Modern Amish Farming as Ecological Agriculture

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Critics of industrial agriculture and advocates of ecological agriculture have cited Amish farming as a model of stewardship and sustainability. Amish farming in St. Lawrence County, New York, embodied ecological agriculture in some respects but not others. In comparison with non-Amish neighbors, Amish farms were smaller in scale, more diverse, and less integrated into the market economy. On the other hand, use of fertilizers and pesticides for crop production appeared to differ in kind, not amount. Amish farmers relied primarily on their own experience, not trade magazines or the local cooperative extension, for agricultural information. The high use of petroleum-based inputs may have reflected the newness of Amish settlement in St. Lawrence County, a lack of awareness of the ecological impacts of these substances, or a shift away from traditional practices. In the self-sufficiency of their lives based on subsistence and diversity, these Amish otherwise exemplified the productive and self-regulatory characteristics of ecological agriculture.

Keywords Amish agriculture, Amish pesticide use, ecological agriculture, New York State agriculture, stewardship, sustainability

For many decades, the Amish way of life has been recognized as one of simplicity, where necessity and practicality guide decision making and lifestyle. In light of this perception, it is only logical that Amish agriculture would be thought to represent "ecological agriculture." A philosophy of reaping what one sows and savoring the simple pleasures derived from daily labor is reflected in Amish agricultural practices (Kolodge, 1993). The religious constructs of Amish society contribute to this notion by making it detrimental to harm the land or destroy something not made by human hands. It can be said that the Amish strive for a harmony among God, nature, family, and community (Berry, 1977; Hostetler, 1987).

Ecological agriculture encompasses the principles of organic farming, in which only natural processes and products are used as inputs to grow crops. Beyond organic farming, ecological agriculture places an additional focus on the larger environmental, social, and economic impacts of farming practices (Goering et al., 1993). Ecological farming ultimately attempts to achieve a diverse, healthy, and productive ecosystem in which biologi-

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cal processes and cycles dominate. The emphasis is on agricultural methods that are sustainable as well as organic. A sustainable farm is one in which the ecosystem on the farm can reach a sort of permanence (Soule and Piper, 1992), accomplished when nutrient inputs and eventual outputs are balanced and do not exhaust the natural resources of the farm. The resulting dynamic equilibrium can adapt to changes and is considered to be ecological because the sustainable farm operates much as a natural system would. The maintenance and stabilization of the dynamic equilibrium on the farm occurs as a result of diversity in crops and farm animals, the avoidance of potential pollution, and the replacement of petroleum products with renewable resources. In addition, alternative means of weed and pest control are preferred to the use of herbicides and insecticides. Alternative means may include crop rotation, integrated pest management, cultivation, or biological pest control (National Research Council, 1989). Such practices contribute to ecological farming because they have been shown to enhance biological interactions rather than suppress them, while at the same time limiting external inputs.

In addition to sustainability, the concept of stewardship was important to earlier critics of industrial agriculture (Jackson, 1980). Stewardship of the land is fundamental to Amish religion; stewardship is a form of good behavior, and eternal life is a reward for good behavior. Both sustainability and stewardship are enhanced by self-sufficiency, which minimizes reliance on the outside world by deflecting external social and economic influences from the Amish culture. Several authors have portrayed Amish agriculture along these lines, but works by Wendell Berry (1977, 1981, 1982) are especially noteworthy for praising the sustainability and stewardship of Amish agriculture.

When one sees an Amish farm and compares it with a modern industrialized farm, there are obvious differences between the two. Berry (1982) has described Amish land as varied, interesting, healthy-looking farm country, containing a great deal of natural and agricultural life. In contrast, he has portrayed industrialized farms as deserts of abandoned buildings and machinery, existing on overworked fields with low crop yields. It is not, according to Berry, uncommon to hear of Amish farmers who brought overworked and unproductive fields back to life and maintained them using methods that have not changed through the centuries.

In light of land improvement because of Amish practices, it might be concluded that their methods are ecologically sound. A close reading of Berry, however, may lead one to question how completely modern Amish agriculture follows the tenets of ecological agriculture. In an essay titled "Seven Amish Farms," Berry (1981) discussed why manure was important on one particular Amish farm and how it decreased dependence on chemical fertilizer. It was conceded, nevertheless, that some chemical fertilizer was used as a starter for corn and oats. This essay also revealed how herbicides were utilized to control weeds. Hay purchased for extra horses that were housed during the winter brought weed seed that had to be controlled. Berry summarized and compared the costs and efficiencies of this particular farm with non-Amish agriculture, carefully downplaying throughout the use of both pesticides and fertilizers on the Amish farm.

A similar analysis was reported by Logsdon (1986), who described how he pursued the matter following discussion after a softball game between some Amish and non-Amish farmers. Logsdon compared the costs of producing corn on a single Amish farm with the costs on a typical non-Amish farm. Although costs were clearly much lower on the Amish farm, it is interesting to note that chemical fertilizers accounted for 21% and pesticides and herbicides for 6% of the total Amish expenses. In comparisons of Amish and non-Amish farming, it is obvious that there are several differences with respect to diversity, technology, use of petroleum, self-sufficiency, harmony with nature, and involve-

ment of family and community. However, in celebrating these differences, writers like Berry and Logsdon have tended to minimize Amish involvement in certain controversial practices that are of importance to the environment, especially the use of pesticides and fertilizers.

Many researchers have conducted studies regarding the culture of Amish settlements (e.g., Hostetler, 1963, 1987; Reschly and Jellison, 1993). Investigators have been especially interested in the ways that Amish communities have adopted facets of modern culture and the ways that Amish society has adapted to both internal and external change (e.g., Ericksen et al., 1980; Foster, 1984; Schwieder and Schwieder, 1976). With respect to agriculture, Ediger (1986) noted that some Amish in Iowa and Ohio used steel-wheeled tractors. Place (1993) described how Amish farmers in Lancaster County, Pennsylvania, had selectively adopted certain modern innovations, such as mechanical milkers, veterinary services, and artificial cattle insemination, although they continued to use horses and mules to pull field machinery.

