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FARMERS' PERCEPTIONS OF WHAT IS SUSTAINABLE

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Farmers' Perceptions of What Is Sustainable

Introduction

Over the years, sustainable agriculture has been conceptualized by various academic, scientific, and policy groups (Yunlong and Smit, 1994). When defining sustainable agriculture, economists, social scientists, and ecologists have emphasized different aspects ranging from supply and demand satisfaction to protection of quality of life and environmental resources (Douglas, 1984; Senanayake,1991). "A sustainable agriculture is one that equitably balances concerns of environmental soundness, economic viability, and social justice among all sectors of society." (Allen et al., 1991:37). This definition, like many others in the literature (Douglas, 1984; Francis, 1990; Allen and Sachs, 1993), advocates an agricultural production system that sustains the ecosystem, human life, and economic growth. While these viewpoints are consistent in presenting end goals of sustainable agriculture, they overlook the dynamic nature of the transition process as agriculture moves from ~~a~~ conventional or traditional practices toward practices that are more sustainable over time. Sustainable agriculture implies a movement from agriculture that is perceived as nonsustainable to one with new management and cropping systems (Doering, 1992; Francis et al., 1995; Hitzhusen, 1991) ~~of concern to farmers and advocates who are working in today's context to facilitate the transition.~~

Working with the concept of sustainability can be ambiguous because it means different things for different audiences (Dunlap et al., 1992). Sustainability is a multiple dimension concept "what is sustainable in one region may not be in another" (Youngs et al., 1991:114). The academic community has tended to put weight on the socio-economic factors and rural welfare with a healthy measure for farmers' consideration of sustainability, environmental protection and resource management (Dunlap et al., 1992).

The research reported in this paper models farmers' perceptions of sustainability as they might be involved in the current understanding of sustainable agriculture. A probit model is used to access the impacts that various farming practices and socio-demographic variables have on the likelihood of farmers' self-classification as sustainable.

Literature Review

Sustainable agriculture is used within a broad context that is often considered to be synonymous with organic, low input, alternative, ecological, and regenerative farming practices (Youngs et al., 1991; Yunlong and Smit, 1993). These diverse definitions are categorized in ways that allow a more coherent picture of its meaning. According to Douglas (1984), the subject of sustainable agriculture was approached by three different groups symbolizing three school of thoughts. First, the agricultural economists are concerned with efficient allocation of inputs and shifts of production supply and consumption demand. Second, ecologists want to control pollution, save environmental resources, and protect endangered species. Third, other social scientists regard the role of people, their communities, values, and culture vis-à-vis global changes that influence their subsistence as of primary importance. Douglas' classification was further interpreted in terms of three interrelated environments that surround agriculture (Yunlong and Smit, 1994). The biophysical environment is self-replenished and regenerative if sustained by a good maintenance system. The socio-political environment deals with social attributes such as culture and customs and institutions that shape human behaviors and their collective actions. Finally, the economic and technological environment is defined by the equilibrium between inputs and output to assure profitable and healthy agricultural business enterprises and efficient marketing systems. With respect to those three environments, establishing a sustainable agricultural system requires more than a few modifications to mainstream or conventional practices (Doering, 1992). Changes are predicted to involve: 1) more diversified farms, 2) fully priced crops that account for adverse environmental effects 3) environmentally sound farm-level decisions, and 4) more family farm operations (Doering, 1992). Making these shifts can be hard because farmers are often pulled between internal and external forces, reversible and irreversible trends, and public health and agricultural productivity decisions (Harrington, 1995). Consequently, some people advocate that a sustainable agriculture system is unreachable at present because of government regulations, strength of market signals, and demographic pressures (Doering, 1992; Olson, 1992a, 1992b; Taylor, 1990; Harrington, 1991).

Federal policies are more directed toward supporting farm income and maintaining low food cost than in protecting the environment (Olson, 1992b). They provide incentive for intensive farming practices regardless of their deviation from environmental soundness (Doering, 1992). Consequently, research in the U.S. has focused more heavily on high-yield inputs and technological effects than on low-input agriculture and efficient management of on-farm inputs (Taylor, 1990). "More ecologically based agriculture could increase production efficiency and decrease environmental impacts, but resource constraints will set an upper limit to sustainable production" (Olson, 1992b:5).

