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ABSTRACT A comparison of labor use by small-scale conventional and sustainable farmers has received little attention from researchers. However, the issue is significant given the growing emphasis being placed on a sustainable farming system, which is considered to require more labor and managerial input compared to the conventional one. This study analyzes labor use of small-scale farmers in Tennessee by classifying them into conventional and sustainable categories. The data were collected using face-to-face interviews of randomly selected farmers. Analysis shows that farm operators were the primary source of labor for production and farm business management both for sustainable and conventional farmers, but there is a significant difference between sustainable and conventional farmers in their use of other family members' labor.

Labor is one of the key resources used in agricultural production in general and small-scale agriculture in particular. The use of labor involves a wide range of activities in farm operations including farm planning, production, management, purchasing inputs, marketing and accounting. There are extensive qualitative and quantitative studies

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pertaining to off-farm labor use (see, for instance, Huffman and El-Osta 1998; Hallberg, Findeis and Lass 1991; Sumner 1982). In contrast, research dealing with on-farm labor use is very limited (Jamtgaard 1995). The issue of on-farm labor use becomes especially critical given the growing emphasis being placed by the U.S. Department of Agriculture (USDA) and others on the need to adopt a sustainable agriculture system, which requires more labor and management skills compared to conventional agriculture (USDA 1996; Bultena et al. 1992; Strange 1988). This combined with the growing phenomenon of off-farm employment among farm households necessitates examining the availability and use of labor by small-scale conventional and sustainable farmers.

In this paper it is hypothesized that use of family labor is related to the characteristics of farmers in the sample in terms of whether they are conventional or sustainable. To the extent that the hypothesis is not rejected, the results may provide insight about labor use practices of the two groups of farmers.

SUSTAINABLE AGRICULTURE

There has been growing concern about undesirable environmental impacts due to excessive use of agrichemicals in conventional agriculture. Agricultural practices are listed as major contributors to water quality problems in 72 percent of river miles due to siltation and nutrient runoff (U.S. Department of Agriculture/Economic Research Service [USDA/ERS] 1997; Crutchfield 1989). In addition, continued economic decline of rural areas where agricultural is a predominant activity has been recognized (Rosset 1999; MacCannell 1988).

Sustainable agriculture, discussed below, emerged to address the above concerns (Allen et al. 1991; U.S. Congress 1990; National Research Council 1989). In the 1990 Federal farm legislation sustainable agriculture is defined as an integrated system of plant and animal production practices having a site specific application that will, over the long term: "satisfy human food and fiber needs; enhance environmental quality and the natural resource base upon which the agricultural economy depends; make the most efficient use of nonrenewable resources and on-farm resources and integrate, where appropriate, natural biological cycles and controls; sustain the economic viability of farm operations; and enhance the quality of life for farmers and society as a whole."

It can be discerned that the above definition incorporates economic, environmental and social aspects. Some government agencies, researchers, and farmers have embraced the concept and have been developing new practices and approaches that would reduce the negative impacts of agriculture on the environment while maintaining the income of farmers (De La Torre Ugarte et al. 1996; Morfaw et al. 1994; Ikerd, Monson and van Dyne 1993; Bultena et al. 1992; Jacobsen et al. 1991). Despite these studies there still exist differences of opinion on the subject of sustainable agriculture, including its definition and approach to measurement. Opinions range from those interpreting it to be an approach to farming with less negative impact on the environment, to being a new philosophy and a way of life. The latter implies the need to incorporate ecological and social aspects into the definition of sustainability (Stockle et al.1994; Neher 1992; Allen et al. 1991).

Differences in the definition of sustainability relate to which goals are most important to emphasize, which methods should be promoted and how policy and research decisions should guide agricultural development (Ikerd 1993). The key question is how to maintain the resource base[1] while meeting the food and fiber needs of future generations at an acceptable environmental cost. Aspects that constitute areas of debate include what tillage practices should be used, the costs and benefits involved, who bears such costs and reaps the benefits, and treatment of tradeoffs not only between economic and environmental objectives but also between different environmental objectives. There is also the well known problem of what discount rate should be used to evaluate the costs and benefits for future generations (Tegegne and Ekanem 1995; Prato, Xu and Ma 1994; Hallberg, Spitz and Ray 1994).