Only a few studies have attempted to characterize Amish agriculture and compare it with that of the non-Amish. These studies have examined attitudes toward environmental issues in farming, as well as energy and land use patterns in Amish and non-Amish agriculture. Previous investigations of Amish agriculture in Ohio are particularly pertinent to the present study, because most of the Amish farmers in the research presented in this article migrated from Ohio to northern New York.

Stinner, Paoletti, and Stinner (1989) discussed Amish culture and agriculture based on the results of a two-summer study of a single Amish farm in Holmes County, Ohio. They described Amish agriculture as one based on "moderation, simplicity of life, frugality, neighborliness, family stability, and financial common sense" (p. 88) and suggested that these characteristics are derived from the strength of community. Jackson (1988) also studied a single Amish farm in Holmes County, focusing on soil characteristics, in comparison with a single non-Amish farm that used no-till agricultural methods. Cropland on the Amish farm exhibited higher rates of water infiltration, higher levels of alkaline-phosphatase activity, less compaction, and more organic matter than the non-Amish farm. It was concluded that traditional horse-drawn farming may cause less soil degradation than no-till farming advocated by the USDA Soil Conservation Service to reduce erosion of topsoil. Both of these studies involved only one Amish farm; despite difficulties of generalizing, they are included here because of the particular relevance of Holmes County to the northern New York community studied in this research.

In another study conducted in three counties of Ohio, 314 non-Amish and 52 Amish farmers were surveyed regarding the threat of groundwater pollution from chemical use and their attitudes toward agricultural practices that might reduce pollution (Sommers and Napier, 1993). It had been hypothesized that the lower levels of formal education, younger average age, and lesser degree of farming experience among Amish farmers would lead to lower levels of knowledge about the threat of groundwater contamination from chemical fertilizers, insecticides, and herbicides. However, Amish farmers were found to be significantly more aware of the potential of chemicals to pollute groundwater and more open to changing their methods to reduce the threat of pollution than non-Amish farmers. For example, the one farmer studied by Stinner et al. (1989) in Holmes County also demonstrated a receptivity to technology that supported conservation, such as the horse-drawn no-till planter.

The energy consumption and efficiency of Amish agriculture in relation to non-Amish were the subject of a study in Mifflin County, Pennsylvania (Craumer, 1979). Forty-seven Amish farmers were interviewed for comparison with data from about 1,180 non-Amish

farms throughout Pennsylvania taken from the 1975 Pennsylvania Dairy Farm Business Analysis. Agricultural input and output were quantified in terms of fossil fuel use, expressed in kilocalories. An efficiency level (energy ratio) was calculated by dividing energy output by input. The Amish were 30% to 40% more efficient than the non-Amish. Non-Amish farms used as much as two times the amount of total energy to produce 1 kg of milk as the Amish farms. The amount of human labor for Amish versus non-Amish farming was also quantified. The Amish required 21% to 67% more energy in human labor to produce the same amount of milk as the non-Amish. The use of draft animals and human labor in place of machinery allowed for greater fossil fuel efficiency on Amish farms. A similar study, published a few years earlier, showed similar results (Johnson et al., 1977).

Land use patterns of Amish agriculture were also categorized in some of the studies cited above. Amish farms were smaller because of limitations imposed by the use of human and animal labor rather than machinery. Amish farms were also smaller than non-Amish ones because of the diversified interests and activities of Amish farmers. Amish men were called upon by their beliefs "to be good husbands, fathers, and neighbors," (Stinner et al., 1989, p. 82). The proportion of farmland devoted to pasture and feed grains was smaller for Amish farmers than for non-Amish farmers, 55% to 57% versus 67% in one study (Craumer, 1979). However, Amish cropland produced a greater diversity of grains and was conserved by a more frequent rotation of crops. The single Amish farmer in the study by Stinner et al. (1989) used non-cropland for timbering, beekeeping, maple sugaring, and gardening, but this pattern of diversity has not been universal. According to Stoltzfus (1973), for example, some Amish farmers in Illinois took to specializing in one crop or animal because of economic conditions in that region about two decades ago.

Regardless of location, all Amish communities are bound to upholding the specific belief system, called the *Ordnung* or *Ottning*. In northern New York, as elsewhere, the *Ordnung* prescribes certain behavior in relation to daily life and the outside world. Most Amish communities are based on agriculture because of their belief that "God created the world and enjoyed it and then created human beings whom he commanded to harness and cultivate the earth" (Johnson-Weiner, 1990, p. 11). The earth, therefore, is viewed as a sacred trust. Nature is not worshipped, but the Amish take comfort as Christians in a close relationship with nature. Religion can serve to reinforce certain practices in farming; farming activities, in turn, have spiritual ramifications. The Bible teaches that "some soil favors good seed and some favors weeds; so too, they [the Amish] believe, some occupations favor a Christian life" (Johnson-Weiner, 1990, p. 11). Farming is therefore more than an occupation; it is a way of protecting the religion and values of Amish culture. According to Savells (1988), in a study of Amish in Indiana, Iowa, Ohio, Pennsylvania, and Tennessee, agriculture has helped to maintain culture by providing opportunities for Amish youths, few of whom have left their communities or religion.

Case Study: St. Lawrence County, New York

Although previous studies of Amish farming have focused on communities in Ohio, Pennsylvania, and elsewhere, no prior research has been conducted on Amish agricultural practices in northern New York. Motivated by the availability of relatively inexpensive property, Amish communities became established in two different locations in St. Lawrence County in the early 1970s. This paper focuses on the Heuvelton-De Peyster community, a settlement of the Swartzentruber Amish. This community is a homogeneous settlement comprising families who originated primarily in Holmes County, Ohio (Johnson-Weiner, 1990).