Federal agricultural programs are currently more market than environmental driven (Doering, 1992). Thus, market signals become important indicators that can cause government priorities to shift and farmers to move away from some conventional practices. However, "the market does not give signals to agricultural producers that reflect the cost of environmental damage; this then provides a rational for government intervention" (Doering, 1992:22). Economic costs of "chemical contaminant in an underground water; soil sediments impacting harbors and lakes; nitrate and pesticide impacts on surface water treatment" are still external to seller and buyer (Hitzhhusen, 1991).

Population growth and poverty are also forces working against sustainable practices (Harrington, 1995). Demand for food is directly related to population growth thus shifting upward the demand for higher yield crops. Population growth and inequitable income distribution support poverty which in turn affect ways in which land is used and natural resources are preserved (Harrington, 1995). The net result of land misused and/or overused is that "soil erosion from croplands is estimated to be about 3 billion tons per year (NARC 1989) with one fifth of cropland subject to serious damage.

Erosion also degrades forest lands; 435 million tons of soil eroded from non-federal forest lands in 1977" (Olson, 1992a:2).

The context surrounding the evolution of sustainable agriculture is not without problems. The application of scientific and indigenous knowledge to developing a sustainable agriculture "may require researchers to turn their backs on some almost sacred features of traditional scientific inquiries" (Painter, 1991). However, there is hope. The case study of the Lambert farm demonstrated that low-input farms can be environmentally and economically profitable (Painter, 1991). Moreover, land grant universities are adjusting their curriculum to ease the transition from conventional to sustainable agriculture and establishing working committees to explore sustainable options (Francis et al. 1995). Sustainable agriculture, though in need of more support (Kirschenmann, 1990), can be a reality (Rodale, 1990) despite government programs that favor conventional farming and universities that have limited resources at their disposition (Olson, 1992b).

Methodology

Model Specification

One of the techniques often used to classify farming practices is to ask farmers to choose a term that best describes their operations. This method, farmer self-classification, though not without problems (see Youngs et al., 1991 for details) was used in the present study to categorize farm enterprises as either conventional or sustainable.

The statistical model is first discussed and is then followed by the description of the data used.

Following with the traditional probit estimation, we first assumed that the i^{th} farmers' response to whether their current farming operations were sustainable or conventional to be a random dichotomous $\mathbf{y_i}$. $\mathbf{P_i}$ is the probability that $\mathbf{y_i}$ equals to 1 if sustainable and 1-$\mathbf{P_i}$ is the probability that $\mathbf{y_i}$ is 0 if conventional. Factors affecting $\mathbf{P_i}$ were investigated in a probit model that resulted in a sustainability index S[1]. This sustainability is hypothesized to be a function of various farming practices and farmers' socio-demographic characteristics. If $\mathbf{S_{i1}}$ is farmers' ideal perception of what a sustainable farm ought to be and $\mathbf{S_{i0}}$ is the current farming practices, the i^{th} farmer will likely consider his/her operation sustainable if $\mathbf{S_{i1} \geq S_{i0}}$. The probability function $\mathbf{P_i}$ is specified as follows:

$$P_i = Pr\left[y_i = 1\right] = Pr\left[S_{i1} \geq S_{i0}\right] = F\left(x_i'\beta\right)$$

where $F(\cdot)$ is assumed to be a normal cumulative density function. The $1 \times K$ vector of explanatory variables, $\mathbf{x_i}$', represents farming practices and socio-economic characteristics of the i^{th} farmer . The parameter vectors, β, are associated with $\mathbf{x_i}$'. The vector of explanatory variable is described in the next section.

