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Donald Taylor
South Dakota State University

Thomas Dobbs
South Dakota State University

James Smolik
South Dakota State University

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South Dakota's Sustainable
Agriculture Technology*

by

Donald C. Taylor, Thomas L. Dobbs
and James D. Smolik**

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Abstract

The sustainable agriculture technology followed by South Dakota farmers is characterized by very limited use of synthetic chemical inputs (fertilizers, pesticides); a fundamental emphasis on crop rotations to control weeds, insects, and diseases; and the use of "organic" markets to enhance returns from selling part of farmers' sustainably-produced grains.

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**Taylor and Dobbs are Professors of Agricultural Economics, and Smolik is a Professor of Plant Science, SDSU, Brookings, SD.

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SOUTH DAKOTA'S SUSTAINABLE AGRICULTURE TECHNOLOGY

Public interest in sustainable agriculture is much on the rise these days. This heightened interest arises because of farmer, policymaker, and general public concerns over environmental degradation (e.g., groundwater contamination, soil erosion), intensive capital needs (and, hence, intensified producer risk exposure), and adverse personal health implications to farmers and diet-sensitive consumers that can result from conventional farming techniques. A related public concern is for an economically sustainable agriculture which is increasingly weaned of its dependency on huge federal subsidies (Knezek, Hesterman, and Wink, 1988; Lee, 1987; Papendick, 1987; Rodale, 1988; Schaller, 1988).

How do "sustainable" farming technologies differ from the technologies of "conventional" farmers? The U.S. Department of Agriculture, in its "low input/sustainable agriculture" (LISA) research and education program, makes the following distinctions (USDA, 1988). Conventional agriculture generally involves the use of synthetic chemical fertilizers and pesticides, capital-intensive farming methods, continuous cropping, substantial reliance on manufactured inputs, and extensive use of credit. Alternative or sustainable farming systems, on the other hand, involve such practices as slightly to greatly reduced use of off-farm purchased inputs, crop rotations, ridge tillage, integration of livestock with crops, mechanical and biological weed control, integrated pest management, and less costly buildings and equipment.

The precise technology that embodies these general features, however, is location-specific. To help determine the nature of South Dakota's sustainable agriculture, a mail survey of the state's sustainable farmers was undertaken during the summer of 1988. In this paper, an overview is presented of the sustainable farm production and marketing techniques currently being followed in South Dakota.

To aid in interpreting our findings, a literature search covering sustainable agriculture farmer-oriented surveys in the U.S. over the past 10-12 years was undertaken. We found 14 such surveys--rather heavily concentrated in the Midwest, but extending from Maine to California--with 20 reports of findings from the surveys (Table 1). This paper includes comparisons of our findings for South Dakota with those of other surveys.

SOUTH DAKOTA SUSTAINABLE FARMS

The purpose of our mail survey was to gain a clearer view of the production and marketing techniques of South Dakota's sustainable farmers, different types of sustainable farming in the state, and

farmer perspectives on comparative yields, profits, and problems with sustainable versus conventional agriculture. A mail survey questionnaire was sent in early June 1988 to the 93 farmers in the state whom we had come to know were possibly following sustainable farming practices.¹ Those who had not responded by early July were sent follow-up letters and questionnaires. Those who had not responded as of late July and could be reached by telephone were so contacted.

Resulting from this process were 32 completed questionnaires. Twenty five of the initially contacted respondents informed us that they either were no longer farming at all or were no longer farming sustainably. Twenty four informed us that they were farming sustainably, but failed to return completed questionnaires. Attempts to contact 12 other non-respondents were unfruitful. Thus, the survey response rate was 57% for those known to be sustainable farmers.

Nearly two-thirds of the South Dakota sustainable farmers have rather evenly balanced--in terms of annual gross farm sales--cash grain and livestock farms. Although the remaining respondents are more commonly specialized in cash grain than in livestock, 88% of them raise livestock commercially. This incidence of livestock on South Dakota sustainable farms is roughly comparable with the 84% (Lockeretz and Madden, 1987), 90% (Lockeretz, et al., 1981), 92% (Wernick and Lockeretz, 1977), and 100% (Klepper, et al., 1977) reported for sustainable farmers in the states directly east and south of South Dakota.

