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IMPACTS OF SUSTAINABLE AGRICULTURE ON NORTH DAKOTA RURAL COMMUNITIES

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Table of Contents

	Page
List of Tables	iii
List of Figures	iv
Highlights	vii
Community Involvement and Sustainable Agriculture	2
Organizational Involvement	2
Trade Patterns	2
Input-Output Interaction	3
Methods	3
Sample	3
Procedures	4
Classification System	4
Farmer Self-Identification	5
Farm Practices	5
Farmers' Attitudes	6
Farm Group Membership	6
Implications of Classification Index	6
Community Involvement	7
Results	8
Organizational Involvement	8
Number of Organizational Involvements	8
Hours of Organizational Involvement	8
Number of Offices Held	9
Organizational Dues	11
Other Contributions and Out-of-Pocket Expenses	11
Trade Area Patterns	13
Miles Traveled	13
City Population	13
Percentage of Purchases	13
Input-Output Interaction	16
Conclusions and Implications	19
References	21
Appendix	25

List of Tables

Table		Page
1	MEAN NUMBER OF ORGANIZATIONS BY TYPE OF FARMER, NORTH DAKOTA, 1989	9
2	AVERAGE HOURS PER MONTH DEVOTED TO ORGANIZATIONS BY CLASS BY TYPE OF FARMER, NORTH DAKOTA, 1989	10
3	AVERAGE NUMBER OF OFFICES HELD WITHIN ORGANIZATION CLASSES BY TYPE OF FARMER, NORTH DAKOTA, 1989	10
4	AVERAGE DOLLARS PAID IN DUES TO ORGANIZATIONS BY TYPE OF FARMER, NORTH DAKOTA, 1989	11
5	AVERAGE DOLLAR CONTRIBUTIONS (EXCLUDING DUES PAID) TO ORGANIZATIONS BY TYPE OF FARMER, NORTH DAKOTA, 1989	12
6	MEAN POPULATION OF CITIES IN WHICH THE MAJORITY OF SELECTED GOODS AND SERVICES WERE PURCHASED BY TYPE OF FARMER, NORTH DAKOTA, 1989	13
7	GROSS BUSINESS ACTIVITY AND EMPLOYMENT FOR NORTH DAKOTA WITH CONVENTIONAL OR SUSTAINABLE FARMING SYSTEMS, 1990	18

List of Appendix Tables

Table		Page
1	AVERAGE MILES DRIVEN TO PURCHASE MAJORITY OF SELECTED GOODS AND SERVICES BY TYPE OF FARMER, NORTH DAKOTA, 1989	27
2	MEAN PERCENT OF PURCHASES MADE AT MAJOR RETAIL CITY FOR SELECTED GOODS AND SERVICES BY TYPE OF FARMER, NORTH DAKOTA, 1989	27
3	AVERAGE TRANSACTIONS BUDGETS OF AG LIVESTOCK SECTOR FOR CONVENTIONAL AND SUSTAINABLE NORTH DAKOTA FARMERS AFTER ADJUSTMENT FOR FARM SIZE 1990	28
4	AVERAGE TRANSACTIONS BUDGETS OF AG CROPS SECTOR FOR CONVENTIONAL AND SUSTAINABLE NORTH DAKOTA FARMERS AFTER ADJUSTMENT FOR FARM SIZE 1990	28

List of Figures

Figures		Page
1	Average Miles Driven to Purchase Majority of Selected Goods and Services by Type of Farmer, North Dakota, 1989	14
2	Mean Percent of Purchases Made at Major Retail City for Selected Goods and Services by Type of Farmer, North Dakota, 1989	15

Highlights

The purpose of this report is to examine the amount of interaction various types of North Dakota farmers have with their local communities. Three farmer types (conventional, mixed-type, and sustainable) were compared in terms of their relative support for community organizations, trade patterns, and economic linkages with businesses in the state.

In March and April of 1990, 495 North Dakota farm and ranch operators were surveyed. Of the 495 farmers, 424 were from a panel previously surveyed by Leistritz et al. (1989), and 71 farmers were associated with the Northern Plains Sustainable Agricultural Society (NPSAS). Farmers were classified on the basis of an index using the Northwest Area Foundation Initiative criteria (Bird and Hassebrook, 1990). A maximum of one point was possible for each of the following categories: 1) member of sustainable group (NPSAS), 2) self defined as low input, 3) attitude toward reduced reliance on off-farm inputs, 4) attitude toward decreased dependence on chemical and scientific advances, 5) use of fertilizer, 6) use of chemicals, and 7) use of green manures. Those farmers with scores greater than 5 on the 7-point scale were categorized as sustainable; 3 to 5 mixed-type; and below 3, conventional.

To measure community involvement, farmers were asked to list those organizations in which they were involved, along with other information, such as the number of hours they contributed to each organization, the number of offices held, and the amount of dues and other cash contributions. To determine trade patterns, farmers were asked to list the name of the town where they purchased a majority of selected goods and services, the number of miles they traveled one way to make these purchases, and the percentage of goods and services they purchased in these towns. Categories of goods and services included food, hardware, banking services, furniture, autos, farm machinery, supplies, and chemicals. Finally, to determine overall economic activity, farmers were asked to list farm income and expenses from their 1989 1040F tax forms and the percentage of income or expense that occurred within the state. Following are some of the highlights.

- *Sustainable farmers participated in more church organizations and devoted more hours per month to farm organizations than did either mixed-type or conventional farmers. They also contributed more cash contributions to farm, commodity, and professional organizations.*

- *The size of towns where the three types of farmers purchased goods and services was not significantly different. Sustainable farmers bought a lower percentage of food at their major retail city than did mixed-type farmers and they tended to travel farther to purchase most of their goods and services.*

- *Sustainable livestock producers' purchases and sales with businesses in the state were not significantly different from conventional livestock producers. Sustainable crop farmers generated less gross farm income from sales of farm crops than conventional farmers and bought fewer goods and services from the financial, real estate, and insurance, and retail sectors of North Dakota. A move toward sustainable farming practices might provide less overall economic activity and employment for other sectors of the economy.*

- *An inadequate infrastructure for sustainable (organic) farming systems was identified. Sustainable farmers did not interact with their local elevators as much as did conventional farmers. Most sustainable farmers sold their products directly out of the state.*

Overall, sustainable farmers were slightly more involved socially in the community's organizations but were less involved economically. A statewide shift to sustainable farming would be bumpy, at least in the short run as local infrastructures try to respond to the different needs of sustainable farmers. This has broad implications for policy makers, especially in states like North Dakota that are looking to increase economic activity. This study emphasizes the need for increased research on ways to make sustainable practices more profitable, and to identify and implement the local infrastructure sustainable farmers need.