St. Lawrence County has a climate generally well suited for agriculture. The growing season is relatively long, with little variability from year to year. The growing season ranges from 140 to 150 days, with an average temperature between 60°F and 62°F. The average precipitation for a growing season is 16 in., a figure only slightly lower than those of other important agricultural areas in eastern North America. Early growing season temperatures are frequently low, however, and the soil tends to remain cool late into the spring. Consequently, the planting of corn and oats is often delayed (Nobe and Conklin, 1957).

Methods

The study area contained parts of five towns within St. Lawrence County: Canton, De Kalb, De Peyster, Lisbon, and Oswegatchie. Possible candidates for participation in the study were identified in a windshield survey of the area. Both Amish farms and neighboring non-Amish farms were selected. Although the Amish farms were of primary interest, an equal number of non-Amish farms was also identified to provide a control group for comparison. Figure 1 identifies the location of the 30 Amish and 29 non-Amish farms that eventually participated in the study. The two groups were intermixed throughout the study area, and the distribution within each town, as shown in Figure 1, was approximately the same. Statistical analysis demonstrated that the numeric distribution of Amish versus non-Amish farms was not significantly different within towns.

It was hoped that by sampling both Amish and non-Amish farms within the same geographic area, certain environmental factors that could affect farming (e.g., soil types, topography, localized weather) would be controlled. In 1957, an economic classification divided St. Lawrence County into various land classes according to net incomes that farms in the county were likely to yield in the future (Nobe and Conklin, 1957). Although this economic classification was compiled a number of years ago, it provided the only measure of anticipated success for agriculture in the county based on natural features of the soil, topography, and drainage. Moreover, it described the anticipated conditions and prospects for farming during a period that unfolded as the Amish began to move into this region of St. Lawrence County.

Table 1 shows the distribution of farms within the 1957 economic land classes that compose the study area. Approximately two-thirds of both Amish and non-Amish farms were in classes 3 and 4. Land class 3 comprised areas in which farm incomes were generally low, yet high enough to meet the minimum requirements for continued operation for an expected 15 years. Many farms existing at the time of designation were small to medium in size, with crop yields frequently limited by adverse soil conditions. Land class 4 consisted of areas where medium incomes were expected from farming in the future. Here, farms were generally larger, maintained higher production rates, and were more efficient in the utilization of farm capital. The soils in these areas were thought to be adequate to support a well-adjusted agriculture for at least two more generations. Land classes further demarked by sub-class 3-x had "sufficiently strong land resources to promise increased incomes if farms are increased in size, more adequately equipped with buildings and machinery, and more intensively operated" (Nobe and Conklin, 1957, p. 1). Areas delineated by sub-class 4-y were thought to be "progressively more handicapped in their competition with other areas in the same class as farming became more intensive" (p. 1). Two non-Amish farms each were in land class 2, which comprised areas where the chances of continued farming were considered to be virtually nonexistent, and land class 5, which consisted of areas projected to have very high income expectancies for at least one generation. The distributions of Amish versus non-Amish farms were not found to be significantly different across economic land classes.