All 32 surveyed South Dakota farmers raise at least one grain and/or forage crop sustainably; 25 (78%) at least one commercial livestock enterprise sustainably; and six (19%) at least one vegetable and/or specialty crop sustainably. The average number of farm commodities produced sustainably per respondent is five. No one raises only a single commodity sustainably.

Over one-half of the survey respondents report using sustainable practices in the production of beef cattle, corn, alfalfa, wheat, and oats. Soybeans and millet are the next most common sustainably produced commodities, followed by barley, rye, and hogs. Analogous findings in the literature are as follows:

- Lockeretz, et al. (1981) report the most common sustainably produced commodities by midwest sustainable farmers, in descending order, to be corn, hay, soybeans, oats, and wheat--which is very similar

¹Sources of information on such possible sustainable farmers were the Northern Plains Sustainable Agriculture Society, South Dakota area farm management and county extension agents, and other varied informants.

to our findings, except for the omission of beef cattle in their listing; and

- Baker and Smith (1987) report only 3% of their surveyed sustainable farms in New York to produce only one commodity sustainably and most to produce at least five sustainably--which also generally parallels our findings.

Sixty three percent of the South Dakota sustainable farmers use sustainable practices on 100% of their cropland. Wernick and Lockeretz (1977) report 83% of the midwestern sustainable farmers in their survey to farm all their cropland sustainably.

Of the 11 South Dakota sustainable farmers who reported only part of their cropland being farmed sustainably in 1988, 5 reported between 60% and 90% of their cropland under sustainable practices and 6 reported between 10% and 50% under sustainable practices. The most common restrictions to 100% sustainable cropping are limited management capacities and land-use restrictions on rented land. Tenancy problems are also cited as restrictions to 100% sustainable cropping for farmers in the Blobaum (1984) and Wernick and Lockeretz (1977) studies.

To understand more fully why some farmers follow sustainable practices on all of their cropland and others do not, some simple two-way associative relationships were examined between the percentage of cropland farmed sustainably by individual respondents--treated as a three-way categorical variable--and the following variables, one-at-a-time: (1) respondent perceived overall intensity of problems with sustainable agriculture; (2) years of sustainable farming experience; (3) cropland acreage operated; (4) percentage of rented cropland; (5) farm type; and (6) the percentages of respondents who (a) judge sustainable farming to be more profitable than conventional farming, (b) judge sustainable farming to require more labor than conventional farming, (c) are officially "certified organic" producers, (d) sell sustainably-raised products through "organic" market outlets, and (e) have regular off-farm work, respectively.

Of the variables examined, only two proved to be significantly related to the percentage of cropland farmed sustainably. The two variables involve two tested measures of a respondent's perceived overall intensity of problems with sustainable agriculture--one a "means" test (ANOVA) and the other a "median" test (NPAR1WAY Median Score). The results show that farmers, who perceive the overall intensity of problems with sustainable agriculture to be less, tend to follow sustainable practices on a larger percentage of their cropland.

The South Dakota sustainable farmers have followed sustainable farm production practices for an average of 14 years. The median length of time is 12-13 years. The longest period for one of the 32 surveyed farmers is 42 years,¹ and the shortest is one year. About 70% of the surveyed farmers have had between 5 and 19 years of experience with sustainable practices, and 5 farmers have had 20 or more years of sustainable farming experience.

This length of experience with sustainable practices for South Dakota farmers is greater than that reported for sustainable farmers in New York by Baker and Smith (1987) and in the midwest by Klepper, et al. (1977), Lockeretz, et al. (1980), and Lockeretz and Wernick (1980). It is roughly comparable, however, to that reported for midwestern sustainable farmers by Lockeretz and Madden (1987).

SUSTAINABLE PRODUCTION TECHNIQUES

Synthetic chemical input practices

Fifty five percent of the South Dakota respondents report using **zero levels** of all **synthetic chemical inputs**--fertilizers, pesticides, and livestock feed additives (antibiotics) and growth stimulants--on all their farm enterprises. The other 45% report using **moderate amounts** of one or more synthetic inputs on one or more of their farm enterprises.² The most common moderately used synthetic chemical input consists of herbicides, with some sustainable farmers making limited use of banded and spot-sprayed applications to particularly weed-prone fields or portions of fields. About one-fourth of the respondents report using moderate quantities of synthetic chemical fertilizer. Studies with somewhat similar types of findings are the following:

- Lockeretz and Madden (1987) report 28% of their surveyed midwestern sustainable farmers in 1987 to "occasionally use" herbicides, 22% super phosphate, and 18% urea;
- Baker and Smith (1987) report "about one in six" of their surveyed sustainable farmers in New York to use some form of N-P-K fertilizers on some or all of their cropland; and
- Keppler, et al. (1977) report only one of their 14 sustainable Corn Belt farmers to use herbicides and none of them to use insecticides.