IMPACTS OF SUSTAINABLE AGRICULTURE ON NORTH DAKOTA RURAL COMMUNITIES

Alternative farming methods gained national interest during the past decade, largely because of the farm crisis and the resurgence of concern for the environment. Legislative suggestions of tying federal agriculture program payments to sustainable farm practices reflect this interest. As American farmers and policy makers become more interested in sustainable agriculture, concern over the impact that these farming systems would have on local communities continues to emerge. Advocates of sustainable farming argue that it will strengthen local communities by making them more self-sufficient. Others argue that sustainable farming will undermine the economic well being of local communities.

In 1988, the Northwest Area Foundation requested research proposals to determine the socioeconomic and agronomic impact of low-input sustainable agriculture (LISA) practices. Five states (Iowa, Minnesota, Montana, North Dakota, and Oregon) received funding from the foundation to participate in this research. This report presents a comparison of the community interaction of farms categorized as sustainable, using the Northwest Area Foundation Sustainable Agriculture Initiative guidelines.

North Dakota is particularly suited for a study on sustainable agriculture because the state relies heavily on agriculture. Forty-three of North Dakota's 53 counties are agriculturally dependent[1], and nearly 10 percent of the total state personal income is from farm sources[2]. Adopting alternative practices could change not only the state's agricultural production and income, but the state's overall economic condition as well.

North Dakota's agriculture industry is based primarily on the production of beef, wheat, barley, and sunflower. Cash receipts from marketing these farm products in 1988 were $651 million, $666 million, $233 million, and $168 million, respectively, accounting for over 70 percent of the state's farm marketing cash receipts, excluding government payments (Bureau of the Census, 1989). This paper will focus on the components of community interaction of sustainable, mixed-type, and conventional North Dakota farmers.

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[1]Agriculturally dependent counties are those where 20 percent or more of the total labor and proprietor income was produced from farming/ranching (Bender et al., 1985; Ross and Green, 1985).

[2]Based on Bureau of Economic Analysis data for 1980 to 1989.

Community Involvement and Sustainable Agriculture

Organizational Involvement

One approach to measuring the interaction of farmers with their local communities is to measure the extent that farmers participated in organizations within the community (Heffernan and Lasley, 1978; Poole, 1981). Previous research of the relationship between type of farmer and level of organizational involvement has led to contradictory expectations. Crosson and Ekey (1988) found that a move to alternative agriculture demanded more management time and skill than did conventional agriculture, suggesting less time would be available to participate in organizations. However, Poole (1981) examined farm scale and community involvement and concluded that there is an inverse relationship between size of farm and family participation in civic affairs. Because sustainable farmers may be constrained to smaller farming operations than conventional farmers due to increased labor demands (Poincelot, 1986; USDA, 1980), sustainable farmers' organizational involvement might be greater than that of conventional farmers.

Trade Patterns

A second method for examining community interaction is to examine buying patterns for goods and services within the community (Goldschmidt, 1978; Korsching, 1984; Goreham et al., 1986). Goldschmidt (1978) argued that as the scale of farms increases or as farmers own a smaller share of the land they operate, purchasing patterns shift. Farmers who own larger operations are more likely to bypass small, local trade centers in favor of larger, urban trade centers. Non-landowning farmers have less invested in the community, and it is less critical to their operations if businesses in the community fail. Greater amounts of resources allow larger farms to depend less on the local community and make them more able to purchase inputs from larger regional or national agribusiness firms.

Korsching (1984) and Goreham et al. (1986) conducted studies of midwestern agriculture that extended Goldschmidt's research. Korsching (1984) found that older farmers tended to purchase food, autos, and other items more often in local communities. Further, a lower percentage of land owned and increased involvement in community organizations were related to smaller amounts of purchases in the smaller, local communities.

Goreham et al. (1986) found similar results. Based on the arguments and findings of Goldschmidt (1978), Korsching (1984) and Goreham et al. (1986), the purchasing patterns of sustainable farmers should differ from conventional farmers to the extent that these farmers differ systematically in size of farm, share

of farm land owned, age, and community involvement. However, it is unclear what the net effect of these factors is likely to be.

Input-Output Interaction

A third method for measuring the interaction of farmers with the local community examines the extent that the farming sector is able to generate new wealth and examines the linkages between this new wealth and economic activity and employment in the community. Farmers' interaction with the other sectors in the economy can have significant impacts on business activity and employment, especially for agriculturally dependent states like North Dakota. Input-output analysis lends itself to examining the contributions of individual sectors of the North Dakota economy. Input-output analysis describes how dollars generated from sales of final goods outside the state are spent and respent within the state (Richardson, 1972). Movement toward sustainable practices could alter these dynamics for the farming sector in North Dakota. If so, analysis of differences in farming types will reflect a technical shift in purchasing and selling patterns in the model's technical coefficients matrix of transactions (Richardson, 1972, p. 170).

Lockeretz (1989) reviewed five studies of conventional and alternative farming systems and concluded that conventional farmers contribute more to the local economy than do alternative farmers. His review did not include multiplier effects of income retained within the area but focused on farming systems that concentrated on crop farms with little livestock integration. In this study, the definition of sustainability includes using a combination of low-input practices, reduced reliance on off-farm purchases of fertilizer or chemicals, and increased use of green manures. This definition of a sustainable farmer with its emphasis on reduced use of purchased inputs and increased use of on-farm inputs suggests that sustainable farmers may generate less local economic activity than do conventional farmers.

Methods

Sample

A survey of 495 North Dakota farm and ranch operators was conducted in March and April of 1990. Their names were obtained from two sources. First, a panel of 424 farmers previously selected at random and surveyed by Leistritz et al. (1989) was resurveyed. The panel had been contacted first in 1985 (N = 933) and again in 1986 (N = 759) and in 1988 (N = 557). Respondents to the initial survey were screened "to ensure that all respondents were less than 65 years old, were operating a farm, considered farming to be their primary occupation, and sold at

least $2,500 of farm products in 1984" (Leistritz et al., 1989, p. 1).

Second, 71 names from the membership list of the Northern Plains Sustainable Agricultural Society (NPSAS) were added to the sample because the farm panel included only a small number of sustainable farmers. This enhanced the likelihood of meaningful comparisons of sustainable and conventional farmers when examining the impact of farm type on community interaction. However, the reader should remain alert to the fact that subsequent analyses contain a disproportionate number of sustainable farmers relative to their actual proportion in North Dakota.

