Reaching the Unreached: Technology as an Ally in Skill and Knowledge Empowerment of the Poor

M. S. Swaminathan
Indian National Academy of Agricultural Sciences
Chairman, M. S. Swaminathan Research Foundation

Sustainability has been a human quest for many thousands of years, and it has taken various forms in agriculture. The early cultivators had their own methods of ensuring sustainability. For example, what we now call slash-and-burn, or shifting cultivation, was one of their sustainable methods of land management when the population was not high.

Today, the concept of global food security, particularly since World War II, has been undergoing considerable refinement and change. After World War II the major obsession was how to produce enough food for the growing population. Next, it was the question of entitlements or economic access to food. As we enter the twenty-first century, our major concern is ecological access to food, largely because of land, water, and biodiversity, as well as potential changes in climate and sea level.

At an individual level of food security, which is ultimately the most important consideration, the three main areas of interest are the availability of food in the market, ability of a person to buy it, and ability of the individual child, woman, and man to digest the food, that is, biological absorption of food. For good food security, food must be available to buy, people must have the ability to buy it, and their body must be able to absorb and utilize the food.

n many parts of the developing countries today, the third area has become an exceedingly important one: The nonavailability of clean drinking water, a lack of environmental hygiene, has led to a whole series of intestinal infection and diarrhea. The second most important area is access to purchasing power. Except in regions where there is civil war or other problems, availability itself is not a major question.

In 1996, before the world food summit in Rome, there was a Science Academy Summit at the M. S. Swaminathan Research Center. Many science academies participated to articulate their view of food security issues. At that meeting a definition of food security was developed. National policies for sustainable food and nutrition security should ensure that every individual has physical, economic, social, and environmental access to a balanced diet. The social indicator includes the gender dimension, which means that the necessary macro- and micronutrients, safe drinking

water, sanitation, environmental hygiene, primary health care, and education are available so that people can lead healthy and productive lives. Food originates from efficient and environmentally benign production technologies that conserve and enhance the natural resource base of crop and animal husbandry, forestry, and inland and marine fisheries.

One of the most serious nutritional problems of today is undernutrition and malnutrition in pregnant mothers, fetal and maternal , and it carries inherent consequences. Even more important is the brain development and cognitive and educational performance of children who suffer from under- and malnutrition, through no fault of their own. We are living in the knowledge century, information century, century of innovations, but almost one-third of the children in South Asia and about one-fourth in sub-Saharan Africa are low birth weight children, that is, less than 2.5 kilograms, related to maternal and fetal undernutrition.

When we discuss equity in terms of sustainability, we consider three dimensions. One is inequity at birth, children with low birth weights. These children are condemned at birth itself to live a subnormal life, and to inequity in later life caused by illiteracy, malnutrition, unemployment, and intergenerational inequity; climate change; loss of biodiversity and so on, which are the longer-term prospects.

We can look back at what has happened within the last 100 years as a result of using what we call Mendelian genetics, or conventional genetics. For example, the remarkable events associated with the green revolution were products of the Mendelian revolution. In other words, the change in plant architecture, the new kinds of rice plants from the old ones, photo-insensitive root systems. There have also been physiological changes. Both have been altered, and they led to a revolution.

As we begin the twenty-first century, the neo-Malthusians are making dire predictions about the balance between population and food supply. Lester Brown, one of the most articulate advocates of neo-Malthusian viewpoints, has for example warned that China and India will have to import large quantities of food, China more than 200 million tons and India more than 45 million tons. (In 1966, under the PL480 program of the United States, India reached its maximum importation of food, about 10 million tons.) Unfortunately, global trade cannot absorb this demand because there is not that much grain in the world.

Addressing the Challenges of Food Security

The first major challenge science must address is defending the gains already made. Even to retain what we have already achieved is a problem. First, we need to promote integrated natural resources management, starting with soil and water conservation and management, gene management, pest management, and nutrient supply, and improved postharvest technology. Until we

develop these types of programs, we will continue to lose ground. For example, the Punjab part of India and the Punjab part of Pakistan are facing many problems, as are many other high earlier green revolution areas, with decreasing water tables, unsustainable exploitation, salinization, and waterlogging, among others.

Second, we need to extend the gains already made, using existing technologies. There is a prevailing vast gap between potential and actual yields at current levels of technology. How do we analyze this gap? What kinds of constraints are responsible? Are there social constraints, technological constraints, economic constraints, political constraints? The answer is, we must analyze interdisciplinary constraints to determine the gap between potential and actual yields. In addition, we must develop and spread scientific land- and water-use farming systems based on the principles of ecology, economics, gender equity, and employment.