South Dakota sustainable farmers view legume crops as their overall most important source of

¹One respondent reports that he is a fourth-generation sustainable farmer.

²In some instance, the "moderate amounts" apply to cropland on a respondent's farm that is not farmed sustainably. For such farmers, "zero levels" could apply to the cropland that is farmed sustainably.

nitrogen for sustainable crop production, followed by crop residues and non-composted livestock manure. Purchased "organic" soil amendments and commercial "organic" fertilizers and organic waste products other than livestock manure, on the other hand, are generally reported to be relatively unimportant sources of nitrogen in sustainable production. Analogous findings in the literature on non-synthetic chemical nutrient sources are as follows:

- Lockeretz, et al. (1981) report midwestern sustainable farmers to "use legume forage as the primary source of sustained soil fertility (along with small amounts of on-farm manure, purchased rock phosphate, and proprietary organic soil amendments of low nitrogen, phosphorus, and potassium content);"
- Lockeretz and Madden (1987) report 84% of surveyed midwestern sustainable farmers to use commercial organic soil amendments or fertilizers in 1977 and 59% in 1987;
- Baker and Smith (1987) report "spreading manure, growing cover crops, and rotating crops" by 75% or more of their surveyed sustainable farmers in New York;
- Altieri, et al. (1983) report 75% of their surveyed sustainable farmers in California to "use cover crops in orchards and/or winter legumes for green manure;" and
- Vail and Rozyne (1982) indicate the following percentages of surveyed organic farmers in Maine to report as their principle sources of soil nitrogen: off-farm manure 71%, on-farm manure 42%, "soluble chemicals" 29%, and green manure 0%.

Other sustainable production techniques

In addition to limiting synthetic chemical input use, all of the South Dakota surveyed sustainable farmers consider the use of **crop rotations** as a main sustainable farming practice.¹ Ninety five percent of their crop rotations involve at least one small grain, 75% at least one row crop, and 63% at least one legume forage. Twenty eight percent of the respondents (especially in central and western South Dakota) summer fallow, and two farmers allow their land to "completely rest" every seventh year.

The South Dakota sustainable farmers report that crop rotations constitute their single most important means for controlling each of weeds, insects, and diseases on their sustainably farmed cropland. The legume forage and green manure cover crop components of crop rotations are considered the most important source of nitrogen and improved soil fertility for sustainably raised crops.

¹Baker and Smith (1987) found only 73% of their surveyed New York sustainable farmers to used crop rotations and Vail and Rozyne (1982) only 33% of their surveyed Maine sustainable farmers.

All the South Dakota survey respondents also report using special sustainable **weed control** practices. After crop rotations, their most important means of weed control are using only certified and/or "clean" seed, adjusting crop planting dates, selecting weed competitive crops, and cultivating and harrowing more frequently. At the other extreme, of the 13 suggested possible weed control practices, the two of least importance are intercropping and biological control.

Lockeretz et al. (1981) report midwestern sustainable farmers to use more mechanical cultivation of row crops (corn and soybeans) than conventional farmers in controlling weeds. The dominant forms of weed control reported by Baker and Smith (1987) are tractor cultivation, hand weeding, and hand tool cultivation--followed by crop rotations and weed suppressing cover crops. Altieri, et al. (1983) report mechanical discing and/or mowing to be the most common methods for controlling weeds in dry farmed orchards and vineyards in California.

Ninety one percent of the South Dakota sustainable farmers report following special **insect and disease control** practices. Their most important insect and disease control measures--considerably after crop rotations--are adjusted crop planting dates, cover crops, modified tillage practices, and selecting pest resistant varieties. Analogous findings from other studies are as follows:

- Lockeretz, et al. (1981) found midwestern sustainable farmers to mainly use crop rotations, not "exotic" biological control techniques, to combat major pests;

- Baker and Smith (1987) report that about 50% or more of their surveyed sustainable farmers in New York select relatively insect-free crops, use plant-derived (e.g., rotenone) and "pathogen" insecticides (e.g., *Bacillus thuringiensis*), and follow crop rotations to control insects; and

- Altieri, et al. (1983) report the use of bell beans as a cover crop, reducing from 45% to 22% the yield losses arising from codling moths in California apple orchards.