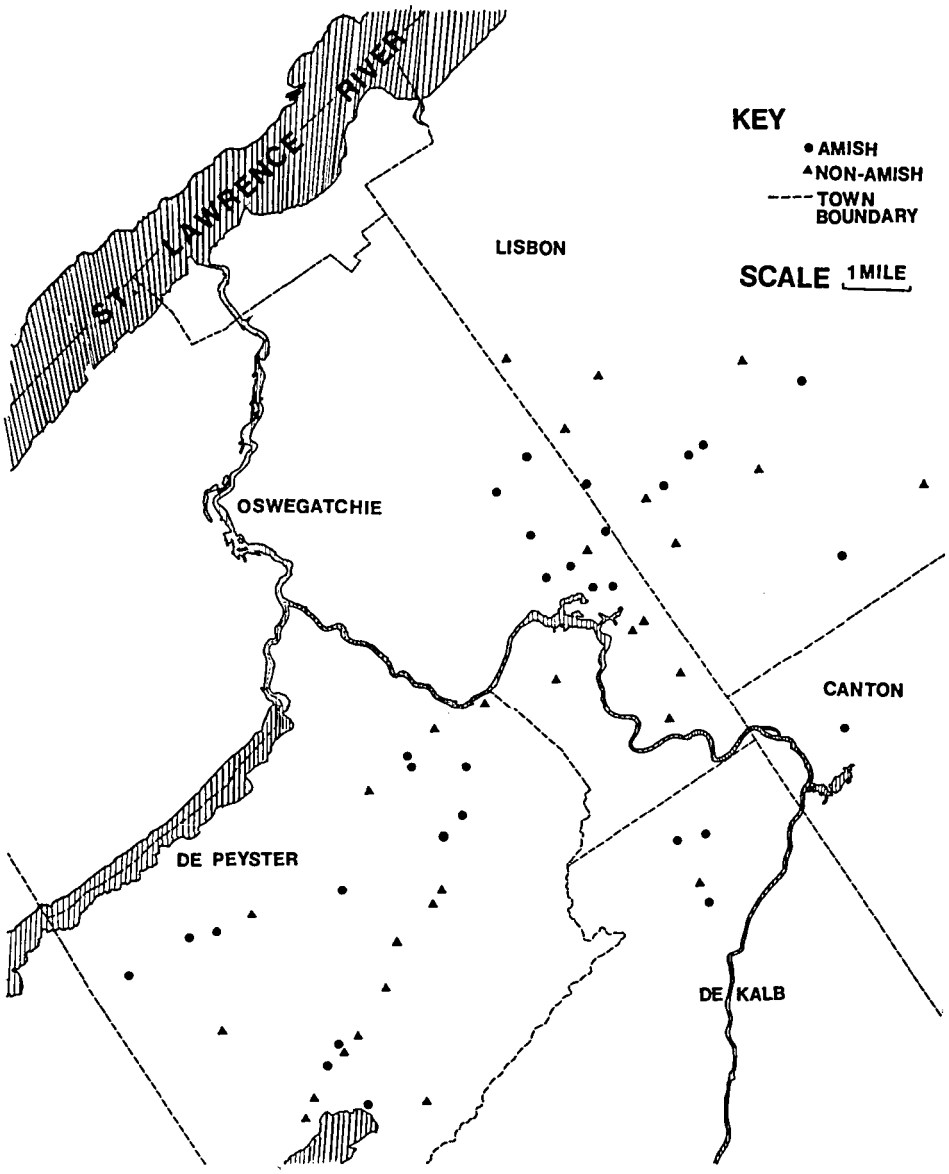

Figure 1. Distribution of Amish and non-Amish farms in study region, St. Lawrence County, New York.

Data on farm characteristics, agricultural activities, and farm inputs and outputs were collected by use of a structured questionnaire. Prior to creating the questionnaire, literature concerning Amish culture and history, and articles pertaining to Amish farming, were carefully reviewed by the authors so as to gain a greater understanding of the subject matter. An initial questionnaire was developed for use on a pilot group before data for the actual study were collected. After seven pilot interviews, the questionnaire was revised so as to collect more accurate and detailed information about certain topics. The revised questionnaire consisted of 14 questions. Specific items inquired about amounts of

Table 1
Distribution of study farms across economic land classes

Land class	Number of Amish farms	Number of non-Amish farms
2 (very low)	0	2
3	10	7
3-x	6	4
4	11	13
4-y	3	1
5 (very high)	0	2
Total	30	29

Note. $\chi^2 = 6.08; p = 0.2981$.

land farmed, land leased, and plans for expansion; crop types and acreage over the past three years; animals on the farm over the past two years; products marketed and locations of markets; methods of pest control during the last growing season, including insecticide and herbicide use (types, amounts, and frequency of applications); fertilizer use and amounts over the past year; crop rotation; and sources of agricultural information. Field interviews were conducted in person with 30 Amish farmers and 29 non-Amish farmers during the autumn of 1994. Of those who were approached for interviews, three Amish farmers and two non-Amish farmers chose not to take part in the study. The overall response rate was therefore 92%. There were approximately sixty-five Amish farms in the Swartzentruber community of Heuvleton-DePeyster. The sample of 30 Amish farmers therefore represented about 46% of the total membership of this settlement.

With the exception of a few answers that could not be easily translated into quantitative terms, most of the information from the questionnaires was coded so it could be entered into a Minitab database. Nonquantifiable answers were summarized and evaluated separately. Elementary statistical analyses were employed to evaluate the data; *t* tests were used to compare Amish with non-Amish, and chi-square tests were used to analyze frequency counts in certain tables.

Results

Farm Characteristics

Figure 2 summarizes Amish and non-Amish agriculture in relation to amount of land farmed. Consistent with research on agriculture elsewhere, the amount of land farmed by each Amish farmer in St. Lawrence County was small enough to be worked properly by a team of horses. The difference in size between Amish and non-Amish farming operations was similar to that found in Pennsylvania (Craumer, 1979) as well as to that found in Ohio (Sommers and Napier, 1993). In addition to their own farmland, as depicted in Figure 2, 16 of the 30 Amish farmers leased an average of 39.8 acres, whereas 15 of the 29 non-Amish farmers leased an average of 149.9 acres. Eight Amish farmers wanted to expand between 5 and 50 acres, and seven non-Amish farmers desired to add between 50 and 400 acres.

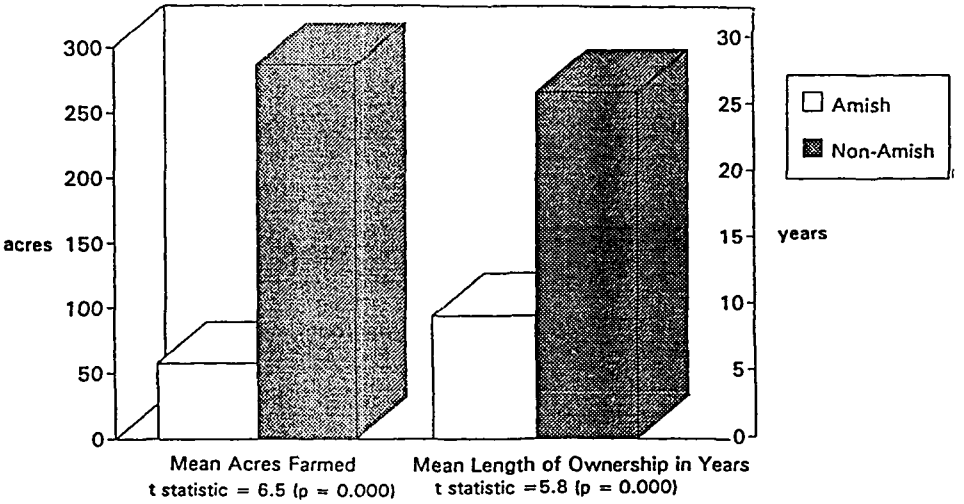

Figure 2. Comparison of acres farmed and length of ownership for Amish and non-Amish farms.

Beyond this obvious difference in farm size, Amish and non-Amish agriculture varied in terms of both amount and type of cropland. The amount of land in various crops and pasture is summarized for 1994 in Table 2. At least 25 of the 30 Amish farmers planted three different crops: corn, oats, and hay. In contrast, only six of the 29 non-Amish farmers grew three or more crops, including oats. Similar data were reported for 1993 and 1992.