Defending the gains we have already made—"maintenance research"—is the foundation from which we work. Then we extend those gains to other areas, that is, rainfall areas, somewhat marginal areas, semiarid tropics, the wetlands, the lowlands, and so on. Human resource development is key to achieving new gains at all levels, from the farm family upwards to the technologist. Today, virtual colleges link scientists and technologists. In Pondicherry, we have a womanoperated, user-controlled, user-driven, demand-driven information center. It is completely controlled by the women, and there are honoraria for these women even though they are not highly educated. Most have received about seven to eight years of schooling, but they have enormous capability. They readily absorb new technologies as long as the pedagogic methodology is learned by doing, not by lecturing.

The women have innovated this system to the point that they are a very important source of health information for their own purpose. They are connected; they are interconnected. It is a hybrid system, wired and nonwired. We are trying to link it with a small community ham radio broadcasting system nearby so that a large number of people can be covered by the system.
In achieving new gains, it is important that we have more value-added production, linking production, and postharvest technologies in order to achieve maximum value addition. The value adders are a new kind of professional, normal agricultural extension workers retrained to be knowledge workers, converting generic information into location-specific information, in many cases, methodological factors and so on.

We are also trying to develop what we call "climate managers." This winter, India has not had a good monsoon, and there is a tremendous shortage of drinking water in parts of the country. Even so, there is always some water, and there is increasing interest today in natural water conservation. *Dying Wisdom* (Agarwal, 1997) discusses the various older methods of conservation of moisture, such as water in the soil.

develop these types of programs, we will continue to lose ground. For example, the Punjab part of India and the Punjab part of Pakistan are facing many problems, as are many other high earlier green revolution areas, with decreasing water tables, unsustainable exploitation, salinization, and waterlogging, among others.

Second, we need to extend the gains already made, using existing technologies. There is a prevailing vast gap between potential and actual yields at current levels of technology. How do we analyze this gap? What kinds of constraints are responsible? Are there social constraints, technological constraints, economic constraints, political constraints? The answer is, we must analyze interdisciplinary constraints to determine the gap between potential and actual yields. In addition, we must develop and spread scientific land- and water-use farming systems based on the principles of ecology, economics, gender equity, and employment.

Defending the gains we have already made—"maintenance research"—is the foundation from which we work. Then we extend those gains to other areas, that is, rainfall areas, somewhat marginal areas, semiarid tropics, the wetlands, the lowlands, and so on. Human resource development is key to achieving new gains at all levels, from the farm family upwards to the technologist. Today, virtual colleges link scientists and technologists. In Pondicherry, we have a woman-operated, user-controlled, user-driven, demand-driven information center. It is completely controlled by the women, and there are honoraria for these women even though they are not highly educated. Most have received about seven to eight years of schooling, but they have enormous capability. They readily absorb new technologies as long as the pedagogic methodology is learned by doing, not by lecturing.

The women have innovated this system to the point that they are a very important source of health information for their own purpose. They are connected; they are interconnected. It is a hybrid system, wired and nonwired. We are trying to link it with a small community ham radio broadcasting system nearby so that a large number of people can be covered by the system.
In achieving new gains, it is important that we have more value-added production, linking production, and postharvest technologies in order to achieve maximum value addition. The value adders are a new kind of professional, normal agricultural extension workers retrained to be knowledge workers, converting generic information into location-specific information, in many cases, methodological factors and so on.

We are also trying to develop what we call "climate managers." This winter, India has not had a good monsoon, and there is a tremendous shortage of drinking water in parts of the country. Even so, there is always some water, and there is increasing interest today in natural water conservation. *Dying Wisdom* (Agarwal, 1997) discusses the various older methods of conservation of moisture, such as water in the soil.

trained to deal with different computer simulation models and various weather probabilities.
In this century particularly, we must produce more food from less per capita land and less per capita water. Up to now, 7 to 8 tons of rice per hectare can be produced, but the green color can only come from the introduction of alien exotic genes through recombinant DNA experiments. We will have to increase total photosynthesis because we have been manipulating only the harvest index; we have not increased the total biomass.

We have numerous new problems, including new pest and disease problems. Similarly, using the biotechnological method we can in this century particularly develop new plant types. The media has christened it "super rice." The new plant types can probably produce 12 to 15 tons of rice per hectare, but that will require more than 300 kilograms of nitrogen alone. Even if you use only 20 kilograms of nitrogen, the nitrate pollution of groundwater is high. This is why we must have concurrent research of breeding and feeding, breeding the plant for high yield and feeding the plant for high yield, both in a sustainable manner. In other words, an environmentally friendly manner of feeding is going to be an important area of research as we make advances in raising the yield ceiling. We will have to find new methods of feeding the plant (or feeding the farm animal).

