Farming for a Sustainable Agriculture

Dr. Jan van Schilfgaarde
Agricultural Research Service U. S. Departuent of Agriculture Beltsville, Maryland, USA

Our Declining Natural Resources Base

There is increasing evidence that our natural resource base worldwide is in a state of decline because of over-exploitation, mismanagement and environmental degradation. For example, commercial fishermen are finding that they must make progressively greater inputs to secure a dwindling number of fish. Governments of some countries are taking stern measures to protect their traditional fishing grounds from others because of a decline in fish populations. Along the Gulf Coast of the United States, seagrass is disappearing. This aquatic vegetation is an important habitat for marine life and a leading indicator of the health and productivity of the marine environment (Neckles, 1994).

Stratospheric ozone is being depleted. Atnospheric carbon dioxide continues to increase. Halogenic and sulfur gases are emitted at increasing rates. The atmosphere is changing and there is extensive debate on global climate change. Is it real? How extensive? What will be the impact?

Excessive soil erosion continues, with soil losses in the order of billions of tons per year. In some areas, wind erosion is a serious problem, with small particles (less than 10 microns) creating a health hazard.

All around us, we see signs of a degenerating resource base and a deteriorating environment.

The Contradiction of Western Agriculture

Despite the decline in our natural resource base and environmental degradation, western agriculture, i.e. western Europe and the USA, has undergone a rapid evolution in which crop yields have increased dramatically while the number of farmers has sharply decreased. Total food production worldwide has increased at about 2.5 percent per year and, until recently, food production per capita had also increased. Farmers and agricultural scientists alike are obviously proud of these accomplishments. In Europe as in the USA, crop surpluses are a continuing problem, more so than deficits.

We recognize a contradiction, or at least a dichotomy in these observations. On the one hand we have evidence of a declining resource base and environmental degradation, and on the other we see record crop yields. The most likely explanation for this is that the more affluent farmers of western Europe and the USA can overcome the associated loss in productivity resulting from soil and environmental degradation by simply increasing their level of inputs, something that most “Third World” farmers cannot afford to do. If this trend should continue, one could argue that sooner or later a time will come when western agriculture is no longer sustainable, if it ever was. Meanwhile, the poor farmers around the world will continue to farm at a purely subsistence level.

Corporate/Industrial Agriculture vs. Family Farms

According to Kirschenmann (1994), agriculture in the western world has reached a fork in the road. One fork has led to industrial agriculture. It depends heavily on off-farm inputs that often are nonrenewable. It strives for efficiency through mass production and specialization, leading to monoculture or, at lease, minimal reliance on crop rotations and multiple crops. It leads to ever larger farm units and fewer people directly involved in farming. It prefers to trade in world markets, quite often in bulk raw products. It separates livestock production from the land.

One viewpoint is that industrial or corporate type agriculture is a marvel of success and the envy of the world. Another is that it has caused almost insurmountable problems with regard to our natural resource base (i.e., impairment of soil and water quality, depletion of water resources, and environmental pollution). This has raised serious questions of whether this type of large-scale agriculture can ever be economically, environmentally and socially sustainable.

When I first came to the State of Iowa in the mid 1940’s, average maize yields for the State were about 2 t/ha; recently peak yields of 19 t/ha have been reported and 10 to 12 t/ha is not an uncommon yield. A peak of 7.3 t/ha for soybean has been reported, while typical yields 20 years ago were 2 t/ha. Similar statistics could be used to illustrate increases in efficiency of feed conversion in poultry or hogs, breeding, fertilizers, management, and sometimes irrigation have led to these yield increases. Overall averages often hide interesting interactions, however, that can have important implications. For example, Frey (1984) shows a huge yield advantage of two maize hybrids over an open-pollinated one when irrigated; when grown without irrigation, the hybrids gave no yield advantage.

On the other hand, conventional agriculture has led to excessive soil erosion. First recognized formally in the mid 1800’s, erosion in the USA was estimated at 3 billion tons/yr in the mid 1980’s (NRC, 1989). Some 60 percent of the pollution of lakes and rivers in the USA comes from agriculture (NRC, 1 993). Agriculture uses far more energy than it produces. These are some of the obvious problems. Possibly more important but also more controversial, the trend toward larger farms and fewer farmers-the number of USA farmers is now estimated at 1.9 million-has caused a drastic change in social structure and in rural communities that carries with it a substantial cost.

The Questions of Sustainability

The other fork in the road to which Kirschenmann referred is sustainable agriculture. Rather than controlling nature, advocates of sustainable agriculture strive to work in harmony with it.

Definition and Concepts

One can address sustainable agriculture and describe some of its features, but it is difficult (and probably unproductive) to define it. The U.S. Congress defined it in 1990 as “an integrated system of plant and animal production practices having site-specific application that will, over the long term: a) satisfy human food and fiber needs; b) enhance environmental quality and the natural resource base upon which the agriculture economy depends; c) make the most efficient use of nonrenewable resources and on-farm re-sources and integrate, where appropriate, natural biological cycles and controls; d) sustain the economic viability of farm operations; and e) enhance the quality of life for farmers and society as a whole.” For obvious reasons, this is the working definition of sustainable agriculture currently used by the U.S. Department of Agriculture.

