EFFECTS OF ALTERNATIVE AND CONVENTIONAL FARMING SYSTEMS ON AGRICULTURAL SUSTAINABILITY

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ABSTRACT

This paper discusses the effect of commercial alternative and conventional farming systems on soil quality and farm profitability in several countries. Soil quality and farm profitability are two of several indices that measure agricultural sustainability. These studies indicated that the organic and biodynamic farming systems have soils of higher biological, physical, and in many cases chemical quality than their conventional counterparts. In addition, the studies showed that the alternative farms are economically viable.

INTRODUCTION

Sustainable agriculture is an umbrella term that embraces, but is not restricted to nor defined by, such terms as “organic”, “regenerative”, “biodynamic”, “ecological”, “alternative” or “low input”. However, just because a farm is “organic” or “alternative” does not mean that it is sustainable. To be sustainable, it must produce adequate food of high quality, be environmentally safe, protect the soil resource base, and be profitable (Reganold et al. 1990).

COMPARISON OF SOIL PROPERTIES

The foundation of sustainable agriculture is a healthy, fertile soil, on which the rest of the farm ecosystem depends. Soil is not just another instrument of crop production like pesticides, fertilizers, and tractors. It is a complex, living, and fragile medium which must be protected and nurtured to ensure its productivity, stability and sustainability. It is a nation’s prime capital resource, the loss of which can lead to social, economic, and political decline.

Several studies have been carried out to compare the effect of organic and conventional farming systems on soil properties. For example, detailed comparisons were made of two commercial wheat farms in eastern Washington State, USA (Weilgart Patten 1982, Bolton, Jr et al. 1985, Reganold et al. 1987, Reganold 1988). One, an organic farm, was managed without any chemical fertilizers and only limited use of pesticides for nearly 80 years, while the other, an adjacent conventional farm, received recommended rates of fertilizers and pesticides. The organic farm used a complex crop rotation system, including green manure legumes as cover crops, while the conventional farm followed a simple rotation system without green manures.

Soil on the organic farm was found to have a significantly higher organic matter content, cation exchange capacity, total nitrogen, available potassium, and polysaccharide content than the soil on the conventional farm. The soil on the organic farm also had a larger and more active microflora, better soil structure and tilth, and 16 more centimeters of fertile topsoil. This topsoil difference was attributed to significantly greater soil erosion on the conventional farm between 1948 and 1985. The data indicate that, in the long term, the organic farming system was more effective than the conventional farming system in maintaining productivity and tilth of the soil and reducing the rate of erosion.

Average yields of winter wheat between 1982 and 1986 were 8% lower on the organic farm than on the conventional farm (Reganold et al. 1987), but matched the average for the region where the farms are located. The ability of the organic farm to produce yields similar to those of neighboring conventional farms, even after almost 80 years of farming without chemical fertilizer, may be attributed in part to the reduction in soil erosion and maintenance of soil organic matter.

In New Zealand, Robertson (1984) made a
comparative study of soil properties in two market gardens, one organic and one conventional, located on similar soils with a common boundary and growing similar vegetables. Soil treatments on the organic farm included poultry litter, compost, biodynamic preparation 500, and green manuring, while those on the conventional farm included applications of nitrogen, phosphorus, potassium, and lime. Weed and pest control were basically nonchemical on the organic market garden (e.g., mechanical cultivation and hand weeding), whereas chemical sprays were the main means of controlling weeds and pests in the conventional market garden.

The soil from the organic market garden was found to have a higher organic matter content, more earthworms, a higher respiration rate, more extractable phosphorus, magnesium, potassium and boron, a higher pH and water content and a lower bulk density than the soil from the conventional market garden. The only soil feature which was more favorable on the conventional farm was a higher level of mineralizable nitrogen. These data indicated that the organic market garden had a more productive, biologically active soil.

Forman (1981) found similar results in a paired-farm study of biodynamic and conventional farms in Australia. Biodynamic farming is similar to organic farming in that no synthetic fertilizers or pesticides are used. However, one major difference is that biodynamic farmers add eight specific preparations to enhance soil quality and plant life which are made from cow manure, silica, and various plant substances (Koepf et al. 1976). Organic matter, extractable phosphorus, and pH were all significantly higher on the biodynamic farm than on the adjacent conventional farm. Levels of potassium were similar; only magnesium and sodium were lower on the biodynamic farm.