In Tokyo, on April 4, 2000, Monsanto made a significant development on the rice genome: The genome contains at least 40,000 genes constituting the instruction book of the rice plant. Monsanto, in collaboration with scientists of the Washington State University in Seattle, has built a working draft of the rice genome and will share the information with the world research community. The draft was released to the Ministry of Agriculture, Forestry, and Fisheries in Japan and to the International Rice Genome Sequencing Project. The sequencing project is using two major groups of rice, japonica rice in Japan and indica rice in China, India, Philippines, and many other countries.

This is an important advancement. For example, YLD2 is a yield gene. Yield is a complex. It is a quantitative trait we call QTL, or quantitative loci. Once we know where these genes are located, it is much easier to transpose them and to select genetic markers, which are enormous new opportunities.

On the other hand, environmentalists have one criticism, apart from food allergy, food safety, and environmental safety, of the development of genetically modified organisms (GMO). Essentially, it reduces biodiversity because large areas are covered with a single genetic strain, and human experience has shown that genetic homogeneity enhances genetic vulnerability to pests and disease.

There are two kinds of prebreeding, or development of novel genetic combination. This should be done in public institutions or public-spirited commercial institutions, which are willing to

share the material, using both Mendelian and molecular genetics, and then applied in a participatory breeding method with farming families. In this way, genetic efficiency and genetic diversity is combined with a large number of locations and specific varieties, and thereby enhancing sustainability.

As we have progressed in food security, the base of food security has increasingly shrunk. That is, a relatively small number of crops, specifically, wheat, rice, barley, corn, and potatoes, dominates the entire scenario. For the Incas, more than 200 or even 300 plants were responsible for the food and health security of local families. Today, in those same areas, only four, five, or six crops are sustained. What is the methodology by which we can revive?

We have always realized in situ conservation (national parks and protected areas) and more recently, a series of ex situ conservation (botanical gardens, zoological gardens, gene banks, and so on). A new aspect of conservation, which has heretofore gone unrecognized, is community conservation. The Convention on Biological Diversity has done a great service by recognizing this segment of conservation. Specifically, the International Rice Research Institute Gene Bank has about 100,000 varieties of rice, and about 75,000 of them have come from community conservation efforts. This is the unsung, unrewarded component we should recognize. Many of the varieties originate in Orissa, one of India's primary rice centers. The women in the community preserve many varieties of rice, and they are doing it at personal cost for the public good. The Indian Parliament is considering legislation that would give formal recognition to this kind of conservationist, and if it is approved, we will be one of the first governments in the world that recognizes this kind of conservationist.

There is a great deal of controversy between the developing world and some commercial companies regarding biopiracy. Simply, in nature there are only plants, there are no medicinal plants. Traditional people say they are collecting medicinal plants, but if we prefix 'medicinal' to a plant name, it is someone's intellectual property. Therefore, medicinal plants are the products of observation and selection.

Individual food security, particularly in the hinterland of Africa and India, is sometimes compromised by lack of communication. In response, the state of Orissa is developing a community food security system. It involves, concurrently, gene management; in situ on-farm conservation; seed management, that is, seed stores as contingencies for drought and flood; and green management, or managing green banks.

Even with innovative conservation methods, the greatest problem of food security in many developing countries, economic access to food, remains. Economic access means jobs, livelihoods, and income. Since World War II the primary sector, that is, the agriculture sector, in most developed countries comprises 1 or 2 percent of the population. In contrast, in many developing coun-

share the material, using both Mendelian and molecular genetics, and then applied in a participatory breeding method with farming families. In this way, genetic efficiency and genetic diversity is combined with a large number of locations and specific varieties, and thereby enhancing sustainability.

As we have progressed in food security, the base of food security has increasingly shrunk. That is, a relatively small number of crops, specifically, wheat, rice, barley, corn, and potatoes, dominates the entire scenario. For the Incas, more than 200 or even 300 plants were responsible for the food and health security of local families. Today, in those same areas, only four, five, or six crops are sustained. What is the methodology by which we can revive?

We have always realized in situ conservation (national parks and protected areas) and more recently, a series of ex situ conservation (botanical gardens, zoological gardens, gene banks, and so on). A new aspect of conservation, which has heretofore gone unrecognized, is community conservation. The Convention on Biological Diversity has done a great service by recognizing this segment of conservation. Specifically, the International Rice Research Institute Gene Bank has about 100,000 varieties of rice, and about 75,000 of them have come from community conservation efforts. This is the unsung, unrewarded component we should recognize. Many of the varieties originate in Orissa, one of India's primary rice centers. The women in the community preserve many varieties of rice, and they are doing it at personal cost for the public good. The Indian Parliament is considering legislation that would give formal recognition to this kind of conservationist, and if it is approved, we will be one of the first governments in the world that recognizes this kind of conservationist.

There is a great deal of controversy between the developing world and some commercial companies regarding biopiracy. Simply, in nature there are only plants, there are no medicinal plants. Traditional people say they are collecting medicinal plants, but if we prefix 'medicinal' to a plant name, it is someone's intellectual property. Therefore, medicinal plants are the products of observation and selection.