Seventy five percent of the South Dakota sustainable farmers report using special **tillage and residue management** practices on their sustainably farmed cropland. The clearest reflection of modified tillage practices is the reduced use or elimination of the moldboard plow in land preparation. Incorporation of green manure crops and small grain stubble is most common in those instances when the moldboard plow is used. Farmers consider special tillage and residue management practices as important means to control both soil erosion and weed growth.

Attention to special tillage and residue management practices is indicated in only one sustainable

farmer survey report that we reviewed. Lockeretz, et al. (1978) report that "most (sustainable) farmers use a chisel plow or disc, which buries less residue than the moldboard (plow) and, therefore results in less soil erosion."

Fifty six percent of the South Dakota sustainable farmers report using special **grain drying** and/or storage practices. The principal thrust of these practices is to avoid artificial, expensive high-temperature drying of grains. Illustrative practices are crib drying of ear corn, planting early maturing grain varieties, somewhat delayed harvesting of crops, and natural bin aeration.

SUSTAINABLE MARKETING TECHNIQUES

Sixty three percent of the South Dakota sustainable farmers are officially "certified organic" producers. The most common reported reason for the other farmers to not be officially "certified organic" is their continued use of moderate quantities of herbicides (and for one farmer, synthetic chemical fertilizers, as well). A belief that there is no demand for "certified organic" products and a lack of information about procedures to become "certified organic" are additional reasons for some sustainable farmers not being officially "certified organic".

Fifty nine percent of the South Dakota sustainable farmers report selling at least part of their sustainably-raised produce through "organic" market outlets. Those who do not, of course, are most commonly the farmers who are not officially "certified organic" producers. Two producers who are officially "certified organic", however, do not sell any produce through "organic" market channels (one to avoid verification costs and the other because of not finding an "organic" market yet). On the other hand, one sustainable farmer who is not "certified organic" (because he spot-sprays herbicides) does sell his corn at a price premium to a hog producer.

The commodity most commonly sold through "organic" market outlets is millet; one-half of the 18 respondents answering this question report the "organic" marketing of millet. The commodities next most commonly sold through "organic" market outlets are wheat, soybeans, and corn. At the other extreme, only one farmer reports selling each of alfalfa seed, buckwheat, dry beans, and oats through "organic" markets and only two farmers sell rye and beef through "organic" markets. Analogous findings from the literature are as follows:

- Wernick and Lockeretz (1977) report that 27% of their surveyed midwestern sustainable farmers marketed some of their livestock through "organic" channels;

- Lockeretz and Madden (1987) report 39% in 1977 and 42% in 1987 of their surveyed midwestern sustainable farmers to be using special markets for some of their sustainably-produced crops and livestock; and

- Blobaum (1984) reports one-half of his surveyed midwestern sustainable farmers to have sold, or to be planning to sell, at least some of their production through special "organic" marketing channels, with the commodities including livestock and poultry fed sustainably-grown grain, wheat, soybeans, other grains and beans, vegetables, eggs, and fruit.

The 19 South Dakota sustainable farmers who sell at least part of their sustainably-raised commodities through "organic" market outlets all report receiving "organic"-based price premiums. These farmers were asked to indicate (1) the shares of each commodity they produce sustainably for which a price premium is received and (2) the approximate magnitude of the price premiums received.

All four farmers who sell flax for a price premium sell 100% of their production at a price premium. Farmers who sell wheat, millet, sunflowers, soybeans, and corn at a price premium report selling an average of between 92% and 76% of their sustainable production at a price premium. At the other extreme, two farmers who sell beef through "organic" market outlets are able to market only 2% and 15% of their total beef production for "organic"-based price premiums.

The only somewhat similar finding in the literature on shares of sustainable produce sold through special "organic" market outlets of which we are aware is that by Lockeretz and Madden (1987) for midwestern sustainable farmers. They report 11% in 1977 and 22% in 1987 of the respective surveyed sustainable producers to make at least one-half of their sustainable crop sales through special markets. The corresponding percentage for sustainable livestock sales is 13% for both 1977 and 1987.

