Charles Hassebrook
Leader, Stewardship
Technological World Agriculture Program
Center for Rural Affairs

Biotechnology, Sustainable Agriculture, and the Family Farm

38 I would like to begin by emphasizing the importance of public debate about biotechnology and the fundamental purposes of public involvement in agricultural research and biotechnology. Public involvement has been important all along, but biotechnology increases the power of agricultural research to shape life and society and thereby makes consideration of these issues more important.

Agricultural research is really a form of social planning. The decisions as to what research is done and what kind of technology and farming systems are perfected, not only shape technology, but they shape agriculture, life in rural communities, social and economic structure, and the environment. Care needs to be taken to make sure that the goals of society are reflected in agricultural research priori-ties, especially publicly funded agricultural research. Who will control technology and technological research, and will the process be a democratic one?

The aim should be to develop a set of research goals, as well as a priority setting process by which the public research agenda reflects and addresses the needs of society. After all, in a democracy, it is important that if, in fact, technological research is a form of social planning, it moves society in the directions that the people want to go. The broad public and the citizenry should have a role to play in setting these directions.

The development of a more sustainable system should be the goal of agricultural research. A sustainable agriculture includes sustaining and protecting the quality of the environment, protecting the ability to produce food for future generations, and sustaining the family farm and agricultural communities. It is not enough to have an agriculture that is environmentally sound if it destroys family farms and rural communities. Part of this agricultural vision needs to be sustaining opportunity in rural communities. I propose five subgoals to guide agricultural research toward developing a more sustainable agriculture.

THE IMPORTANCE OF THE FAMILY FARM

We need to strive to develop farming systems that create as many opportunities as possible for people to own and operate their own farms. One of the things that characterizes the nation's heartland is a relatively egalitarian social structure. Unlike the Deep South and many of the major cities in the nation, this part of the country has not historically been characterized by sharp social divisions. Heartland communities have not been divided into a class of people who own farms, another class of people who manage farms, and yet another class of people who provide the labor. Instead, the owner of the farm is also the manager and the worker and that is the preference of the people in this region. Poll after poll of people in Iowa and the rest of the heartland show a broad preference for trying to maintain as many smaller, family farms as possible. However, this is not just a matter of emotion or personal preference; a large body of research shows that the family farm creates healthier communities than industrial style agriculture.

A study prepared by Dean McCannel of the University of California provides an overview of the various studies that look at the relationship between the structure of agriculture and the well-being of rural communities. McCannel's conclusions are as follows:

> "As farm size and absentee ownership increases, social conditions in the local community deteriorate. We have found depressed median family incomes, high levels of poverty, low education levels, social and economic inequality between ethnic groups, etc., associated with land and capital concentration in agriculture. Communities that are surrounded by farms that are larger than can be operated by a family unit have a bi-modal income distribution, with a few wealthy elites, a majority of poor

laborers, and virtually no middle class. The absence of a middle class at the community level has a serious negative effect on both the quality and quantity of social and commercial services, public education, local government, etc."

The case is clear that by maintaining broad opportunity in the family farm system, farmers as well as communities benefit.

HEALTH CONCERNS

Agricultural research should develop farming systems that enhance human health. This issue has gotten a lot of attention recently, given the Natural Resources Defense Council's report on chemical health effects on children. However, a bigger health crisis concerning farm chemicals and agriculture may exist right here in the heartland.

Some epidemiological studies clearly show the health risks involved in farming today. Study after study show elevated rates of leukemia in particular, and cancers in general among farmers and the people living in farm communities. One of the more interesting studies in Kansas, for example, found that farmers who use herbicides for more than twenty days a year have six times the rate of non-Hodgkin's lymphma, a form of leukemia. Agricultural methods that do not endanger the health of the people who farm must be established.

ENVIRONMENTAL CONCERNS

Farming systems that enhance the quality of the natural environment, rather than degrade it, need to be developed. Many problems exist in agriculture today and changes need to be made. There are four areas especially in need of attention.