Individual food security, particularly in the hinterland of Africa and India, is sometimes compromised by lack of communication. In response, the state of Orissa is developing a community food security system. It involves, concurrently, gene management; in situ on-farm conservation; seed management, that is, seed stores as contingencies for drought and flood; and green management, or managing green banks.

Even with innovative conservation methods, the greatest problem of food security in many developing countries, economic access to food, remains. Economic access means jobs, livelihoods, and income. Since World War II the primary sector, that is, the agriculture sector, in most developed countries comprises 1 or 2 percent of the population. In contrast, in many developing countries 45 to 50 percent (in India, 60 percent) of the population are employed in agricultural. The main agriculture sector crops have been animal husbandry, fisheries, and forestry.

In response, the World Bank has sponsored summits on microenterprises and their needs. Unfortunately, with today's world trade agreement, many of the macroeconomic policies and microenterprises are not compatible. Many national and global macroeconomic policies are designed to suppress microenterprises. On the one hand, poverty elevation requires microenterprises; on the other, current policies quash them from the economic survival point of view.

We must develop methods by which we can deliver technologies to the poorest of the poor, which we call "reaching the unreached." One method is being tested in an experiment called "bio-villages." This experiment has two main components: rural poverty and resource degradation. How do we prevent resource degradation?

The name bio-village is derived from "bios," or living, and biology the science. Bio-village is therefore a term for humans and their development. In the bio-villages the people are the decision makers. Their needs are ascertained through participatory rural service. The activities taken up are demand and market driven. The beneficiary approach of development based on patronage gives way to an approach that regards rural women and men as producers, innovators, and entrepreneurs, which is a very important change in the mind set. The enterprises are identified based on market studies, economic environment, and social viability. There is what we call an "evergreen revolution," that is, high productivity by units of land and water without associated ecological harm. Its foundation is a farming system, and it must be based on integrated natural resource management. It involves participatory research with farming families and ecotechnology, blending traditional wisdom with modern science. It also involves precision farming using the inputs in a precise way. It involves producers and marketing.

Interacademy Collaboration

This conference has already enlarged the concept of sustainability from a purely economic one to environmental and social sustainability. We need a new kind of research leader, research leaders who can apply the matrix approach to project design and implementation, involving concurrent attention to the principles of ecology, economics, gender and social equity, employment, and energy. It is clear that if we want to achieve this objective, we must embrace a multidisciplinary approach in project design itself, reaching the unreached virtual colleges. We have enormous opportunities with modern information and communication technology to link women and men living in poverty with scientists and technologists.

Conflict resolution has become exceedingly important, and for which the InterAcademy Council (IAC) is a necessary forum. Another important issue is genetic modification. We need a credible

set of professionals who have no personal agenda except the welfare of humankind. We already have an intergovernmental panel on climate change, but it is very important we establish a multistakeholder interacademy panel capable of inspiring public and political confidence. Public confidence is related by the media and political confidence and trust.

How will the poor access the benefits of findings created by proprietary science? How do we foster a new social contract between science and society? We are harnessing science and technology for meeting basic human needs—food, water, health, work, shelter, and education. Therefore, when you are subject to a research project, ask yourself, Is the orientation of the technology development and dissemination pro-nature; is it pro-poor; is it pro-woman and pro-jobs or pro-livelihood?

Lastly, how do we achieve a world without hunger through concurrent attention to food availability, access, and absorption? My suggestion is, we must have a global hunger elimination forum under the auspices of the interacademy council. Limited experimentation has shown that with a holistic approach to this problem it is more easily solvable, starting with who are the hungry; who are the ultra-poor. The people themselves identify them. Information empowerment under entitlements; micronutrient deficiencies, particularly iron, iodine, and vitamin A; and hidden hunger are exceedingly important issues, as are biological absorption of food, safe drinking water, environmental hygiene, and strong economic access to food through microenterprises supported by microcredit.

Global collaboration particularly requires collaboration between the North and the South because many of the northern policies to the World Trade Agreement can quash most of the microenterprises in the developing world. We must be diligent in creating a mutual understanding because without it, we may inadvertently cause a lot of harm.

In addition, we must accord pregnant and nursing mothers and preschool children special attention, with particular reference to reproductive health and maternal and fetal nutrition. Parents have a responsibility to give their children happiness, not just existence. Population growth can be limited if people have a duty towards those who are not yet born, and the IAP should see how children can be born for happiness.

Mahatma Gandhi said, "Be the change you want to bring about." The fundamental question we must ask ourselves is, Can our academies be the change they want to bring about, are we going to be the change we want to bring about in society and science?

REFERENCE

Agarwal, A. 1997. Dying Wisdom: India's traditional water harvesting systems. New Dehli: Rajiv Gandhi Foundation