THE PROFITABILITY OF ALTERNATIVE FARMING SYSTEMS

In most cases, farmers select which farming system to use, whether conventional or alternative, by considering profitability in the short term. Until recently, conventional agricultural systems have usually appeared to be more profitable in the short term than alternative agricultural systems. This comes as no surprise, given that agricultural research and policy over the last four decades have promoted conventional agriculture (Committee on Government Operations 1988). Even so, the long-term profitability of conventional agriculture seems questionable if the environmental and health costs are taken into account. Indirect costs such as off-site damage from soil erosion, pollution of surface water and groundwater, hazards to human and animal health, and damage to wildlife from conventional farming practices are at present borne by society. If these external costs were factored into the costs of farm production, the overall profitability and benefits to society of alternative farming systems would probably be much higher (Reganold et al. 1990).

Although both alternative and conventional farms may fail in the face of unfavorable weather or marketing problems, it seems that alternative farms may have a better chance of long-term success because of the diversity of their cropping systems and the efficiency of their farm operations. Several farm management studies in the United States have shown that alternative farming systems can achieve net returns which are comparable to those of conventional farms (Kraten 1979, Lockeretz et al. 1981, Goldstein and Young 1987). While their yields are usually somewhat lower, alternative farms often compensate for this through lower input costs and greater net returns. In addition, studies comparing organic and conventional grain production systems have shown organic farming to be more energy efficient (Kraten 1979, Lockeretz et al. 1981, Pimentel et al. 1984).

One of the best known studies was conducted by Lockeretz and his colleagues (1981), who examined energy efficiency and economic costs of crop production on numerous pairs of organic and conventional farms in the American Midwest. Between 1974 and 1978, energy consumption for crop production on the organic farms was only about 40% of that used by the conventional farms to produce one dollar’s worth of crop yield. While the organic farms produced lower yields than did the conventional farms, operating costs on the organic farms were lower by about the same cash equivalent (Table 1). Thus, the net incomes from crop production on the two types of farm were about equal. An exception was in 1978, when the net returns from the conventional farms were higher due to extremely favorable weather.

Another U.S. study (Kraten 1979) was conducted comparing five pairs of organic/low input and conventional farms in Washington and Idaho for farm inputs, returns, and energy use in 1976 and 1977. The results showed that, on average, the conventional farms produced 2% more crop value per acre than the organic farms. However, higher input costs (especially variable costs) on the conventional farms meant that the net return for the organic
farms was 22.4% higher. As in the Lockeretz study, energy consumption for crop production on the organic farms was significantly lower. The organic farms used only about 66% as much energy as that used by the conventional farms to produce one dollar’s worth of output (Kraten 1979).

Painter (1991) conducted a four-year economic assessment of the same organic/conventional farm pair in Eastern Washington State where Reganold et al. (1987) had done their soil studies. During the 1986-1987 study period, net returns from the conventional system averaged 33% more than from the organic system, assuming participation in government subsidy programs. However, the average government subsidy per hectare was much higher for the conventional farm ($119) than for the organic farm ($74) during the study period. (The organic farm used a green manure crop every third year, and thus had a smaller area of subsidized wheat).

If both farms had received the same government commodity subsidy, the net return for the conventional farm would have been only 10-12 percent higher. If in addition the soil-building grass and Austrian winter pea plantings of the organic farm had received a modest subsidy, the profitability difference between the two systems could have been eliminated. This study supports arguments made by others (Committee on Government Operations 1988, Young and Goldstein 1988, National Research Council 1989) that government programs favor conventional farming systems rather than alternative systems such as organic or low-input farming.