Supporters of sustainable agriculture believe in reducing the use of synthetic chemical inputs. Some draw a contrast between the sustainable and the industrial form of agriculture. Most fall in between the two forms. The industrial model relies on industrial technologies and biotechnology to boost productivity. The sustainable model on the other hand stresses smaller-scale farms which use small

[1] The Federal Agricultural Improvement and Reform Act of 1996 established a $35 million fund authorizing the Secretary of Agriculture to purchase voluntary easements with emphasis in natural resources and preserving wild life habitat.

farm technologies, reduced use of nonrenewable energy, more on-farm labor and management, greater biological diversity in fields and among crops and livestock, less processing of food, more resource conservation, more direct marketing, farm and regional self-sufficiency (Food and Agriculture Organization [FAO] 1999; Rosset 1999; Netting 1993). This holistic view calls for a systems approach to farming, more cooperation among farmers, and more involvement with the local community. The systems approach involves the integration of tillage practices, crop rotation schemes, on-farm fertility programs, natural and cultural methods, and complementary crop and livestock activities (Gardner, Jamtgaard and Kirschenmann 1995).

Many of those who view sustainable agriculture as a holistic concept are concerned that conventional agriculture contributes to the decline of small towns and rural communities. Rural communities they believe would be enhanced by a system of smaller farms that depend on relatively more local labor and management expertise (U.S. Department of Agriculture 1998; Steele 1997; Cartin and Saupe 1993; Labao 1990; Shaffer, Salant and Saupe 1986).

Peterson (1997) argues that small-scale farms are at least as efficient as large commercial farms if adjustments are made for environmental and other issues. D'Souza and Ikerd (1996) also maintain that small-scale farms are more sustainable than their large counterparts based on social, economic and environmental considerations.

Sources of Farm Labor

The assumption that labor can be readily available for agricultural activities cannot be made given the growing importance of off-farm employment which significantly contributes to the total household income of rural community residents (Hallberg et al. 1991).

Family labor is one of the most important farm-based resources displaced by machines and chemicals used by conventional agriculture. Herbicides have replaced hoeing to control weeds as well as the demand for skilled labor to machine cultivate crops. Labor inputs involved in the management of crop rotation schemes and the coordination of various farm operations are reduced due to synthetic fertilizers. Thus, labor-saving technologies have reduced the core farm work force to the minimum level (Huffman and El-Osta 1998).

The cost of purchased inputs could be replaced by family labor, providing farmers with the potential for more profit while at the same

time protecting the environment. On the other hand, lack of an adequate labor supply could be a barrier for adopting a more sustainable farming system, especially given the aging farm population and the seasonal nature of farming. The latter poses a problem in two respects: first, obtaining sufficient help during the peak season and, second, keeping workers busy during the waiting period in between crop production (Pfeffer 1983). Thus, for farm households, the transaction cost of finding, hiring, and training someone to do a job and paying for the time in transition to hiring them can be high.

Data and Analysis

The data used in this paper were collected as part of a larger collaborative USDA project aimed at evaluating impacts of adopting sustainable agriculture practices in rural communities of Tennessee. The study covered farmers in four counties operating diverse enterprises involving crops such as cotton, soybean, wheat, corn, tobacco, livestock, fruits and vegetables. The counties are: Dyer and Haywood in West Tennessee; Franklin and Wilson in Middle Tennessee. Responses were obtained from face-to-face interviews of 53 randomly selected farmers.

Farmers were asked to choose if adopting sustainable agriculture system could in the long run lead to an increase, a decrease or no change with respect to each of the following: 1) purchase of external inputs; 2) enterprise diversification; 3) environmental quality; 4) quality of rural life, and 5) farm profitability. External inputs refer to all purchased inputs such as nitrogen fertilizer, purchased fertilizer, herbicides and insecticides. Enterprise diversification involves both crops and livestock operations. The responses encompass the three categories of economic, environmental and social aspects used in the 1990 Federal farm bill.