Procedures

Farmers were approached in three stages: 1) farmers received a letter explaining the nature of the project and indicating they would soon be contacted by phone. 2) Approximately a week later, the phone survey began. At least four efforts were made to contact each farmer. The response rate for this phone survey was 80.0 percent (340 panel, 80.2 percent; 56 NPSAS, 78.9 percent). 3) Those who responded to the phone survey received a mail survey that included a number of Likert-scale items that could be answered more rapidly in a self-administered questionnaire than by phone. A follow-up postcard was sent to farmers thanking them for their participation if they had already completed and mailed the survey and asking them to complete the survey if they had not. The response rate for the mail survey relative to those initially contacted by phone was 69.7 percent (230 panel, 67.6 percent; 46 NPSAS, 82.1 percent) while the response rate for the mail survey relative to the original sample was 55.8 percent (panel, 54.2 percent; NPSAS, 64.8 percent).

Classification System

Since the analysis focused on type of farmer as the independent variable, a method was needed to determine whether a farmer was either conventional or sustainable or perhaps somewhere in between, that is, mixed-type. Youngs et al. (1990) examined a number of different approaches to measure the type of farmer and found considerable variability among approaches. The type of farmer is a complex variable that involves multiple dimensions of comparison, and no single measure is likely to tap all dimensions simultaneously.

Rather than pick and choose among measures, the Northwest Area Foundation's Sustainable Agriculture Initiative approach was adopted (Bird and Hassebrook, 1990). This approach involves constructing an index based on a farmer's self-identification, practices, attitudes, and farm organization membership. Each

dimension is scored to reflect the degree to which a farm operation relies on internal resources versus off-farm inputs.

The index is based on responses to seven questions measuring the above noted dimensions. Responses to each question were recoded to range from 0 (high input/conventional) to 1 (low input/sustainable) and combined to give an overall index with values ranging from 0.00 to 7.00. However, to simplify subsequent analyses, the scale was converted to three categories: conventional (0.00 to 3.00; N = 187), mixed-type (3.01 to 5.00; N = 54), and sustainable (5.01 to 7.00; N = 29). The questions used in the index are described below.

Farmer Self-Identification

Farmers were asked to classify their farm operation's input use. They were asked, "Which of the following lists of characteristics best describes your present farm/ranch operation?" Farmers could check one of the following statements: a) "My operation relies on such purchased inputs as fertilizer, pesticide, and/or energy inputs"; b) "My operation is actively reducing reliance on such purchased inputs as fertilizer, pesticide, and/or energy inputs"; and c) "My operation primarily relies on low-input practices." Farmers who chose the last option were classified as sustainable farmers and received a score of 1 for the index. Farmers who chose the other options received scores of 0.

Farm Practices

The questions on farm practices for the index focused on inputs. Farmers were asked about their use of two off-farm inputs, herbicides and commercial fertilizers, and about their use of one on-farm input, green manure. The questions on farm inputs were identical in format: "On what percent of your cropland, if any, did you use [herbicide/commercial fertilizer/green manure] in 1989? ____ %" To be consistent with the overall index, farmers' answers were converted from percentages to proportions with 100 percent as 1.00. Larger values were coded to reflect the use of fewer off-farm inputs. Thus, the answers to the questions on herbicides and commercial fertilizers were subtracted from 100 percent before being converted to proportions. For example, a farmer who used herbicide on 30 percent of his or her cropland received a score of .70 on the index. No such conversion was needed for the question on green manure because larger values already implied greater use of farm-produced inputs. These percentages were converted directly to proportions.

Farmers' Attitudes

Farmers were asked about their attitudes on LISA-related issues. Two of the questions focused on their attitudes toward chemical inputs and energy inputs. These questions were derived from work of Beus et al. (1988). Farmers were asked to indicate the extent to which they agreed with the following statements: "The domination of nature by humans should be maintained through chemicals and scientific advances"; and "Farmers should reduce their reliance on external sources of energy and inputs." Each statement was followed by seven-point Likert scales labeled "strongly agree" to "strongly disagree." These scales were collapsed to scores of 0 or 1 to fit with the overall sustainability index. All responses on the disagree side of the midpoint for the question on chemical inputs and all answers on the agree side of the midpoint for the energy input question were assigned the score of 1, while the remaining scale values for either question were assigned the score of 0.

Farm Group Membership

Farm group membership was taken into account in calculating the index. Farmers who belonged to the Northern Plains Sustainable Agricultural Society received a score of 1 while nonmembers were scored 0.

Implications of Classification Index

Combining these questions into one index created a continuous scale from 0.00 to 7.00 that was collapsed into three categories: conventional, mixed-type, and sustainable. To determine the relation of each of the components of the index to the overall index, a Kendall's Tau *b* coefficient was calculated for each question (scored 0 to 1) and the overall, three-category index. These coefficients are as follows: self-classification (.67), herbicide use (.61), commercial fertilizer use (.52), green manure use (.44), attitude toward chemical use (.53), attitude toward energy inputs (.42), and farm group membership (.66).

These are modest coefficients for an index. However, their size is not surprising given the distinct dimensions represented by the seven questions composing the index. Their size also is consistent with research on farmer classification by Youngs et al. (1990), who found that farmers who might be classified as sustainable, mixed-type, or conventional along one dimension of farming sometimes fall into a different category along another dimension. Nevertheless, each of the Chi Squares for the above coefficients was significant at $p < .0001$.

The mixed-type category of the index was examined to gain some understanding of the future intentions of these farmers. Are they simply mixed-type or do they intend to shift toward either conventional or sustainable farming in the future? Following the questions on herbicide use, commercial fertilizer use, and green manure use, respondents were asked to indicate whether they thought their use of any of these items would increase, decrease, or stay the same in the next five years. Farmers could also indicate that they didn't know what to expect.

The majority of mixed-type farmers planned to stay the same (herbicide, 58 percent; commercial fertilizer, 62 percent; green manure, 55 percent). For herbicides and commercial fertilizers, nearly as many planned to increase (13 percent and 19 percent, respectively) as to decrease (21 percent and 17 percent) their use of these products. In contrast, very few mixed-type farmers planned to decrease their current use of green manure (4 percent) while a third (33 percent) planned to increase their use of green manure. Overall, mixed-type farmers were simply mixed-type. If they were moving toward one end of the scale or another, there was some evidence of a shift toward the sustainable end, but it was not a dominant trend.

Community Involvement

Several measures were used to assess interaction of farmers with their local communities. First, a series of questions were asked to measure the extent that farmers participated in organizations within the community. Specifically, farmers were provided with a list of different types of organizations and asked to provide names of specific organizations to which they belonged within each type. Farmers also were asked to list the average hours of involvement per month, offices held, dues paid, other cash contributions, and place of involvement for each organization they listed. The types of organizations and the related parenthetical examples included: farm organizations (Farmers Union or Farm Bureau); commodity groups (wheat growers or cattlemen's associations); civic or service clubs (Lions or Toastmasters); professional or business organizations (Jaycees); PTA or other school organizations; township or county commission or other governmental offices; church (men's groups or Sunday school); cooperative extension groups (4-H or advisory committees); or other community groups (softball clubs or singing groups).