Table 3 presents the types of animals reported on farms participating in this study. At least 24 of the 30 Amish farms had the following animals in 1994: dairy cattle, heifers, pigs, chickens, and horses. Although livestock production is labor-intensive, requiring daily attention to maintain animals properly, it was handled easily on Amish farms by efficient use of family labor, which was plentiful because of the large size of Amish fami-

Table 2
Amounts of land in crops and pasture for Amish and non-Amish farms in 1994

	Amish		Non-Amish	
Crop	Number of farms (%)	Mean number of acres (*SD*)	Number of farms (%)	Mean number of acres (*SD*)
Corn	27 (90)	17.0 (6.8)	23 (79)	74.5 (58.4)
Oats	25 (83)	11.0 (5.7)	6 (21)	27.0 (36.1)
Hay	28 (93)	32.7 (29.5)	26 (90)	149.5 (74.6)
Peas	0 (0)		3 (10)	14.3 (20.8)
Sorghum	0 (0)		3 (10)	13.3 (10.4)
Wheat	2 (7)	6.0 (1.4)	0 (0)	
Barley	0 (0)		1 (3)	20.0 (0.00)
Pasture	27 (90)	45.7 (29.1)	26 (90)	64.2 (48.2)

Note. $\chi^2 = 19.04; p = 0.0031$.

lies. Non-Amish farmers had a larger number of dairy cattle, but far fewer nondairy animals than the Amish farmers. In addition to the animals cited above, a handful of both Amish and non-Amish farmers had turkeys, ducks and geese, goats, beef cattle, sheep, and fallow deer. Each of these animal types was found on only one or two farms. Data for 1993 showed a similar pattern in the number and diversity of animals.

Although they were not systematically recorded as part of this study, obvious differences in agricultural machinery were observed during the course of interviewing. Amish respondents were particularly interested in talking about this aspect of their farms. Clearly, their machinery was rudimentary. They relied on horse-drawn equipment in the field, whereas stationary, petroleum-powered engines were used occasionally around farm outbuildings, for example, in cold-water systems for cooling milk and on equipment for lifting hay into barns.

Farm Products

Another major difference between Amish and non-Amish farmers was in the diversity of products generating revenue for the farm. One non-Amish farmer offered products for sale on a roadside stand, in comparison with 20 of the Amish farmers. Both the non-Amish and Amish farmers offered a variety of products, including strawberries, asparagus, squash, peas, tomatoes, cucumbers, corn, beets, potatoes, carrots, and pumpkins. The Amish farmers also included maple syrup, honey, and eggs among the items for sale. The self-sufficiency of Amish farms could be seen in the wide diversity of fruits and vegetables offered for sale to the public. The variety and fluctuating amounts of products found at the average Amish roadside stand reflected cultural values and family orientation that define Amish agriculture in this region. Food grown in the garden was primarily for subsistence, and only extra items that were not useful to the family were sold at the stand. Amish farmers explained that their roadside stands did not serve as a major source of income, but merely provided a few dollars from items not consumed by the family.

Twenty-six of the 29 non-Amish farmers produced milk, averaging 2752.3 pounds per day. This milk was shipped to cooperatives and cheese factories located within the

Table 3
Number of animals on Amish versus non-Amish farms in 1994

	Amish		Non-Amish	
Animal	Number of farms (%)	Mean number of animals (*SD*)	Number of farms (%)	Mean number of animals (*SD*)
Dairy cows	29 (97)	6.4 (4.2)	27 (93)	69.6 (34.3)
Heifers	28 (93)	22.0 (12.7)	27 (93)	54.6 (39.0)
Bulls	20 (67)	2.3 (1.9)	14 (48)	4.1 (6.7)
Pigs	24 (80)	9.2 (13.1)	3 (10)	535 (922)
Chickens	27 (90)	27.9 (17.1)	2 (7)	30.0 (28.3)
Horses	28 (93)	7.3 (3.3)	1 (3)	2.0 (0.0)
Other	5 (17)	4.0 (3.1)	6 (21)	6.5 (8.4)

Note. $\chi^2 = 41.76$; $p = 0.0000$.

county. The Amish farmers were not involved in milk production to the same extent as their non-Amish neighbors. Only 12 of 30 Amish farmers produced milk for sale, averaging 207.2 pounds per day. Amish farmers sent their milk to a cheese factory used exclusively by Amish farmers throughout the area and also located within the county. Because of the growth of Amish settlements in recent years, a second cheese plant was under construction at the time of the survey. Milk production on a per cow basis was slightly higher for non-Amish farmers (39.5 pounds per cow per day) than for Amish farmers (32.4 pounds per cow per day).

In terms of livestock sales, both Amish and non-Amish farmers sold pigs and dairy cattle, primarily as heifers. These sales were handled by companies that brought cattle to local and regional auctions. Ten Amish farmers sold on the average 11.8 cows in 1994, whereas ten non-Amish farmers sold on the average 30.8 cows in the same year. In terms of hogs, four Amish farmers marketed an average of 86.3 animals in 1994, and one non-Amish farmer sold 1,500 animals. Amish farmers did not engage in livestock sales involving other animals. On the other hand, two additional non-Amish farmers engaged in the sale of beef, with one marketing 75 beef cattle in 1994 and the other marketing an unspecified number. Finally, one additional non-Amish farmer sold an uncertain amount of baled hay.

These data reveal the differing philosophies underlying Amish and non-Amish agriculture. Although both groups raised a variety of animals in the aggregate, each Amish farmer was individually diverse, whereas each non-Amish farmer specialized in one, or at most two, animals. Furthermore, as reflected in market sales, Amish farmers raised far fewer animals for sale. The diversity of animals on Amish farms was mostly for personal consumption by their families; the motive behind animal production was primarily self-sufficiency and subsistence. The non-Amish farmers specialized and marketed a far larger number of certain animals for profit in the marketplace.