The magnitudes of "organically"-based price premiums reported by the South Dakota sustainable producers vary considerably from farmer to farmer and by commodity.³ In general, however, the premiums appear to be highest for flax (commonly double or more) and next greatest for sunflowers and millet. The lowest reported price premiums (most commonly 20-30%) are for soybeans and beef. These price premiums tend to be higher than those few that are reported elsewhere in the literature:

³In interpreting these price premiums, one must recognize that regenerative price premiums are based on a cleaned and delivered basis, with high quality requirements, and are usually paid on a 30-60 day term basis rather than for immediate cash.

- Blobaum's (1984) study of midwestern sustainable farmers showed "organically"-based price premiums "as high as" 70% on oats, 30% on wheat, 25% on soybeans, 20% on corn, and 10% on beef; and
- Berardi's (1978) study of New York sustainable farmers showed a \$0.04/kg (20-25%) price premium for "organically"-produced wheat.

Respondents were asked to describe what they have learned about opportunities for and limitations to the effective marketing of sustainably-raised products. Several indicated that there is a growing "organic" market, but one has to work hard to access the market. Establishing a solid reputation as a regular supplier of quality product helps a great deal. The most common problems in marketing cited by respondents involve long distances from their farms to grain processing plants and the uncertain timing of purchases by wholesalers--which can present storage and cash-flow problems to individual producers. To help overcome these problems, some respondents suggest the development of marketing network systems and wholesalers assuming responsibility for storing "organic" products in more centralized and appropriately equipped warehouses.

SUMMARY AND CONCLUSIONS

A substantial number of practicing sustainable farmers in South Dakota, like many of their counterparts in other states, are not "pure" from the standpoint of using absolutely no synthetic chemical inputs. Nevertheless, all 32 of South Dakota's surveyed sustainable farmers are committed to achieving minimum levels of synthetic chemical use and are "experimenting" to that end each year on their farms.

A main sustainable farming technique reported by South Dakota's sustainable farmers is crop rotations. Farmers view crop rotations as the single most important means for controlling weeds, insects, and diseases on their sustainably farmed cropland. The legume forage and green manure cover crop components of crop rotations are considered the most important source of nitrogen and improved soil fertility for sustainably raised crops.

While only 2 of the 14 other researchers whose work was reviewed document the importance of crop rotations in reports of their sustainable farmer-oriented surveys, and neither report crop rotations to have the fundamental importance in sustainable farming that the South Dakota farmers do, we believe crop rotations are absolutely fundamental in sustainable agriculture. Accordingly, we are currently interviewing over 20 of the 32 mail survey respondents to determine in detail the configuration of, and specific cultural practices followed in, the farmers' crop rotations.

All the surveyed South Dakota sustainable farmers also report using special weed control practices. After crop rotations, their most important means of weed control are using only certified and/or "clean" seed, adjusting crop planting dates, selecting weed competitive crops, and cultivating and harrowing more frequently. Three-fourths or more of the surveyed farmers also follow special (1) insect and disease control and (2) tillage and residue management practices.

Fifty nine percent of the South Dakota sustainable farmers report selling at least part of their sustainably-raised produce through "organic" market outlets. Each reports receiving "organic"-based price premiums for sustainably-raised produce. Those farmers who sell each of sustainably-raised flax, wheat, millet, sunflowers, soybeans, and corn report that they receive a price premium for three-fourths or more of their respective total production of the crop.

The magnitudes of "organically"-based price premiums (for high quality product, on a cleaned and delivered basis) reported by the South Dakota sustainable producers vary considerably from farmer to farmer and by commodity. The lowest reported price premiums are roughly 20-30% for soybeans and beef; for other commodities, reports of doubled prices are quite common.