Second, several questions were asked to examine buying patterns for goods and services. Specifically, each farmer was asked 1) to list the cities where they purchased the majority of food, hardware, banking services, furniture, automobiles, farm machinery, farm supplies, and farm chemicals; 2) to estimate the percentage of these goods and services they purchase in these

cities, and 3) to indicate how far they traveled one-way to purchase these goods and services.

Finally, as an extension of these measurements, the effect of the farming sector's ability to generate new wealth was examined along with the economic and employment linkages between the local community and farmers. The results of these approaches are presented below.

Results

Organizational Involvement

Organizational involvement was compared by farm type (conventional, mixed-type, and sustainable) to see if the amount of organizational support within the community differed. Only organizational involvements that occurred in the state were included in the analysis. A one-way analysis of variance (ANOVA) with farm type as the independent variable was done on each of the measures of organizational involvement. A Tukey test of pairwise comparisons was performed on the means when ANOVAs indicated significance. The results of these tests should be treated with some caution because the sample data do not fully meet all of the assumptions for these tests.

Number of Organizational Involvements. The average number of organizations in which the three types of farmers were involved was not significantly different. Sustainable farmers participated in an average of 3.88 organizations compared to 3.48 organizations for conventional farmers and 3.64 organizations for mixed-type farms (Table 1).

One difference did emerge among the three farm types when specific groups of organizations were analyzed. There was a significant difference among the farm types in the number of church organizations in which the farmers were involved. Sustainable farmers interacted significantly more with church organizations than did their conventional counterparts (1.16 and .64 church organizations, respectively). The number of church organizations in which mixed-type farmers were involved (.93) fell between sustainable and conventional farmers but was not significantly different from either of the other groups. Some examples of the kinds of church organizations the farmers listed were Sunday schools, church boards, Bible schools, church choirs, church men's clubs, prayer groups, stewardship committees, youth committees, and ladies' aid.

Hours of Organizational Involvement. A second measure of organizational involvement was the average number of hours per month devoted to organizations. Sustainable farmers devoted an average of 16.98 hours per month to organizations, compared to

TABLE 1. MEAN NUMBER OF ORGANIZATIONS BY TYPE OF FARMER, NORTH DAKOTA, 1989

Class	Conventional	Mixed-type	Sustainable	F
Respondents	147	42	25	
Farm organization	1.04	.98	.91	.44
Commodity group	.56	.38	.48	.82
Civic club	.39	.45	.16	1.66
Professional	.14	.19	.24	.65
School	.12	.10	.12	.09
Government	.46	.26	.36	1.93
Church[a]	.64	.93	1.16	5.15**
Coop extension	.07	.14	.08	1.06
Other organization	.19	.21	.24	.14
Total organizations	3.48	3.64	3.88	.45

[a]Conventional significantly different from sustainable ($p<.05$).
* $p < .05$
** $p < .01$

12.93 hours per month for conventional farmers and 11.68 hours per month for mixed-type farmers. These differences were not statistically significant (Table 2).

Analysis of the average number of hours members of the three groups were involved in the various types of organizations revealed two significant differences. Sustainable farmers participated in farm organizations an average of 3.03 hours per month. This differed significantly from their conventional and mixed-type counterparts who averaged .67 and .95 hours, respectively. Since no significant difference was found in the number of farm organizations that each type of farmer supported (Table 1), apparently sustainable farmers either 1) voluntarily devoted more hours to their chosen farm organizations and/or 2) their organizations required more hours of involvement.

Number of Offices Held. A third measure of organizational involvement was the number of offices farmers held. Conventional farmers held an average of 3.44 offices compared to their sustainable and mixed-type counterparts, who held an average of 3.22 offices and 3.35 offices, respectively (Table 3). These averages were not significantly different. Analysis of the number of offices held in the various organizations revealed no statistically significant differences among the farmer types.

TABLE 2. AVERAGE HOURS PER MONTH DEVOTED TO ORGANIZATIONS BY CLASS BY TYPE OF FARMER, NORTH DAKOTA, 1989

Class	Conventional	Mixed-type	Sustainable	F
Respondents	147	42	22	
Farm organization[a,b]	1.67	.95	3.03	3.86*
Commodity group	.69	.17	2.05	1.94
Civic club	2.15	3.60	.68	.42
Professional	1.14	.59	.41	.39
School	.45	.17	.18	.61
Government	2.52	1.20	.91	.47
Church	3.85	3.05	8.55	2.01
Coop extension	.08	.52	.50	3.49*
Other organization	1.09	1.91	.50	.63
Total organizations	12.93	11.68	16.98	.34

[a]Conventional significantly different from sustainable ($p<.05$).
[b]Mixed-type significantly different from sustainable ($p<.05$).
* $p < .05$

TABLE 3. AVERAGE NUMBER OF OFFICES HELD WITHIN ORGANIZATION CLASSES BY TYPE OF FARMER, NORTH DAKOTA, 1989

Class	Conventional	Mixed-type	Sustainable	F
Respondents	147	42	22	
Farm organization	.90	.90	.95	.05
Commodity group	.53	.36	.41	.98
Civic club	.40	.38	.14	1.48
Professional	.14	.19	.18	.24
School	.12	.10	.05	.46
Government	.46	.26	.41	1.88
Church	.64	.86	.77	1.56
Coop extension	.07	.12	.05	.66
Other organization	.17	.19	.27	.52
Total organizations	3.44	3.35	3.22	.13

Organizational Dues. The amount of dues paid to organizations also indicated organizational involvement. The average for this measure ranged from a high of $129.48 for sustainable farmers to $54.98 for mixed-type farmers. Conventional farmers paid an average of $82.82 in dues. Sustainable farmers were paying substantially more in dues for farm, commodity, and church organizations. However, these differences were not statistically significant among farm types either for the measure of total dues paid to all organizations or for the dues paid to any of the specific organizations (Table 4).

TABLE 4. AVERAGE DOLLARS PAID IN DUES TO ORGANIZATIONS BY TYPE OF FARMER, NORTH DAKOTA, 1989

Class	Conventional	Mixed-type	Sustainable	F
Respondents	147	42	23	
	----------dollars----------			
Farm organization	18.34	18.07	28.70	2.46
Commodity group	20.54	7.67	40.00	1.82
Civic club	8.78	5.05	2.91	1.11
Professional	2.72	8.79	10.30	1.07
School	.37	.05	.00	.60
Government	4.57	.00	.44	.42
Church	25.05	13.10	43.48	.37
Coop extension	.00	.12	.00	2.04
Other organization	2.44	2.14	3.65	.13
Total organizations	82.81	54.98	129.48	1.58

Other Contributions and Out-of-Pocket Expenses. Contributions and out-of-pocket expenses to organizations were another indicator of community involvement. Sustainable farmers contributed significantly more to organizations in 1989 ($807.40) than did the conventional farmers ($195.20) or the mixed-type farmers ($104.69) (Table 5). A comparison of contributions made to specific organizations revealed that sustainable farmers contributed significantly more to farm, commodity, and professional organizations than did either the conventional or mixed-type farmers. In addition, sustainable farmers appeared to contribute more to church organizations ($453.10) than did conventional ($173.20) or mixed-type ($85.30) farmers; however, these differences in contributions were not significantly different. Contributions to farm, commodity, professional, and church organizations made up the bulk of sustainable farmers' organizational contributions.