Permit me, however, not to take issue with it, but to expand on it. Agriculture, by definition, is a modification of nature. To be truly sustainable, it must modify nature in a fashion that at least maintains, if not improves, the resource base-primarily the soil. Substitution of commercial nitrogen fertilizer for legumes may result in a cheap form of nitrogen but is likely to extract a price in terms of soil quality. Commercial agriculture also depends heavily on fossil fuels that are nonrenewable. Irrigation that depletes the groundwater, or causes water quality problems downstream, may not constitute sustainable resource use.

In one form or another, sustainable agriculture has been advocated and debated since the 1920’s. Possible, the earliest concept was that of biodynamic agriculture, the principles of which were outlined by Rudolf Steiner in 1924 (Koepf, 1989). In the 1930’s, Sir Albert Howard developed his system of organic agriculture. At present, there are many practitioners and advocates of various systems that may be considered as striving toward sustainability. Some practitioners simply desired to cut their costs; others based their actions on deeply-held and well-developed philosophical premises.

The Farm as a Living Organism

There is another aspect, however, to protecting the resource base and reducing the farmer’s dependence on purchased inputs. A farm, ideally, should be viewed as a living organism. This organism in turn depends on numerous subsets of organisms: plants, animals, microbes and insects. To the extent one can recognize the interactions, and the interdependencies, of these organisms living within the farm, one can learn to manage them. That is what “working in harmony” means. It differs drastically, in a philosophical sense, from viewing the farm as a mechanical production line and imposing industrial efficiency concepts.

Carrying these concepts a step further, the farm family and the surrounding community also need to be part of the organism called “farm”. The harmony spoken of includes harmony among humans. As a negative example, mechanizing cotton cultivation and harvesting, and displacing farm labor to metropolitan centers where there is no work, does not necessarily increase total economic efficiency and clearly carries with it a social cost.

Value-Added Products

Positively, when farm produce is locally-processed and when “value-added” products are then sold regionally, the farm becomes a positive and central component of a viable social structure. As an example, Walnut Acres is a 240 ha farm in central Pennsylvania where a wide range of crops are grown in rotation-wheat, maize, oats, cabbage, tomatoes, peas, beets, clover and others. Cattle and poultry comprise an animal component. Many of the products are locally-processed and sold, both wholesale and retail, in regional markets (including New York City and Washington, D.C.). Originally a 40-ha, 2-person farm, Walnut Acres now employs 100 people full time, plus another 100 part time; and workers own a share of the enterprise. Using manure and legumes for fertility and natural methods for pest control, the farm is nearly independent of purchased inputs, and has become a community center, both economically and socially.

Research on Sustainable Agriculture: Policies and Perspectives

Smith (1995), in a thoughtful article on research policy, points out that the culture in agricultural universities and research organizations is still heavily focused on commercial agriculture. In part, this is the consequence of the discipline orientation and the awards system that credits highly specialized, reductionist (and often irrelevant) research, rather than interdisciplinary, holistic studies. Also, the latter type of research is more difficult and requires departures from well-established notions of statistical analysis. Furthermore, current budgetary pressures and hiring freezes (not only in the USA) result in a slower faculty turnover and thus a disproportionate influence of the established order. For the same reasons, one encounters a similar resistance to change in government circles. Altieri (1989) is more blunt in his judgment, proposing that the current system provides a continuous need for new products and thus provides employment security for academics.

An additional component of the problem was illustrated by Anderson (1995). As stated before, a truly sustainable agriculture must include a viable rural community. Expanding on Smith’s (1995) analysis of professional reluctance, Anderson calls for integration of the biological and physical sciences with the social sciences. Unfortunately, such comprehensive thinking is often ignored.

Another voice calling for a new paradigm that goes beyond the classical, reductionist mode of research is focused on development. Arguing that reductionist science applied to development programs has often led to disappointing results, Grove and Edwards (1993) proposed a more appropriate paradigm which they entitled “socio-ecological”. They call for system-based research that encompasses social values and customs and community structure, as well as agronomic practices. I advocated a similar approach with reference to irrigation development (van Schilfgaarde, 1994), noting that many presumable well-designed engineering structures failed to deliver the expected benefits be-cause the needs and customs of local farmers were not considered.

Thus, one might conclude that, notwithstanding a significant increase in visibility and in political advocacy, sustainable agriculture still tends to be the stepchild in academia and official government circles. Lip service is prevalent; commitment is another thing. One of the reasons for this reluctance is the belief that sustainable agriculture- more often, biodynamic agriculture- is economically not feasible and unable to provide the food and fiber needed to meet demand.

Sustainable Agriculture and Economic Growth

White and colleagues (1994) addressed some of the underlying economic questions. Sustainability is often considered incompatible with, presumably desirable, economic growth. Economic growth generally, in turn, is measured by a change in gross national product (GNP). Unfortunately, however, standard measures of GNP are inadequate because they ignore the cost of mining resources, of a deteriorating environment, or of a change in human capital, often referred to as “quality of life”. In other words, standard economic analysis is dismally inadequate to assess the value of sustainability. Lacking expertise in economics, I shall not pursue these arguments further, except for the following comments.

