross farm income
	risks:	enterprise diversity
Ecological Soundness	resource conservation	soil loss energy use
	environmental protection	agrichemical use cropping diversity
Social Responsibility	economic and social opportunities	potential number of local farm families
	productive use of community resources	local economic activity