The interpretation of responses to items 3 and 4 above is that production decisions by farmers were being made with consideration of impacts on the environment and the well-being of the community in which they are located. Item 5 indicates that profitability remains an important goal for sustainable farmers. Those who responded decrease to the first question above and increase to the other four questions were classified as sustainable and all others as conventional. In addition, responses provided by the two groups of farmers on key farming practices involving crop rotation, tillage, fertilization program and pest control were analyzed.

A recent study, (Comer et al. 1999), based on data from the same project as this paper, used the same criteria in classifying farmers into conventional and sustainable categories. It found no differences between the two groups of farmers when variables such as age, education, experience and off-farm employment were examined.

The labor-use data was obtained by asking conventional and sustainable farmers to indicate the proportion (in percent) of labor used in their operations in general that came from the operator, other family members and hired sources[2]. This procedure generates a reliable response given that most individuals have a relatively good perception about how their time is allocated in general. In contrast, farmers will not accurately recall if they were asked to respond to a question about their labor allocation for particular activities or commodities due to multiplicity of activities involving different enterprises (Juster and Stafford 1991).

The responses received for each source of labor were summed, and averages computed for all three categories. A *t*-test was done to assess if statistically significant differences exist between conventional and sustainable farmers in their use of farm operator's labor, other family members' labor and hired labor.

Characteristics of Sustainable and Conventional Farmers

Based on the five items discussed above, 23 of the respondents were classified as sustainable and 30 as conventional. The overwhelming majority of the sustainable farmers indicated that adopting sustainable farming systems would improve the quality of rural life, increase farm profitability and improve environmental quality (Table 1). On the other hand, responses to the same issues were much lower for conventional farmers, ranging from one-half to one-third.

On the question of whether or not adoption of sustainable agriculture will lead to a decrease in purchase of external inputs and

[2]Family in this study refers to the nuclear as well as the extended family such as the farm operator, spouse, children and stepchildren, brothers, sisters, parents and parents- in-law, grandchild and/or daughters-in-law. Non-household labor involves hired contract or custom workers including for short-term help in such operations as fruit and vegetable production.

Table 1. Selected Small-Scale Conventional and Sustainable Farmers' Expectation of Long-Run Effects of Adopting a Sustainable Farming System (In Percent).

Issue	Conventional (n=23)	Sustainable (n=30)
Improvement in quality of rural life	50.00	90.47
Increase in farm profitability	42.30	90.47
Improvement in environmental quality	34.61	90.47
Decrease in purchase of external inputs	26.92	71.42
Increase in Enterprise diversification	11.53	71.42

increase diversification of enterprises, over two-thirds of the sustainable group responded "yes." Only a small segment of the conventional group expects an increase in enterprise diversification and slightly less than one-third expect a decrease in purchase of external inputs (Table 1).

Both groups of farmers were also asked to indicate their operations with respect to each farming practice involving crop rotation, tillage, fertilization program, and pest control. The responses given in Table 2 show that less than one-third of the conventional group practiced rotation involving very few crops. In contrast, two-thirds of the sustainable farmers rotated multiple crops with emphasis on legumes as cover crops. With respect to tillage, over half of the conventional farmers used mechanical cultivation or moldboard

Table 2: Farming Practices, Fertilization and Pest Control Methods of Selected Small-Scale Conventional and Sustainable Farmers (In Percent).

Element of Farming system	Conventional (n=23)	Sustainable (n=23)
Crop rotation	Only 26.92 rotated very few crops	66.66 rotated many crops with emphasis on legumes used as cover crops
Tillage	61.53 used mechanical cultivation or mold-board plowing	61.9 used conserva-tion tillage (minimum or no till)
Fertilization pro-gram	84.61 used chemical fertilizers	66.66 used less chemical fertilizers and soil structure regeneration program
Pest Control	88.46 routinely applied chemical pesticide	71.42 used low input biological controls and other cultural methods with chemi-cal pesticides used as last resort

plowing and a similar number of the sustainable group used conserva-tion tillage (minimum or no till).