The first area concerns soil erosion. As of 1985, about 25 percent of the land farmed in this country was eroding faster than new soil could form. In other words, 25 percent of the land is being farmed in a way that will ultimately result in a loss of soil and crop productivity. This simply has to change. Society cannot continue to destroy the soil and the ability of future generations to feed themselves. Some progress has been made since the 1985 farm bill was passed, but there is still a lot of work to be done.

Secondly, there is the problem of groundwater contamination. Studies in Iowa indicate that 25 percent of the people in the state drink water from wells that have been contaminated by farm chemicals. There is also a recent study of some of the irrigated areas of Nebraska, where 30 percent of the wells tested had atrazine in them.

Thirdly, the nation's dependence on nonrenewable sources of energy, particularly petroleum, need to be reduced. Recent studies indicate that domestic supplies of petroleum are likely to be exhausted early in the next century, and world supplies of petroleum are likely to be exhausted by the middle of the next century. There is no choice but to learn to farm in ways that are less dependent on petroleum.

Lastly, farmers must be concerned about their use of biological resources. In order to maintain a resilient food system that is not vulnerable to pests and disease, genetic diversity and a large, stable, and balanced population of various organisms must be protected.

Agricultural research programs should strive to advance these goals as they simultaneously continue to strive for economically viable farming systems. Food must be produced efficiently and a productive system of agriculture maintained that allows the people living on the land to make a profit and stay in business.

Can agricultural research in general, and biotechnology in particular, help achieve these goals? It can, but only if today's overall direction of agricultural research and biotechnology is changed. In addition to changing the direction that research will take, the decision making process concerning what research is undertaken must also be changed. The current research path might best be described as supporting an industrial system of agriculture. Biotechnology itself is promoting and supporting more of an industrial system than a sustainable system of agriculture. These two systems embody very different approaches to the use of technology and the relationship between people and technology.

INDUSTRIAL SYSTEMS

Industrial systems embody some of the well-established trends that are found in agriculture today. The trend is toward fewer and larger farms, with less opportunity for people in agriculture. This trend is moving agriculture away from the system where the person who works on the farm also owns and controls it, to a more industrial system, where one class of people own and make the decisions, and another class of people do the work.

Industrial systems embody some very clear agronomic trends, such as monocropping, continuous corn production systems, or systems that simply are not very diverse, like corn and soybean rotations.

Industrial agriculture concentrates livestock in confinement systems on a few very large farms. Unlike sustainable systems, industrial systems use technology to reduce the role of people in agriculture. They reduce both the amount of labor involved in agriculture, and the sophistication of labor involved in a way that allows one person to farm more land and more of the farm labor to be provided by unskilled and poorly paid employees. This facilitates the industrial structure.

Industrial systems also use technology to override natural systems. Instead of trying to find ways to work in concert with nature, systems are used that conflict with nature, such as growing continuous corn. To avoid the inevitable problems that intensify when the same crop is grown on the same land every year, technology is used to override the natural systems. For example, we use chemicals to solve fertility problems, disease, or to control corn rootworms associated with monocultures. In many instances, biotechnology is being used in the same way chemicals have been used—to reduce the labor and the sophistication of labor involved in agriculture and to override natural systems.

This presents many of the same problems that chemicals have caused over the years. If corn with Bacillus thuringiensis, (Bt) is used in the field to control corn borers and rootworms, it will not be long until most of these pests become resistant to Bt, and another biological magic bullet will have to be found. As with chemicals, greater and greater risks with safety will have to be taken, simply to meet the evolution of the pest.

SUSTAINABLE SYSTEMS

Sustainable systems look at the relationship between people and agriculture differently than industrial systems. Sustainable systems enhance the role of people in agriculture, rather than reducing it. For example, in an industrial system a dollar might be spent on chemicals in order to replace two dollar's worth of labor. In a sustainable system, the farmer would spend one dollar worth of additional time on hands-on management and the managing of natural systems to replace two dollar's worth of chemicals. It is a very different approach, but it tries to enhance the role of people in agriculture and make it profitable for more people to be involved.