TABLE 1. SURVEY STUDIES OF SUSTAINABLE AGRICULTURE FARMERS

Report	Nature of survey (No. of respondents)	Year(s) of survey	Geographic focus	Commodity focus	Primary subject matter focus
Altieri, <u>et al.</u> , 1983	Mail survey, 120 organic farmers	n/a	California	Fruits, vegetables, nuts, some rice	Agronomic management strategies, social constraints, biological features, economics; apple production case study
Baker and Smith, 1987	Mail survey, 62 organic farmers; a follow-up personal interview of 10 farmers	1986	New York	Highly diverse, vegetables, fruits, specialty crops, livestock	Problems with organic farming, information sources, farmer perspectives on adequacy of land grant university research in meeting their needs
Berardi, 1978	Personal interviews with 10 organic and 10 conventional farmers	1974-75	New York	Winter wheat	Comparative energy and overall economic inputs and output
Blobaum, 1984	Survey of 214 organic farmers	n/a	Illinois, Iowa, Minnesota, Missouri, Nebraska	Grains, livestock, vegetables, fruits, eggs	Barriers to switching from conventional to organic farming methods
Buttel and Gillespie, 1988; Buttel, <u>et al.</u> , 1988	Mail surveys of 72 organic and 324 "small" and "commercial" conventional farmers	1987	New York	n/a	Comparative study of preferences for reduced input production practices (assuming no differences in yields and profits)
Foster and Miley, 1983	Mail survey of 58 organic farmers and 32 organic nonfarmers, with follow-up personal interviews	n/a	Kansas	n/a	An exploratory study of organic farmers and organic nonfarmers (consumers)
Harris, <u>et al.</u> , 1980	Mail survey of 96 organic and 378 conventional farmers	1978	Michigan	Highly diverse, grains, livestock, fruits, specialty crops	Compare the characteristics and practices for organic and conventional farmers
Klepper, <u>et al.</u> , 1977; Lockeretz, <u>et al.</u> , 1976; Lockeretz, <u>et al.</u> , 1977; Lockeretz, <u>et al.</u> , 1978 ¹	Personal interviews and subsequent mail survey, 14 matched pairs of organic conventional Corn Belt farmers	1974-76	Illinois, Iowa, southern Minnesota, northern Missouri, eastern Nebraska	Field crops, livestock	Comparative study of yields, labor, requirements, profits, energy use intensity, and soil erosion loss with organic versus conventional farm production practices
Lockeretz and Madden, 1987	Mail survey of 58 midwestern organic farmers	1987	Iowa, northern Illinois and Missouri, southern Minnesota, eastern Nebraska	Field crops	Determines changes in perceptions and experiences of organic farmers who had been studied 10 years earlier (Wernick and Lockeretz, 1977), with added attention in 1987 to the financial status of the farms
Lockeretz, <u>et al.</u> , 1980 ¹	Direct measurement of corn yields on 26 matched pairs of organic and conventional farmers	1975-78	Northern Illinois, Iowa, southern Minnesota, northern Missouri, eastern Nebraska	Corn	Comparative corn yields on matched pairs of organic and conventional farms, comparative effects of organic and conventional practices on soil properties
Madden, 1987	Mail survey and follow-up telephone interviews with 344 expected organic farmers in 1981 (250 of the 344 responded in 1986); the respondents included organic and mixed organic and conventional farms, plus a small number of conventional farms	1981 and 1986	California (vegetables, fruits, nuts), Idaho (field crops and general crops), Kansas (wheat, cash grain), Maine (diversified, with vegetables and melons most common), Oregon (vegetables and melons), Pennsylvania (dairy), Washington (wheat, grain)		Acreage, gross sales, herd size, crops, pest control measures, fertility farms; advantages of organic farming
Shearer, <u>et al.</u> , 1981 ¹	Survey of 23 organic farmers	1977-78	Mainly Iowa, also northern Illinois, southern Minnesota	Crop enterprises on beef and hog farms	Comparison of yields, cropland use, operating expenses, net returns, and energy use intensity on sampled organic farms versus all-farm averages for respective counties from which the organic farms were selected
Vail and Rozyne, 1982	Three hour personal interviews with 31 small organic farmers (over an 8-month period)	1978	Maine	Vegetables (?)	Soil management practices on small organic farms; main attention to soil amendments
Wernick and Lockeretz, 1977 ¹	Mail survey of 174 midwestern organic farmers	1977	Illinois, Iowa, Minnesota, Missouri, Nebraska	Field crops	Motives for and perceived advantages and disadvantages of farming organically; production practices of organic farmers

¹The following reports reflect findings from the four referenced surveys: Lockeretz and Wernick (1980) and Lockeretz, et al. (1981).

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