In a three-year study of organic and conventional farms in New Zealand, Haystead (1987) examined the economic performance of dairy and mixed (crops and livestock) farms using gross mar-

<table>
<thead>
<tr>
<th>Year</th>
<th>Value of crops produced</th>
<th>Operating expenses</th>
<th>Net returns</th>
</tr>
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<tbody>
<tr>
<td>1974</td>
<td>393</td>
<td>426</td>
<td>69</td>
</tr>
<tr>
<td>1975</td>
<td>417</td>
<td>478</td>
<td>84</td>
</tr>
<tr>
<td>1976</td>
<td>427</td>
<td>482</td>
<td>91</td>
</tr>
<tr>
<td>1977</td>
<td>384</td>
<td>407</td>
<td>95</td>
</tr>
<tr>
<td>1978</td>
<td>440</td>
<td>527</td>
<td>107</td>
</tr>
</tbody>
</table>

1 A sample of 14 pairs of organic and conventional were compared
2 A sample of 23 organic farms were compared with regional conventional averages
3 A sample of 19 organic farms were compared with regional conventional averages

Source: Lockeretz et al. 1981

<table>
<thead>
<tr>
<th>Year</th>
<th>Dairy farms #1</th>
<th>Dairy farms #2</th>
<th>Dairy farms #3</th>
<th>Mixed farms #1</th>
<th>Mixed farms #2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1984</td>
<td>737</td>
<td>632</td>
<td>758</td>
<td>542</td>
<td>526</td>
</tr>
<tr>
<td>1985</td>
<td>786</td>
<td>612</td>
<td>834</td>
<td>542</td>
<td>616</td>
</tr>
<tr>
<td>1986</td>
<td>764</td>
<td>516</td>
<td>847</td>
<td>625</td>
<td>563</td>
</tr>
</tbody>
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1. Gross margins were originally in NZ$/ha. The conversion rate used was NZ$1.00 = US$0.60
2. Economic data was not available for this year.

Source: Haystead 1987
gin analysis, the budgetary method most commonly used by farmers and their advisers in New Zealand. (The gross margin of a farm enterprise is the difference between the total farm income earned and the variable or operating costs incurred). Haystead found that the organic dairy farms were more prosperous than their conventional counterparts, whereas the exact opposite was true for the organic mixed farms (Table 2).

The healthy dairy income was partly due to lower variable costs, but in some cases because the organic milk sold at a higher price. Haystead believed that the lower incomes on the sheep and cropping farms (partly due to lower crop yields) could be improved if similar alternative marketing outlets were developed for organic cereals and lamb.

REFERENCES


DISCUSSION

Discussion after the paper presentation was concerned with the definition of “organic farming”, which Dr. Reganold described as a system which did not use synthetic chemical pesticides or fertilizers, but which used complex crop rotations, green and animal manures, and other management tools which are good for the soil. He pointed out that farmers may stop using chemicals for several years, but unless they applied nutrients to balance those taken up by the crop, they were not practicing an organic farming system but mining the soil of the nutrients applied earlier. Such a farm could not be certified as “organic” in the United States. In response to a question from Dr. Y.D. Park, he estimated that 1% of farms in USA were organic, with probably a similar percentage in New Zealand and Australia, while possibly this percentage would be higher in Western Europe.

Dr. Sri Adiningsih raised the important question of whether organic farming could supply sufficient plant nutrients in a tropical country like Indonesia, where the productivity of upland soils is rather low. She suggested that it might not be possible to use organic matter as the sole source of crop nutrients, especially on upland soils. Dr. Reganold agreed that agriculture in the tropics might need some applications of chemical fertilizers, and also of pesticides. He suggested that many farmers have developed sophisticated systems of organic farming, and may in some cases be technically more advanced than the scientists!

Furthermore, as he pointed out, conventional farming in the United States is wearing out the soil because of the overapplication of chemicals, while the organic matter content of the soil is low, and felt that this situation cannot continue indefinitely. He described a crop rotation used in New Zealand of four years of crops (wheat, barley and pea) followed by four years of pasture with cattle and sheep. While the grain gave a higher income than the pasture, the fallow under grass built up the soil and maintained it in a very healthy condition, although chemicals were used during the four years of arable farming. He suggested that a similar system might be feasible in the tropics. Dr. Umali pointed out that the perception of organic farming in Asia is different from that of temperate countries, since the integration of farming systems is a strong tradition in Asia, as is organic recycling. Traditional technology might be beneficial if blended with modern technology, while maximum use should be made of local resources of nutrients and energy to generate employment and income in rural areas. He referred to the long experience of nutrient recycling in Japan, Korea and China, but pointed out that organic farming in the tropics is handicapped by the fact that at a temperature of 20°C, the destruction of soil organic matter is faster than the rate at which it can accumulate. Humid tropical conditions also give pests and diseases a continuous growing season in which to proliferate.