Sustainable systems might use biotechnology to gain a better understanding of natural systems so that farms can work more in concert with nature. Or, biotechnology might promote sustainable agriculture

by finding new uses for the crops that have been added to rotations in sustainable systems. Better markets must be found for crops like alfalfa and oats to make it more profitable to grow them in rotation with corn.

CURRENT DIRECTIONS IN BIOTECHNOLOGY

Unfortunately, much of the current emphasis on biotechnology research supports industrial systems. For example, no area of biotechnology research has been the focus of more investment than the development of herbicide-tolerant crop varieties. While there is no clear evidence of the exact impact of herbicide-tolerant crop varieties on the volume of herbicide use in agriculture, it is very clear that the development of herbicide-tolerant crop varieties will continue the trend of making farmers more dependent on chemicals for weed control. What it would do to the exact volume may be an issue for debate, but it clearly moves in the direction of continuing complete dependence on farm chemicals for weed control. It also has some pretty clear structural impacts. For example, if a corn variety is tolerant to Roundup®, which kills almost any plant on contact, it would be more feasible to rely totally on chemicals for weed control, reduce the role of people, and totally eliminate mechanical weed control. This encourages a system that makes it possible for one person to farm more acres and for fewer people to farm the nation's land.

There should be alternative biotechnological approaches to weed control. Crop varieties that are better suited to light mechanical weed control should be developed. The use of a rotary hoe and some light row cultivation does not contribute to soil erosion and does not use large amounts of fuel. Some work is being done at the University of Wisconsin, to develop more cold-tolerant cucumbers that will germinate and emerge faster in the spring. If a variety of corn, sorghum, or soybean could be developed that would grow to a height of six inches during the cool spring weather in half the time that current varieties take, weeds could be more easily controlled mechanically.

The control of weeds need not be dependent on risky chemical products. This is the way for people to use their skilled labor to make a profit at the same time that we broaden the role of people in agriculture and the potential for family farming.

With respect to pathogen and insect control, a whole new series of biological products are being developed, including genetically altered

microorganisms and new plants, to take the place of farm chemicals and allow farmers to grow the same crop on the same piece of ground, year after year. In the future, there will probably be major efforts in biotechnology to control corn diseases such as gray leaf spot and head smut, which are really only a problem if continuous corn is grown.

This research supports industrial systems. To support sustainable agriculture, we should instead focus on the study of agroecology to gain a better understanding of how all the various organisms in agricultural ecosystems interact, how they effect each other, and how they are affected by farming practices. From this understanding, new farming systems might be developed that would create the proper balance of life where more of the beneficial organisms and fewer of the harmful organisms would exist. Biotechnology can help farmers reach this balance.

Biotechnology enables scientists to put markers in microorganisms in the soil so they can study how a change in farming practices might effect the population of different types of organisms. This is a positive way of using biotechnology and depending on the marker used, it would not have to carry much environmental risk at all.

In addition, biotechnological research should focus on developing crop varieties resistant to those diseases and pests that persist even in sustainable systems where the crops are rotated. Disease problems, such as leaf rust in corn and leaf blight, are not really a problem unique to continuous corn. The types of diseases that cannot be controlled simply by using rotation, should be a higher priority in biotechnological research. Unless the growth of continuous corn is to be encouraged, there is no reason to focus research efforts on the problems related to this method. It is a questionable practice to focus on the problems of continuous corn, because there are a whole range of adverse environmental problems associated with it and it lends itself to industrial systems rather than family farm systems.

Likewise, if we are to have a sustainable agriculture, research cannot merely focus on the disease problems of corn, wheat, and cotton. Instead a diverse set of crops must be studied. The U.S. Department of Agriculture (USDA) is proposing a plant genome mapping system that will begin to map the genetic makeup of major crops. Early reports indicate that this system will focus only on the four major crops. Such a limited focus will do little to improve the profitability of sustainable

systems which include rotation crops such as oats and alfalfa. If all research efforts simply address the disease problems of corn and soybeans, these crops will be the most profitable to grow.