Soil Maintenance

Table 4 presents the type and amount of fertilizer applied in 1994 by farmers participating in this study. This table shows that Amish and non-Amish used different types of fertilizers to a significant extent. Amish farmers used 6-24-24 on their fields to a much larger degree than non-Amish farmers; while triple 19 (19-19-19) was utilized solely by

Table 4
Fertilizer applications on Amish and non-Amish farms in 1994

Fertilizer nitrogen/phosphorous/ potassium (as percent of total)	Amish		Non-Amish	
	Number of farms (%)	Mean lbs/acre	Number of farms (%)	Mean lbs/acre
6/24/24	25 (83)	116.8	2 (7)	225.0
15/15/15	12 (40)	204.3	13 (45)	253.9
19/19/19	0 (0)		5 (17)	252.0
Other	4 (13)	175.8	13 (45)	194.3

Note. $\chi^2 = 28.87; p = 0.0000$.

non-Amish, and triple 15 (15-15-15) was employed by about the same number in each group. In addition, more than a dozen other substances were reported as fertilizing agents during the interviews. All but a few of these fertilizers were utilized by only one of either the Amish or non-Amish farmers.

The formulae of inorganic fertilizers refer to percentages of the three most important elements of plant nutrition. The first number represents the percentage of nitrogen, the second stands for phosphorous, and the third denotes potassium as potash. Of all elements in soil, these three are most readily depleted by the growing of crops, especially corn, and they are the ones that must be replenished in the largest amounts. Amish farmers spread fertilizer containing less nitrogen because levels of this nutrient can be maintained by applications of animal manure.

Although virtually all farmers with livestock probably disposed of animal manure on their fields as a form of waste disposal, it was interesting to note how many farmers thought of manure as fertilizer. The question on the survey was open-ended, asking respondents to list various fertilizers used to maintain soil and assist in the growing of various crops. Without a specific prompt about manure as a form of fertilizer, 22 of the 30 Amish farmers thought to mention animal waste, compared with only 13 of the 29 non-Amish farmers. This difference in perception can be attributed to the disparity in underlying philosophies of agriculture: The self-sufficient nature of Amish farming reinforces an ideology emphasizing the cycles and dynamic equilibrium of ecological agriculture based on permanence. Amish farmers are therefore apt to think of animal waste products as fertilizers.

All Amish and most non-Amish farmers spread inorganic fertilizer only in the spring. In addition, some Amish farmers (12) and some non-Amish farmers (5) applied manure only in the spring. The remaining 10 Amish and eight non-Amish farmers spread manure in seasons other than spring. In some cases, fall and winter applications were preferred. In other cases, manure was spread as a form of waste disposal whenever facilities for storage became insufficient.

In general, most farms were characterized by similar crop rotations. The main difference was in the greater frequency with which oats were interjected into the cycle by Amish farmers, to provide feed for horses. Most (21) of the Amish farmers employed a standard three-year rotation of corn-oats-hay, or a six-year cycle of corn-corn-oats-hay-hay-hay, with an occasional fourth or more years of hay added, lengthening the cycle. The length of time that a field would be planted in hay depended on the quality of hay produced from year to year. One Amish farmer was uncertain about his crop rotation, because he had been farming in the region for only one year at the time of the study. Seventeen of the 29 non-Amish farmers rotated crops. Eleven farmers utilized a crop rotation of corn and hay in three- to four-year shifts. Five farmers incorporated a three-crop rotation, which sustained an eight- to 11-year cycle of two to three years of corn, followed by one year of oats and then five to seven years of hay. The last farmer employed a three-year cycle rotating corn, peas, and hay on an annual basis.

Insect and Weed Control

Insect and weed control differed somewhat between Amish and non-Amish farmers. Overall, the Amish used about the same amounts of pesticides as the non-Amish, but the specific types of chemicals varied, as did the proportions. More pronounced differences were observed in relation to the use of herbicides than to the use of insecticides.

With respect to insecticides, 11 Amish farmers used them on their gardens, including two that also used them on cropland; one additional Amish farmer used them on cropland

only. In contrast, only two non-Amish farmers used insecticides on cropland. On gardens, insecticides were applied once or twice daily; on cropland, insecticides were applied one to three times during the growing season. The insecticide used most commonly was carbaryl (brand name: Sevin). Carbaryl is a relatively nonpersistent chemical in wide use, although it is a known teratogen, a suspected carcinogen, and a strong toxicant for a variety of animals, including bees, worms, crustaceans, fish, and birds (Briggs, 1992).

The larger number of Amish who used insecticides on their gardens compared with the number of non-Amish may be attributable to a larger proportion of Amish farmers having gardens, but this possibility could not be tested because the questionnaire did not inquire about the practice of gardening. A more likely explanation is that Amish participants in the survey thought of gardens as part of their farms, whereas non-Amish participants did not. In particular, gardens are essential for Amish subsistence, and a large number of Amish farmers in the study sold surplus vegetables at roadside stands. Gardens may be important for non-Amish farmers, but they are unlikely to be necessary for existence, and they are certainly not part of the agricultural enterprise. Thus, when asked about pest control, Amish respondents thought to include what they did in their gardens, whereas non-Amish participants did not.