1 For more detailed explanation of the probit model see Judge, et al.(1998) and Greene (1991).

Data

The probit model was operationalized with data obtained from a mail survey sent to a sample of 1,364 dairy and vegetable farmers living in ten southeastern Pennsylvania counties[2]. Survey instruments were designed to access farmers' attitudes and opinions about trends in agriculture and current farming practices. In addition, the instrument asked socio-demographic and economic information on farmers and farm management situations. As a result of using Total Design Method (Dillman, 1978), 739 questionnaires were returned for an overall response rate of ~~54.2%~~

The dependent variable, a qualitative dichotomy, measures farmers' perception of their farming practices as either sustainable or conventional. This binary variable, SUSTAIN, was coded 1 for sustainable farmers and 0 for conventional farmers.

Independent variables are factors that explain farmers' self-classification as sustainable or conventional. Elements that capture current farming practices were found in answers to fifteen "yes or no" questions[3]. Farmers were asked to indicate farming practices used in their operations (see Table 1). All but two coefficients, chemical fertilizers and age, were expected to be positive because they described practices that support sustainability. The farmers' socio-economic and demographic characteristics

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[2] This study is part of a larger Regional Infrastructure for Sustaining Agriculture (RISA). RISA is a project funded by the Kellogg Foundation and is designed to create alliances of farmers, community and government leaders, consumers, and scientists. RISA was formed to help southeastern Pennsylvania communities organize their efforts to sustain farming in a rapidly urbanizing area.

[3] Table 1 contains definitions of the variables, their hypothesized signs, and their abbreviations Correlation coefficients were calculated for all the variables and no evidence of multi-collinearity existed.

were also considered. These variables were binary coded as 0 and 1 except for age, revenue, and total acreage farmed, which were continuous (see Table 1).

Table 1 Independent Variables: Names, Definitions, and hypothesized behavior

Variable Name	Description	Expected Behavior
Farming Practices		
NOTILL	1 if no till or limited tillage was used, 0 otherwise	+
GREENMC	1 if green manure crops were used, 0 otherwise	+
CHEMICF	1 if chemical fertilizers were used, 0 otherwise	-
ROTATPC	1 if cultivation or rotation was used for weed or pest control, 0 otherwise	+
ORGANIF	1 if the farm was organic, 0 otherwise	+
INSECTS	1 if farmers scout for insects, 0 otherwise	+
CUINSEC	1 if famers made calendar use of Insecticides, 0 otherwise	+
COMPMAN	1 if compost manure was used, 0 otherwise	+
IRGRAZE	1 if farmers used intensive rotational grazing, 0 otherwise	+
COVERCP	1 if cover cropping was used, 0 otherwise	+
HRBCIDE	1 if post emergency herbicides were used, 0 otherwise	+
RAWMANU	1 if famers used raw manure, 0 otherwise	+
PROBIOT	1 if famers regularly used probiotics, 0 otherwise	+
BIOPEST	1 if biological pest control was used, 0 otherwise	+
DIVERSF	1 if the farm was diversified, 0 otherwise	+
Socio-Demographic Characteristics		
DAIRY	1 if operation a dairy farm, 0 otherwise	
ACRE	Number of owned and rented acres	
REVENUE	1 if under $10,000 2 if $10,000 - $39,999 3 if $40,000 - $99,999 4 if $100,000 - $249,000 5 if $250,000 - $499,999 6 if over $500,000	+
AGE	Age in years of respondent	-
PROGRAM	1 if participated in any government program, 0 otherwise	+
CREDIT	1 if farmers borrowed for their operations, 0 otherwise	+
LABOR	1 if farmers relied on available labor supply, 0 otherwise	+

Empirical Results

In Table 2, the likelihood ratio statistic supported that the overall model had significant explanatory power. The qualitative interpretations of the estimated coefficients matched the hypothesized signs for all the significant variables.

From the independent variables that measured farming practices, six were significant at 0.1 or better (see Table 2). Farmers who either used notill or limited tillage, **NOTILL**, were 10.2% more likely to consider themselves as sustainable. The probability increased by 3.4% when green manure crops were applied. The marginal effect of operating an organic farm, 0.183, was the largest positive coefficient among the significant variables representing farming practices. Organic farming was the most important factor that positively influence farmers' perception of sustainability. When a farmer answered 'organic' he/she was 18.3% more likely to choose sustainability for his/her practices. Similarly, farmers whose farms were diversified (**DIVERSF**) and who regularly used compost manure (**COMPMAN**) and probiotics (**PROBIOT**) were more likely to classify themselves as sustainable (see Table 2)

As was expected, the use of chemical fertilizers had negative influences on farmers self-definition as sustainable. As more chemical fertilizers were employed, farmers tended to view their practices as conventional. Adoption of chemical fertilizers reduced the probability in sustainability by 22.5%. The absolute value of the marginal effect of **CHEMICF** , being the largest among the significant farming practices, informs that using chemical fertilizers was a very important criterion in lowering farmers' self-perception of sustainability (see Table 2).