Another area of concern is the development of new uses for farm commodities. There is no area in research today that is more politically attractive among the farm state members of Congress. A bill was attached to the Senate Trade Bill two years ago, which never became law, but would have made a $70 million appropriation to find new uses for farm commodities using biotechnological research. That bill was mainly focused on wheat, cotton, and soybeans. Instead of developing markets only for these crops, a much higher priority should be placed on finding new uses for a more diverse set of crops, including forage crops. Ways to make crops such as native grasses more profitable should be looked at. Native grasses could be planted on highly erodible land without excessive erosion. We also need greater emphasis on developing new uses for rotation crops, such as oats and alfalfa.

Along these lines, some interesting work has been done in developing grass varieties that contain less lignin. The fascinating thing about native grass is that it can produce as much energy per acre as corn; it is just that the energy in such grass cannot be digested because it is bound up by lignin. If native grasses could be used to feed cattle instead of corn, it would be good for family farming, because it would tie cattle production to the land base. It would also be better for the environment, if highly erodible land were planted in grass instead of in corn.

LIVESTOCK RESEARCH

With respect to livestock, bovine growth hormone research does not promote sustainable agriculture. There is wide agreement that bovine growth hormone is going to lead directly to a reduction in the number of family farms, and that should be a concern. The claim that bovine growth hormone promotes feed efficiency should be questioned. It may require redefining the way feed efficiency is understood. It may be true that more milk can be produced from a given amount of corn and soybeans by using bovine growth hormone, but it also makes dairy herds more dependent on corn and soybeans instead of on forages. If forages are to be grown to protect the soil and make farm systems sustainable, a better forage-based system must be developed that produces more milk effectively. In a sense there is more feed inefficiency

with the use of bovine growth hormone, because it creates feed requirements for dairy cattle that the natural resource base cannot provide sustainably.

Instead, major initiatives in livestock research should be mounted in two directions: low investment livestock production systems and a livestock system that fits the resource base. Unless some low investment systems are implemented, there will not be much opportunity for young people to get started in farming. There must be a way for these young farmers to get a foothold in agriculture without a lot of money and by using their management skills. If such a system was developed, it would be very helpful to the future of family farming.

Instead of focusing on disease problems like pseudorabies, which is principally a problem resulting from the close confinement of hogs, the disease problems in low-investment systems should be addressed. Issues such as animal parasites, developing animals that have better hair cover to make them more tolerant to temperature extremes, and other means of adapting animals to fit low-investment family farm systems, should be studied.

Biotechnology can make a contribution to sustainable agriculture, but there is danger in thinking that just because it is an exciting new science, there should be a lot of money spent on it. People are convinced that it is the key to competitiveness. Biotechnology can contribute to sustainable agriculture, but it should not be the emphasis.

If a sustainable system is really going to work, more emphasis must be placed on studying agroecology. When studying agricultural systems, more attention needs to be focused on discovery rather than on invention. Biotechnology can make a contribution, but it must not be as overemphasized as it is today. Biotechnology tends to be more ideal for product development, but this is not the most important goal for sustainable agriculture.

RESEARCH MANAGEMENT

It is vital that public control over technology and technological research be regained. In the next farm bill, Congress needs to state very clearly why it is investing so much money on agricultural research, and what it wants from its investment. The government's emphasis should be on family farms, and environmentally sustainable agriculture. Congress also needs to establish procedures to make sure that the

purposes set forth in a bill are in fact reflected in the research decision-making process of the land grant university. When competitive grants are made, these factors must be taken into consideration. A portion of the formula funds that go to every land grant university, should be withheld until the land grants show that they have established a research priority-setting process that reflects Congressional goals.

Finally, the public needs to extend its reach into private sector research. After all, if research is social planning, the public has a role to play in every aspect of it. Of course, the public is already involved in private sector research by subsidizing it heavily through research and development tax credits, it is not just a question of how involved the public should be. The public should declare what kind of research it wants. New investment in research facilities receives a 20 percent tax credit.These credits should only be given for research that reflects the direction that society has chosen.