Table 5 summarizes weed control for corn crops during the 1994 growing season. The number of farmers using herbicides was not appreciably different for the Amish (23 of 27) and the non-Amish (20 of 23). However, considerable differences were reported in the types and varieties of herbicides preferred by the two groups. Most of the Amish farmers applied atrazine only to control weeds in corn. Although these farmers appeared to apply more atrazine per acre than their non-Amish neighbors, this difference was not statistically significant. Any difference, furthermore, was counterbalanced by the simultaneous use of several other herbicides by more of the non-Amish farmers. Of the Amish farmers who applied herbicides in cornfields, 83% used only one chemical (atrazine),

Table 5
Weed control methods associated with corn production on Amish and non-Amish farms in 1994

	Amish		Non-Amish	
Control method	Number of farms (%)	Mean lbs/acre	Number of farms (%)	Mean lbs/acre
None	2 (7)		0 (0)	
Cultivation	8 (30)		7 (30)	
Herbicide Use	23 (85)		20 (87)	
Atrazine	18 (67)	2.2	15 (65)	1.9
Cyanazine (Bladex)	0 (0)		4 (17)	1.3
Glyphosate (Round-up)	1 (4)	4.9	5 (22)	3.8
Metolachlor (Dual)	0 (0)		3 (13)	2.3
Pendimethalin (Prowl)	0 (0)		10 (43)	3.1
Simazine (Princep)	4 (15)	4.2	0 (0)	
2,4-D (Amine)	3 (11)	0.9	1 (4)	0.6
Other	1 (4)	2.6	4 (17)	0.3

Note. $\chi^2 = 27.67; p = 0.0004$.

13% used two chemicals, and 4% used three chemicals. In contrast, only 30% of the non-Amish farmers used just one chemical, 45% used two chemicals, 20% used three chemicals, and one used four different chemicals to control weeds in corn. In terms of nonchemical means of controlling weeds in corn, the same proportion of Amish farmers, 8 of 27, mentioned the use of cultivation as non-Amish farmers (7 of 23).

The greater dependency of Amish farmers on atrazine, simazine (brand name: Princep), and 2,4-dichlorophenoxyacetic acid or 2,4-D (brand name: Amine) is troublesome. Of the herbicides listed in Table 5, these three are the most dangerous in terms of harm to the environment and human health. Atrazine is a known carcinogen and immunotoxin; simazine causes long-term damage to the kidney, liver, thyroid, and testes, with consequent disturbances in sperm production; and 2,4-D is a known carcinogen, teratogen, and immunotoxin, a suspected fetotoxin, and a toxicant to the kidney, liver, and central nervous system. Atrazine and 2,4-D also create serious ecological impacts for a wide variety of nontarget species (Briggs, 1992).

The greater frequency with which oats were planted by Amish farmers may have dictated a certain need for some herbicides and fertilizers, because oats demand more of these petroleum-based inputs than hay. Of the 25 Amish farmers who grew oats, nine used 2,4-D and three used glyphosate (brand name: Round-up). According to Craumer (1979), the Amish in Mifflin County, Pennsylvania, also required such inputs for the growing of oats. One Amish farmer in Holmes County, Ohio, also justified his use of herbicides by the need to grow feed grain for animals housed during the winter (Stinner et al., 1989).

Source of Agricultural Information

Figure 3 compares the places where Amish and non-Amish farmers learned about agricultural practices and innovations. It was important to inquire about where farmers thought they had obtained their knowledge about agriculture, because cultural differences

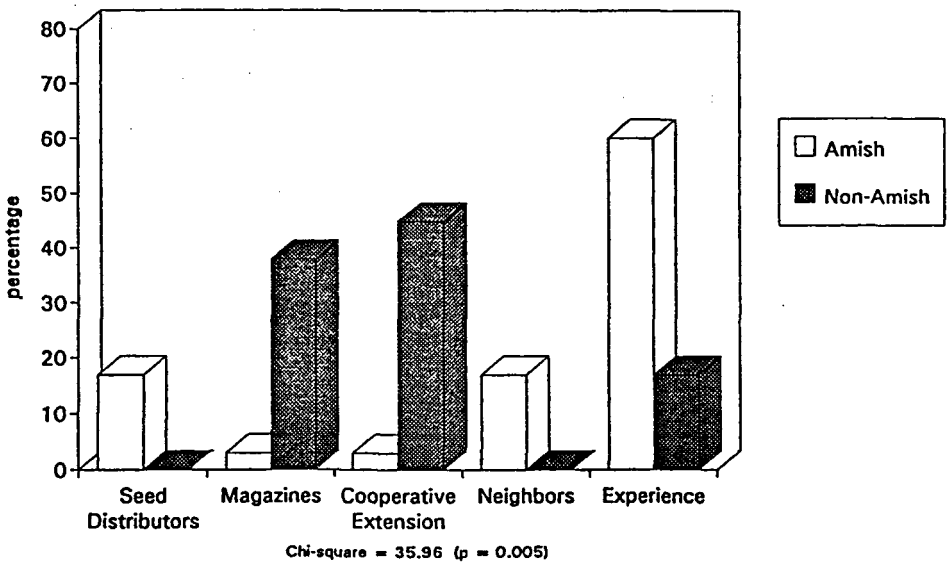

Figure 3. Primary sources of agricultural information for Amish and non-Amish farmers.

have been reported to play an important role in encouraging or discouraging interaction with others. The present results, in fact, seem to support this view. Amish farmers depended primarily on their own experience, and, to a lesser extent, on neighbors and seed distributors. On the other hand, none of the non-Amish farmers reported that they relied primarily on neighbors for agricultural information. The non-Amish, instead, used the cooperative extension of Cornell University and subscribed to farming magazines.

The results here reinforce the observations of other investigators, who have found that the Amish are reticent to seek help from government programs and agencies as part of a deliberate strategy to separate themselves from non-Amish. For example, Place (1993) found that Amish farmers in Lancaster County, Pennsylvania, do not solicit aid from the county Conservation District or the USDA Soil Conservation Service in relation to plans for managing animal manure and other farming practices. However, many Amish in Lancaster County do consult with the cooperative extension of Pennsylvania State University, viewing it as a resource for information rather than a government agency, and others subscribe to agricultural periodicals. Although all Amish both harbor suspicions about government and desire to maintain the integrity of their culture through community self-sufficiency, there are clearly differences among communities, with the Swartzentruber Amish of northern New York apparently among the more conservative settlements.