TABLE 5. AVERAGE DOLLAR CONTRIBUTIONS (EXCLUDING DUES PAID) TO ORGANIZATIONS BY TYPE OF FARMER, NORTH DAKOTA, 1989

Class	Conventional	Mixed-type	Sustainable	F
Respondents	146	40	16	
	----------dollars----------			
Farm organization[a,b]	.07	.00	15.13	12.70**
Commodity group[a,b]	5.27	1.00	231.25	8.46**
Civic club	5.69	8.00	.00	.53
Professional[a,b]	.14	.00	104.69	12.90**
School	.14	.13	1.25	2.29
Government	3.80	.50	.00	.50
Church	173.20	85.30	453.10	2.58
Coop extension	.17	.00	.00	.19
Other organization	6.68	.00	2.00	.43
Total organizations[a,b]	195.20	94.90	807.40	8.98**

[a]Conventional significantly different from sustainable ($p<.05$).
[b]Mixed-type significantly different from sustainable ($p<.05$).
** $p < .01$

In summary, few significant differences were found among the three farm groups' organizational involvements as measured by the overall number of organizational memberships, hours devoted to organizations, offices held, or dues paid. Only overall contributions differed significantly by farm type.

Despite the lack of significant results for overall measures, there were some significant, specific comparisons and some interesting trends across indicators. Sustainable farmers had significantly more church memberships than did conventional farmers. They contributed significantly more hours to farm organizations than conventional or mixed-type farmers. Farm type significantly affected average number of hours contributed to cooperative extension with higher averages for sustainable and mixed-type than conventional. Sustainable farmers contributed more dollars to farm organizations, commodity groups, and professional groups than did mixed-type or conventional farmers. In addition, the largest means for number of organizational memberships, average hours, dues paid, and dollar contributions belonged to sustainable farmers in each case even though the differences for each indicator were not significant (except for dollar contributions). Thus, to the extent that a pattern exists, sustainable farmers were involved more heavily in community organizations; however, the differences were not substantial enough to have general policy implications.

Trade Area Patterns

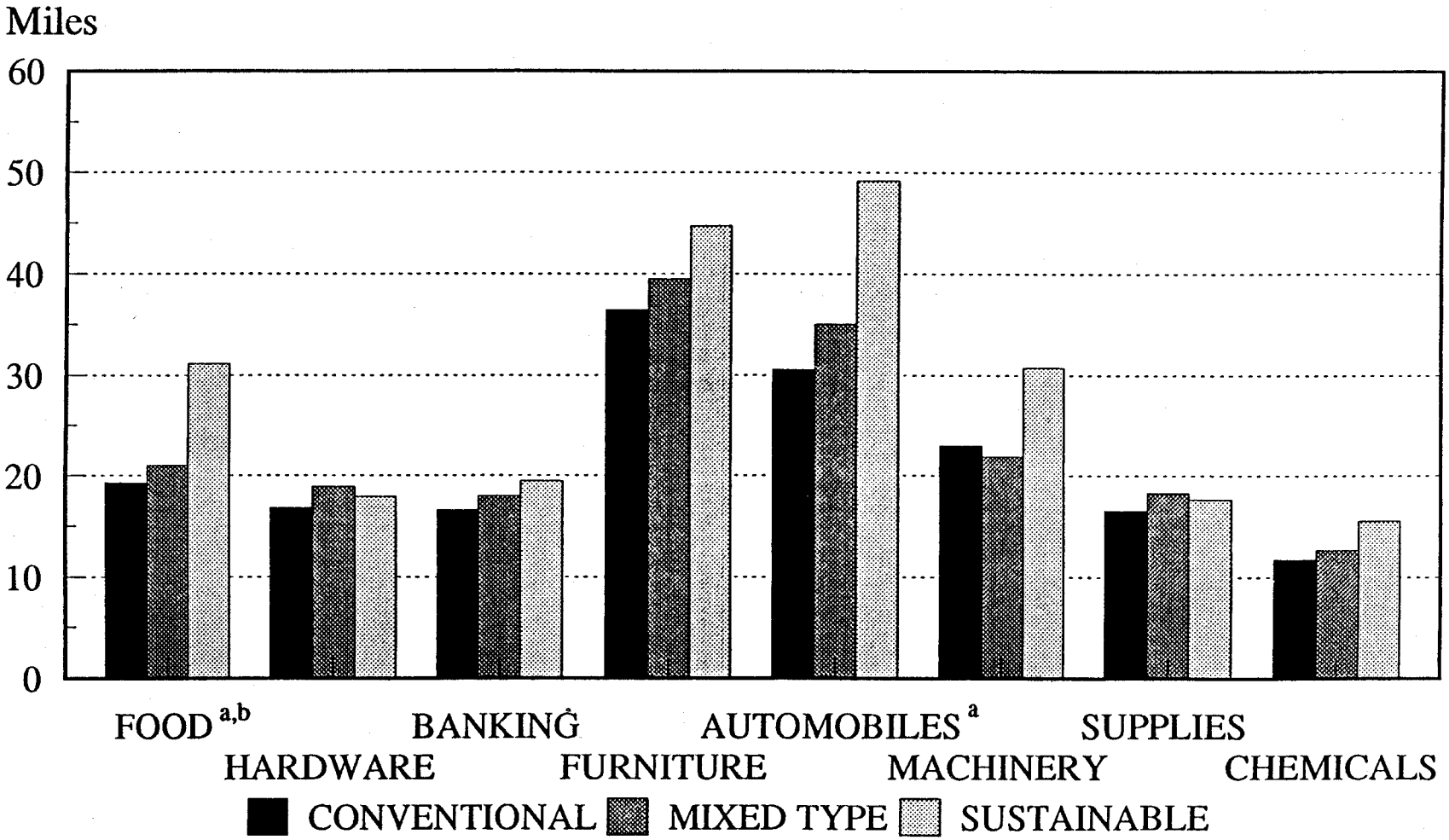
Miles Traveled. The distances farmers traveled to the major retail outlets for selected retail goods and services were compared. Conventional and mixed-type farmers traveled shorter distances (19.3 miles and 21.0 miles, respectively) than did sustainable farmers (31.1 miles) to purchase food (Figure 1 and Appendix Table 1). Sustainable farmers traveled farther than did conventional farmers to purchase automobiles (49.15 miles and 30.6 miles, respectively). No other significant differences in the number of miles driven to retailers were observed. This suggests that sustainable farmers may be located farther away geographically from major retail centers or they may prefer retail centers farther away than do conventional and mixed-type farmers.