Accepting sustainability as a desirable goal, White et al. (1994) see three “overlapping phases of progress”: efficiency changes, substitution, and redesign. Examples of improvements in efficiency include not using more fertilizer (or pesticide) than necessary. I would argue that this approach, while valuable in its own right, basically is an excuse to avoid confronting the need for sustainability. In one sense, it is a co-opting that leads to sabotage of the concept. Substitution, for example, of mechanical weed control for herbicides, is valid in principle, but can lead to different adverse effects; in this example, increased erosion. Redesign, drastic as it seems, it what is called for. It takes a different viewpoint - paradigm in the words of Grove and Edwards - to develop a farming system that integrates various crops, legumes, and livestock into a unified, interdependent whole, than one that maximizes production of one or two crops.

Of course, the question of economic viability also needs to be evaluated in terms of an explicit time horizon. Here one might argue that the problem is philosophical rather than economic, but the problem remains. It is generally accepted that, ideally, we should pass on our natural resources to future generations in a condition that is better than we found them. However, this “intergenerational” issue soon gets caught up in arguments over discount rates, uncertainty of measures of resource quality, and speculation whether evolving science and technology can generate substitutes for these resources. Whereas a general, non-specific, commitment to resource conservation is easily obtained, a specific, personal commitment to modify one’s actions accordingly is an entirely different matter.

Our Databases on Alternative and Sustainable Agriculture Are Limited

Finally, no analysis - biological, economic, or social - can proceed without a database. For reasons that have already been alluded to, the research literature on alternative agricultural practices is growing, but still very limited and often weak. When one’s training and indoctrination have been to isolate variability and demand replicability; when statistical tools lead one to avoid complicated interactions; when grants have duration of 1 or 2 years; then the incentive to design and conduct complicated, un-replicated, long-term field experiments is minimal at best. Just the same, an increasing volume of research on alternative agricultural practices is being published, Reganold (1995), for example, presented a thoughtful overview, including an evaluation of changes in soil properties by introducing biodynamic principles. Hatfield and Karlen (1994) edited a book that draws on and interprets a number of research findings. The last 1994 issue of California Agriculture contains a series of articles on organic production of apples. Bird, et al. (1995) reported on a 4-state survey of “sustainable” and “conventional” farms, with intensive whole-farm performance assessments. Thus, research in alternative agriculture is gaining respectability and becoming more prevalent, but much of it is still of limited value. Part of the problem seems to lie in the vagueness of, or lack of agreement on, the concept of sustainability.

Raised with the principles of scientific inquiry, we tend to look for a clear and quantitative index. In an important study published by the National Academy of Sciences (NRC, 1993), a main thrust was the need to improve soil quality, and therefore to define it and' find the means to measure it. The U.S. Environmental Protection Agency has an elaborate and pricey program (EMAP) that attempts to first identify, then monitor, indices of environmental health in different ecosystems. These are good and conceptually necessary initiatives. However, they don’t get to the heart of the issue.

Concluding Remarks

Thompson et al. (1994) argue, in a book on ethics and public policy, that sustainability is the wrong criterion by which to judge agriculture. In part, their argument is that current trends in agriculture may be undesirable, but not necessarily unsustainable. Proponents really are addressing a value system. So be it; we shall accept their suggestion and henceforth speak of alternative agriculture instead.

Erosion has caused extensive loss of topsoil. Fertilizers have led to mono-cropping. Mono-cropping has led to the need for insecticides. Insecticides have adversely altered the soil biota and the fauna in general. Thus, we have adversely affected soil quality as well as water quality, and a host of other things. Consequently, water quality and soil quality become legitimate subjects for study; however, they are only part of the problem. With Wes Jackson and Wendell Beny (see Thompson, 1994) - though I part ways with them in many aspects - let us return to a basic, ethical, point of view. Through agriculture, man works with the earth to create an environment that enables him to prosper. This earth, as the soil, is a living organism that needs to be nurtured. Starting with that premise, alternative agriculture must employ systems that maintain (or create) a healthy soil, a wholesome environment, a sustaining landscape, and a thriving community. The objective should not necessarily be to maximize crop yields, but to maximize the benefit to the community.

A colleague reminded me some years ago of the origin of the expression “real estate”, now used to describe holdings of land and buildings. Real estate means royal estate, or the holdings of the ruler. All the land, originally, belonged to the Crown, and was given in trust to noblemen to manage for the common good. In contrast to currently prevalent concepts of private property rights, the concept of stewardship can be traced to the idea of real estate, or more fundamentally, to admonitions in the book of Genesis. Ownership of real property carries with it a duty of stewardship. The concept of sustainable agriculture may best be described as an ethic of stewardship - stewardship directly of the land and, indirectly of the community.

The worldwide emerging interest in alternative agricultural systems is encouraging. The initiative of Kyusei Nature Farming and Sekai Kyusei Kyo in organizing this conference, and especially in recognizing the soil as a living organism, is to be applauded. Let us hope that the concepts described here and in similar fora take root and flourish.

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