Discussion

In general, it was found that Amish farmers in upstate New York differ from their non-Amish counterparts in terms of scale (small versus large), diversity (high versus low), technology (low versus high), and philosophy (self-sufficiency for subsistence versus production for the market economy). Amish farms are smaller and more diverse than non-Amish farms. Amish farmers grow a wider variety of vegetables and raise a wider variety of animals than non-Amish farmers. The primary focus of Amish agriculture is on self-sufficiency rather than production for profit. Amish farmers are concerned only with generating enough output to live consistently with their beliefs and to get children started out on their own farms. Non-Amish farmers raise animals primarily to participate in the regional marketplace, particularly with respect to dairy cattle and milk production. In contrast to non-Amish farmers, most Amish have only enough cows to yield the amount of milk that the family will consume. Some Amish farmers do produce surplus milk for the manufacturing of cheese at an Amish-operated plant, and a few sell heifers and hogs, as well, but these quantities are far smaller than those of their non-Amish neighbors. A trend toward diversity and self-sufficiency is also evident in vegetable gardens. What is produced is to be eaten by the family, with any amount left over to be sold at roadside stands. Both Amish and non-Amish farmers use inorganic fertilizers and synthetic pesticides. Although the two groups use somewhat different kinds of fertilizers and pesticides, the overall amounts are approximately the same. More importantly, the environmental impacts of substances used by both groups are equally problematic in terms of ecological impacts and human health effects. The use of these substances dispels the notion that the Amish in this region are organic farmers.

Amish agriculture in St. Lawrence County, New York is not appreciably different from Amish agriculture in other northeastern states (Pennsylvania and Ohio), to the extent that comparisons can be made on the basis of published literature. In certain respects, the Swartzentruber Amish in northern New York are comparatively conservative, for example, in their very limited contact with any governmental agencies. On the other hand, it seems that the Amish in St. Lawrence County utilize synthetic pesticides and inorganic

fertilizer to a greater extent than their brethren elsewhere. However, the literature on Amish agriculture is not only sparse, but also somewhat dated, some of it having been published 15 to 20 years ago. One possibility is that Amish farming everywhere has been increasingly adopting higher agricultural inputs.

Amish farming in St. Lawrence County is congruent with the definition of ecological agriculture in several aspects. By having small and diverse farms, these Amish farmers have avoided the specialization and monocultures characteristic of industrial agriculture. On the other hand, the use of petroleum-based fertilizers and pesticides contradicts the principle of sustainability embedded in ecological agriculture. Although these Amish farmers perceive animal manure as a source of nutrients for maintaining soil, their reliance on fertilizers such as 6-24-24 and triple 15 is not indicative of a self-sufficient system that recycles internally, like the biological processes of a productive and self-regulating ecosystem. The use of insecticides and herbicides, such as carbaryl, atrazine, simazine, and 2,4-D, obviously violates the notion of stewardship. Quite clearly, ecological agriculture prefers organic means of pest control to prevent chemical contamination of the environment. One question is whether the dynamic equilibrium of Amish agriculture can be sustained if the Amish continue to rely so heavily on petroleum-based inputs. Because the Amish in this area prefer their own experience as a source of information to guide their agricultural practices, they may be in a good position to recognize early warning signs of trouble and to adjust accordingly.

Why do the Amish of St. Lawrence County embrace petroleum-based inputs such as fertilizers and pesticides? This question suggests several possibilities for future research. In light of the expectation that the Amish would be found to practice ecological agriculture, it came as a surprise that pesticides and fertilizers were widely used in this community. Therefore the focus here has been on documenting the extent of this use rather than rigorously engaging the more intriguing question of why.

In further studies, the present authors expect to explore at least three explanations for use of fertilizers and pesticides by Amish farmers in St. Lawrence County. First, the use of these substances may portend a fundamental shift away from traditional practices; Amish farming in this particular community may be in the early stages of conversion to an industrial style of agriculture. Alternatively, the use of these substances may indicate a temporary strategy rather than a profound change. The Swartzentruber Amish may not be sufficiently established in the Heuvelton-De Peyster area to have developed the productive and self-regulating characteristics of ecological agriculture. They started to settle in this area only about 25 years ago, having an average length of residency of about nine years. Fertilizers may be necessary only to enhance poor soil conditions or to revitalize soils depleted by the exhaustive practices of the non-Amish farmers who previously occupied the land. Herbicides may be necessary only to control weeds until a generation or two of Amish farmers have established the dynamic equilibrium of a permanent system that minimizes the need for petroleum-based inputs. In northern New York, however, the climate and perhaps the soil are more problematic for labor-intensive farming than in Holmes County, Ohio. Finally, the use of fertilizers and pesticides may not be accompanied by an awareness of the associated ecological disruptions. Consistent with an ethic of stewardship, Amish farmers in Ohio have expressed a willingness to modify agricultural practices that cause environmental problems (Sommers and Napier, 1993; Stinner et al., 1989). Under this third hypothesis, Amish farmers in St. Lawrence County can be expected to reduce or abandon inorganic fertilizers and synthetic pesticides if and when they become aware of the ecological problems these substances create. Anecdotal evidence, based on preliminary conversations, suggests that all of these explanations are plausible.

Amish farming has been praised by both critics of industrial agriculture and advocates of ecological agriculture. It is often assumed that the Amish practice organic farming and that they represent an appropriate model for ecological agriculture based on substainability and stewardship. However, a closer examination of their current farming methods, with particular attention to the use of fertilizers and pesticides, brings this assumption into question. Although modern Amish farming subscribes to many of the tenets of ecological agriculture, Amish practices in relation to fertilizers and pesticides may not, in the future, be significantly different from those of the non-Amish engaged in industrial agriculture.

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