City Population. Farmers identified the city in which they did the majority of their retail business for selected goods and services. Subsequently, the 1988 population estimates for these cities were obtained. The average population of the towns where food, hardware, banking services, furniture, automobiles, farm machinery, farm supplies, and farm chemicals were purchased were not significantly different among the farm types (Table 6).

TABLE 6. MEAN POPULATION OF CITIES IN WHICH THE MAJORITY OF SELECTED GOODS AND SERVICES WERE PURCHASED BY TYPE OF FARMER, NORTH DAKOTA, 1989

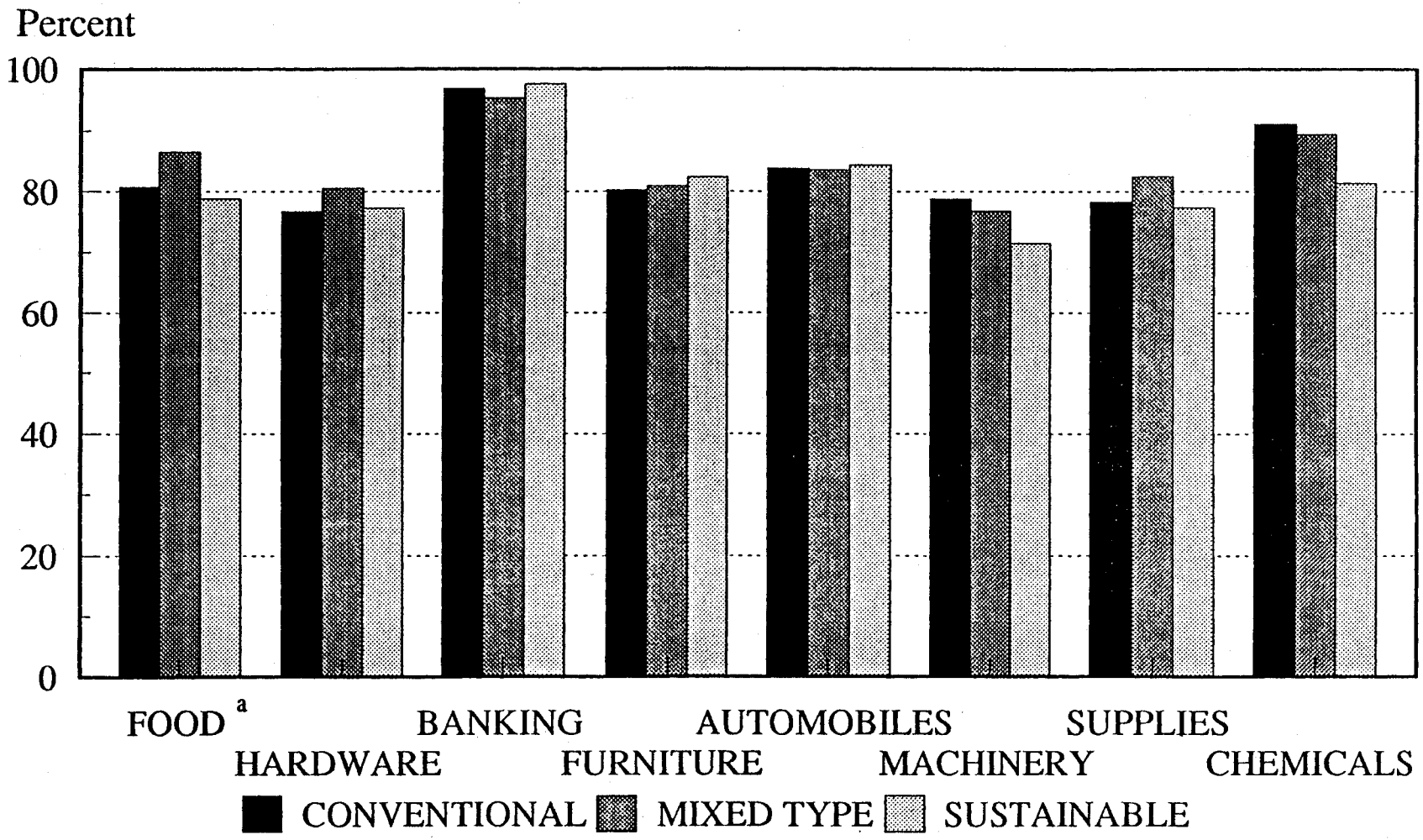
Item	Conventional	Mixed-type	Sustainable	F
	----------(population)----------			
Food	13,606	12,953	19,814	1.35
Hardware	9,907	10,442	10,919	.06
Banking	6,916	9,151	8,576	.58
Furniture	24,831	25,953	28,281	.28
Automobiles	16,843	18,703	19,852	.29
Machinery	6,700	7,974	9,613	.68
Supplies	7,012	9,561	8,713	.66
Chemicals	4,552	4,820	7,013	.95

Percentage of Purchases. Farmers' trade patterns in the cities where they conducted a majority of their retail trade for food, hardware, banking services, furniture, automobiles, farm machinery, farm supplies, and farm chemicals were compared. The average percentage of these goods and services purchased are shown in Figure 2 (Appendix Table 2). Sustainable farmers purchased a smaller percentage of their total food expenditures in the city where they did the majority of their retail trade for



[a] Conventional farmers significantly different from sustainable ($p < .05$).
[b] Mixed type farmers significantly different from sustainable ($p < .05$).

Figure 1. Average Miles Driven to Purchase Majority of Selected Goods and Services by Type of Farmer, North Dakota, 1989



[a] Mixed type farmers significantly different from sustainable ($p < .05$).

Figure 2. Mean Percent of Purchases Made at Retail City for Selected Goods and Services by Type of Farmer, North Dakota, 1989

food than did mixed-type farmers. Conventional farmers' food purchases were not significantly different from either sustainable or mixed-type farmers. There were no other significant differences among the farm types.

Comparing all aspects of retail trade interaction with local communities, sustainable farmers drive farther than their counterparts for food and automobiles. They buy a smaller percentage of their total food purchases in the city where they make most of their food purchases than do mixed-type farmers. This suggests that sustainable farmers may bypass local communities for food and automobiles. Perhaps sustainable farmers have a slightly different market or geographic orientation than others, but the overall differences in the retail trade patterns of the different farming types do not appear to be substantial.

Input-Output Interaction

To examine the impact of sustainable farming on the state's economy, the North Dakota Input-Output model was used (Coon et al., 1985; Coon et al., 1986). This model describes and analyzes the economic linkages within the state and contains 17 economic sectors. Agriculture is divided into two sectors, a livestock sector and a crop sector.