In terms of fertilization program, over three-fourths of conven-tional farmers used chemical fertilizers while two-thirds of the sustainable farmers used less chemical fertilizer and used soil structure regeneration programs such as soil testing. The contrast between the two groups is also marked when considering pest control, with the vast majority of the conventional farmers routinely applying chemical

Table 3: Labor Use for Selected Small-Scale Conventional and Sustainable Farmers in Tennessee (In Percent).

Source	Sustainable (n=23)	Conventional (n=30)	*t*-value
Farm operator	Mean=68.64	Mean=72.17	0.563
Other family member	Mean=17.46	Mean= 9.52	2.118*
Hired labor	Mean=12.81	Mean=18.31	1.03

*Significant at 0.05 level

pesticides while more than two-thirds of the sustainable farmers utilized low input biological controls and other cultural methods with chemical pesticides reserved as a last resort. These results are consistent with those found by others regarding farming practices of the two groups of farmers. (U. S. Department of Agriculture/Cooperative State Research Education and Extension Service [USDA/CSREES] 1991; Bultena et al. 1992).

Farm Labor Use

The farm operator was the primary source of labor for the conventional and sustainable groups in carrying out both production and farm business management activities of farm operations. The former involves nutrient practices, weed control, livestock care, planting, tillage and pasture management while the later includes managing finances, bookkeeping and purchasing inputs.

The share of labor coming from the farm operator was much higher than that of other family members and hired sources both for

sustainable and conventional farmers. This shows that the farm operator is the primary source of labor for both types of farmers.

A *t*-test showed no statistically significant difference between the two groups of farmers in their use of farm operator's labor and hired labor while there was a statistically significant difference between the two groups in their use of other family members' labor (Table 3). This is consistent with findings by others that sustainable farming is family-centered and is based on knowledge acquired from working on the farm (see, for example, Rosset 1999; Strange 1984).

Discussion

The importance of transition to a sustainable agriculture system has been emphasized by various groups. It includes the USDA, which issued a recent report specifically focusing on small-scale farms (USDA 1998) and has been implementing the Sustainable Agriculture Research and Education (SARE) program.

This paper analyzed use of labor from family and other sources by selected small-scale conventional and sustainable farmers in Tennessee. The study used a review of literature, response of farmers on their expectations of the effects of adopting sustainable agriculture system and farming practices used to classify them into conventional and sustainable categories. The findings that the farm operator is the primary source of labor for both types of farmers, and that sustainable farmers utilize more labor of other family members compared to conventional farmers, are consistent with findings by others. The results have important implications for farmers, policy makers and researchers.

First, given the aging farm population and the seasonal nature of farming, use of family labor is important in providing a reliable source of labor supply for a sustainable agriculture system. Use of family labor could also enhance farm profitability as a result of reduced cost of labor.

Second, as sustainable agriculture is characterized by diverse and complex activities such as farm planning, pasture management and row crop cultivation, the need for labor could be all year round, especially if livestock enterprises are predominant. This indicates that labor could be a constraint for small-scale farmers making the transition to a sustainable system of agriculture; policy makers should be cognizant of this phenomenon. Given that small-scale farmers lack adequate resources, limited access to labor would impose constraint on their production and

management capacity. The perishable nature of agricultural products, especially fruits and vegetables produced by small farms, requires timely harvesting and delivery if significant loss in income is to be avoided.

Finally, research using more detailed data involving different farm enterprises and the demand for and the supply of labor during different phases of operation could provide further evidence on the role of labor in a sustainable system of agriculture. Implications for survivability of small-scale farms particularly and rural development generally can be discerned from such research which is especially important in the southern region where the majority of small-scale farmers are found.

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