Among the socio-economic and demographic vectors, **LABOR** and **DAIRY** were significant at 0.05 level (see Table 2). Availability of reliable labor, though with a low probability of 0.8%, was a positive factor that influenced a farmer to respond '"yes" to sustainability. Dairy farmers in general were less likely to classify themselves as sustainable (see Table 2).

The non-significant socio-demographic factors were also informative. Farm size and revenue had no impact on farmers' self-classification as sustainable. As Francis (1990) explained, sustainable farming can be practiced in both small family and large farms. Similarly, participation in government and credit farm programs made no difference in farmers' responses. Since those programs are more oriented toward supporting income and price levels (Olson, 1992; Doering 1992), the hypothesis that farmers join them mainly for financial motives is supported.

Table 2 Probit Regression Results

Variable Name	Mean	Coefficient β	Marginal Effect	t-Ratio
SUSTAIN	0.279			
CONSTANT		-0.514	-0.164	-1.784*
NOTILL	0.556	0.320	0.102	2.392**
GREENMC	0.497	0.425	0.136	3.079***
CHEMICF	0.832	-0.703	-0.225	-4.384***
ROTATPC	0.802	-0.084	-0.027	-0.530
ORGANIF	0.132	0.871	0.183	3.300***
INSECTS	0.757	0.030	0.009	0.195
CUINSEC	0.314	-0.131	-0.042	-1.034
COMPMAN	0.127	0.291	0.093	1.731*
IRGRAZE	0.171	0.247	0.079	1.600
COVERCP	0.724	-0.002	-0.780E-03	-0.015
HRBCIDE	0.740	-0.051	-0.016	-0.339
RAWMANU	0.781	0.014	0.004	0.088
PROBIOT	0.114	0.358	0.114	1.999**
BIOPEST	0.171	0.043	0.014	0.267
DIVERSF	0.329	0.325	0.104	2.521**
Dairy	0.795	-0.352	-0.112	-1.991**
ACRE	166	0.220E-03	0.704E-04	0.810
REVENUE	155,000	0.414E-06	0.132E-06	0.909
AGE	43.7	-0.186E-03	-0.595E-04	-0.463
PROGRAM	0.768	0.020	0.006	0.139
CREDIT	0.698	-0.096	-0.031	-0.727
LABOR	0.357	0.250	0.080	2.058**
Log Likelihood	-317.81			
Likelihood Ratio	110.75[a]			
Number of Observation	630			

* Significant at 0.10 ** Significant at 0.05 *** Significant at 0.01

[a] The likelihood ratio statistic is distributed as a Chi-square with 22 degrees of freedom and is significant at the 0.01 level.

Conclusions

Using a probit model, this paper investigates factors that affect the probability of a farmer self-classifying his/her farming operation as sustainable or conventional. The empirical analyses showed that farmers generally agree with academics and others on practices that are sustainable. For example, the use of chemical fertilizers varied inversely with farmers' perception of sustainability. On the other hand, the practice of organic farming exerted the most positive influence on a farmer's choice of sustainable. While availability of reliable labor was positive and significantly related to sustainability, farm size and participation in government and credit programs were not.

In this study, farmers' practices were found to be compatible with their generally held perception of sustainability which in fact was coherent with various implications underlying the definitions considered earlier. So, while there may be working disagreements between scientists, policy makers, and farmers as to what sustainable agriculture means, a common ground is beginning to emerge. Farmers' perception of a sustainable agriculture that protects the environment, profitability, solvency, and labor market is consistent with policy makers and academics.

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