To measure the impacts of sustainable practices on communities and government units, data were developed for use in the Input-Output model by asking the farmers about farm income and expenses from their 1989 1040-F Tax form. Farmers were asked for the amount of income or expense listed on each line of the 1040-F form and what percent of each item of income or expense was conducted outside the state. Income and expenses were divided into instate and outstate transactions based on this percentage. Individual income and expense amounts were divided into the proportion of those activities associated with livestock and the proportion associated with crops. Those transactions that could be considered to be from either sector were divided into crop or livestock transactions based on the percentage of crop and livestock sales actually from livestock. Income and expenses were classified as transactions with the appropriate sectors of the North Dakota economy for the input-output model (Coon et al., 1985). This formed a transactions budget for each of the two agricultural sectors in the input-output model.

Two pairs of transactions budgets were developed from the income and expense responses; one pair profiles the activities of an average sustainable farmer in the data set and the other reflects the activities of an average conventional farmer in the data set. Both pairs of budgets were based on the average dollars of transactions between each of the agricultural sectors

and the remaining sectors in the North Dakota model plus imports to and exports from the state. Budgets for the sustainable farm were altered in proportion to the difference in farm size between the average sustainable (1,171 acres) and conventional farms (1,965 acres).

From these budgets, the percentage differences between the conventional and sustainable farms' transactions were calculated under the assumption that differences between the two groups were an appropriate basis for adjustment from current transactions to those of sustainable farms. This represented the change in transactions due to a shift to sustainable agriculture. The baseline input-output technical coefficients matrix and interdependence coefficients matrix of the North Dakota Input-Output Model were assumed to represent conventional North Dakota farmers. Then baseline technical coefficients were adjusted by the percentage differences in transactions to form a sustainable technical coefficients matrix which was inverted to form the input-output interdependence coefficients matrix for sustainable farmers.

The interdependence coefficients matrices for conventional and sustainable farmers along with estimates of sales for final demand by each sector were the inputs to the input-output model. Baseline projections of final demand for 1990 were generated within the input-output model. Projections for final demand for each sector of the North Dakota model were estimated, using a modified Delphi analysis technique (Coon and Leistritz, 1989). The estimates of sales for final demand for the crops and livestock sectors were decreased for the sustainable farming system to reflect the sustainable farmers' lower sales for final demand for both crops and livestock.

The model produced estimates of gross business volumes and employment for conventional and sustainable farmers (Table 7). Total employment for the conventional farming system was 307,917 jobs. This prediction compares favorably to the actual observed employment of 321,527 in June of 1990 (Job Service North Dakota, July 1990).

Comparison of conventional and sustainable systems for North Dakota showed that livestock activity will increase by about $410 million (23 percent) if all North Dakota farmers adopted sustainable practices. Crop activity will decrease by $638 million (16 percent), making the net loss to agriculture about $228 million (4.2 percent). Nonmetal mining and utilities will increase marginally. Construction, professional services, and the finance sectors will decrease minimally, while retail trade and the agricultural processing sectors will decrease in activity $226 million (4.1 percent) and $398 million (18.9 percent),

TABLE 7. GROSS BUSINESS ACTIVITY AND EMPLOYMENT FOR NORTH DAKOTA WITH CONVENTIONAL OR SUSTAINABLE FARMING SYSTEMS, 1990

Sector	Business activity Conventional	Sustainable
	----- (Thousands Dollars) -----	
(1) Ag livestock	$1,701,964	$2,111,757
(2) Ag crops	$4,020,068	$3,382,938
(3) Nonmetal mining	$54,525	$56,465
(4) Construction	$782,970	$763,712
(5) Transportation	$97,015	$123,681
(6) Comm & pub util	$743,330	$755,881
(7) Ag processing & misc mfg	$2,330,692	$1,891,097
(8) Retail trade	$6,058,124	$5,814,148
(9) Fin,ins,real estate	$1,267,090	$1,254,484
(10) Bus & personal service	$558,690	$673,202
(11) Prof & Social service	$599,387	$596,736
(12) Households	$9,159,934	$9,167,247
(13) Government	$774,400	$742,420
(14) Coal mining	$180,256	$180,256
(15) Elec generation	$291,640	$291,640
(16) Petrol explor/extrac	$539,347	$538,766
(17) Petrol refining	$121,476	$121,476
TOTAL	$29,280,908	$28,465,906
TOTAL EMPLOYMENT	307,917	303,507

respectively. Transportation and business services will increase by $24 million (27.8 percent) and $115 million (20.7 percent), respectively. Overall, these budgets suggest that the economy initially could decline about $815 million (2.8 percent) and employment could decrease by 4,410 jobs (1.5 percent) if farmers switched from conventional to sustainable practices.

The employment numbers above may need further adjustment. The input-output model does not consider differences in farm types when it calculates farm employment. If on-farm family employment increased by adopting sustainable practices, this change in employment would occur with the impacts of reduced economic activity in agriculture and almost no change in household activity (Table 7). The household sector's activity reflects personal income within the state. Thus, if movement to sustainable practices increased on-farm family employment, farm families would have fewer income dollars that would have to be spread over more people. The extent to which sustainable farming would trigger more on-farm family employment is unclear.

Another interaction with the community that may not be reflected adequately in the North Dakota Input-Output Model is the interaction between farmers and their local country elevator. Conventional and mixed-type farmers reported selling 95.3 percent and 96.7 percent of crops within the state, respectively, which was significantly more than the 55.6 percent of crops sustainable farmers sold within the state. The reduced interaction with the local elevator in the volume of products sold per farmer could hamper employment and economic activity for the local communities. Development of an adequate infrastructure for sustainable (organic) crops would reduce these negative impacts. Thus, initial movement toward sustainable systems may lower gross business activity and employment for the state more than those presented by the input-output model because of this difference in interaction with the local elevator. As the local infrastructure responds to the shift to sustainable systems by providing the goods and services that the sustainable system needs, farmers may increase their interaction with local businesses. At this point, estimating how long this shift would take and the magnitude of the net effect is difficult.

Conclusions and Implications

The present study found several differences between sustainable and conventional farmers in their level of organizational involvement and nature of their economic activity. Overall, sustainable farmers appear to be slightly more involved in community organizations than were conventional farmers. Sustainable farmers were more likely to be involved in church organizations; they contributed more hours to farm organizations than did conventional or mixed-type farmers. They spent more hours in cooperative extension programs and advisory committees than did conventional farmers and they contributed more dollars to farm organizations, commodity groups, and professional groups than did mixed-type or conventional farmers. However, there were no significant differences between sustainable and conventional farmers on most measures of organizational involvement. If all farmers in North Dakota were to suddenly become sustainable farmers, the level of organizational involvement among farmers would not change dramatically.

The present study compared the trade patterns of sustainable and conventional farmers. On most measures of economic interaction with the local community, farm types did not differ significantly. However, sustainable farmers traveled farther for food and automobiles than did either the mixed-type or conventional farmers.

The present study applied the North Dakota Input-Output Model to the reported pattern of income and expenses from sustainable and conventional farmers. This procedure determined

the impact of these farm types on the state's economy if either type were the only type of farming in the state. Two conclusions emerged. First, a shift toward sustainable farming could trigger substantial shifts in economic activity from sector to sector. The economic activity in the agricultural livestock, transportation, business services, and communication and public utilities sectors could increase while economic activity in construction, agricultural processing and miscellaneous manufacturing, retail trade, finance-insurance-real estate, professional services, and agricultural crops sectors could decline.

Second, the input-output model suggested that the net effect of a complete shift from conventional to sustainable farming would be a modest decline in the state's level of economic activity. This finding must be placed in context. The economic activity measured in the model does not directly assess the relative costs and benefits to the environment or to public health. These costs and benefits are difficult to quantify economically, but the present research project is currently studying the agronomic consequences of these farming types.

Public policy could alter the predictions of the model. If the trend toward greater concern over the environment continues, this concern could trigger increased taxes, regulations, and restrictions on the use of certain fertilizers, pesticides, and herbicides. A related development could be increased owner/lender liability for contaminating ground water. These policy changes could increase the profitability of sustainable practices in comparison to conventional practices and could reduce conventional farmers' purchases of these articles from the local communities. Changes in any of these policy measures could alter the differences in transactions of conventional and sustainable farming systems with the community and alter the predictions of the model.

Finally, the model cannot logically take into account infrastructure changes that may occur with a shift to sustainable farming. A shift to sustainable farming is likely to trigger substantial changes in the needs of farmers, and these new demands may trigger new infrastructures.

In summary, a shift to sustainable farming could be bumpy in the short term. The relative economic activity of various sectors could shift with a net decline in economic activity. At the same time, the results also suggest that a shift toward sustainability is not likely to undermine the farm economy fundamentally even within current economic structures and policies. Current and future research both economic and agronomic will aid in better assessing the overall costs and benefits of these different types of farming systems.

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APPENDIX

APPENDIX TABLE 1. AVERAGE MILES DRIVEN TO PURCHASE MAJORITY OF SELECTED GOODS AND SERVICES BY TYPE OF FARMER, NORTH DAKOTA, 1989

Item	Conventional	Mixed-type	Sustainable	F
	----------(miles)----------			
Food[a,b]	19.33	21.03	31.14	5.67**
Hardware	16.85	18.93	17.93	.45
Banking	16.62	17.99	19.48	.47
Furniture	36.44	39.49	44.75	1.23
Automobiles[a]	30.60	35.06	49.15	3.84*
Machinery	23.02	21.94	30.74	2.04
Supplies	16.56	18.35	17.69	.24
Chemicals	11.73	12.67	15.57	.32

[a]Conventional significantly different from sustainable ($p<.05$).
[b]Mixed type significantly different from sustainable ($p<.05$).
* $p < .05$
** $p < .01$

APPENDIX TABLE 2. MEAN PERCENT OF PURCHASES MADE AT MAJOR RETAIL CITY FOR SELECTED GOODS AND SERVICES BY TYPE OF FARMER, NORTH DAKOTA, 1989

Item	Conventional	Mixed-type	Sustainable	F
	----------(percent)----------			
Food[a]	80.75	86.57	78.90	3.01*
Hardware	76.74	80.61	77.32	.95
Banking	96.85	95.29	97.59	.06
Furniture	80.28	80.95	82.41	.11
Automobiles	83.83	83.52	84.40	.02
Machinery	78.81	76.84	71.52	1.69
Supplies	78.41	82.53	77.41	1.48
Chemicals	91.17	89.40	81.43	2.19

[a]Mixed type significantly different from sustainable ($p<.05$).
* $p < .05$

APPENDIX TABLE 3. AVERAGE TRANSACTIONS BUDGETS OF AG LIVESTOCK SECTOR FOR CONVENTIONAL AND SUSTAINABLE NORTH DAKOTA FARMERS AFTER ADJUSTMENT FOR FARM SIZE 1990

Sector	Conventional		Sustainable	
	Income	Expense	Income	Expense
	----------Dollars----------			
(1) Ag livestock	7785.12	7785.12	703.70	703.70
(2) Ag crops	0.00	4319.55	0.0	2418.13
(3) Nonmetal mining		0.00		0.00
(4) Construction		45.62		37.56
(5) Transportation		113.09		408.07
(6) Comm & pub util		414.79		854.70
(7) Ag Processing	0.00	2301.33	0.00	501.03
(8) Retail trade	105.34	6144.54	374.01	10894.07
(9) Fin,ins,real estate	578.55	2437.51	503.75	4442.73
(10) Bus & pers service		371.51		1364.14
(11) Prof & soc service		767.74		787.20
(12) Households		7269.33		6905.71
(13) Government	138.82	376.33	277.00	648.42
(14) Coal mining		0.00		0.00
(15) Elec generation		0.00		0.00
(16) Petrol exp/ext		0.00		0.00
(17) Petrol refining		0.00		0.00
Imports		3170.53		1701.79
Exports	24465.41		21702.36	

APPENDIX TABLE 4. AVERAGE TRANSACTIONS BUDGETS OF AG CROPS SECTOR FOR CONVENTIONAL AND SUSTAINABLE NORTH DAKOTA FARMERS AFTER ADJUSTMENT FOR FARM SIZE 1990

Sector	Conventional		Sustainable	
	Income	Expense	Income	Expense
	----------Dollars----------			
(1) Ag livestock	4319.55	0.00	2418.13	0.00
(2) Ag crops	5968.00	5968.00	4011.44	4011.44
(3) Nonmetal mining		0.00		0.00
(4) Construction		1824.80		1362.89
(5) Transportation		563.26		635.51
(6) Comm & pub util		1559.54		1873.28
(7) Ag Processing	0.00	0.00	0.00	0.00
(8) Retail trade	919.87	48840.83	374.01	36560.27
(9) Fin,ins,real estate	9780.46	15427.95	503.75	11129.12
(10) Bus & pers service		1769.71		3003.92
(11) Prof & soc service		581.55		230.08
(12) Households		29740.44		25062.31
(13) Government	835.65	6494.23	277.00	1532.31
(14) Coal mining		0.00		0.00
(15) Elec generation		0.00		0.00
(16) Petrol exp/ext		0.00		0.00
(17) Petrol refining		0.00		0.00
Imports		4898.26		7859.45
Exports	68184.92		57125.84	