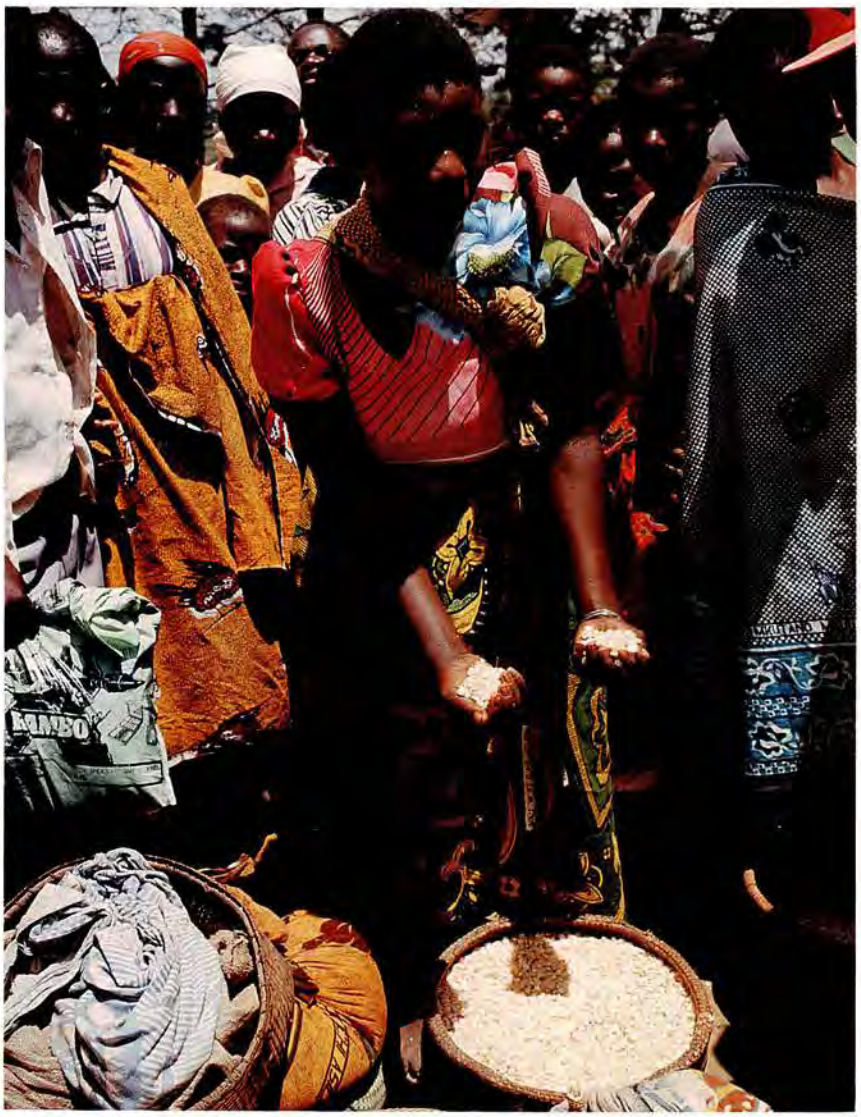
Africa's Agricultural Development in the 1990s: Can It Be Sustained?

CASIN/SAA/Global 2000



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Proceedings of a Workshop
14-18 May 1991
Arusha, Tanzania

Organized by:
Centre for Applied Studies in International Negotiations (CASIN),
11a avenue de la Paix, 1202 Geneva, Switzerland

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Global 2000, Inc., The Carter Center, One Copenhill Road, Atlanta, Georgia 30307, USA

Funded by:
Sasakawa Foundation (JSIF), Senpaku Shinko Building, 1-15-16 Toranomon, Minato-Ju, Tokyo 105, Japan

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Preface

*Jean F. Freymond**

In 1985 some 30 specialists in various disciplines and representatives from public life gathered at Geneva to examine how sub-Saharan Africa could be helped to achieve greater food security. That first meeting led to the establishment about a year later of pilot projects in three African countries for transferring appropriate agricultural technology to farmers; subsequently the work was extended to three more countries. Almost every year since the initial workshop, further meetings have been held to review the achievements of the pilot projects and to study critical issues related to their work. These proceedings provide a record of the fifth such gathering.

The pilot projects were launched in the face of considerable skepticism about the prospects for raising Africa's food production, especially through an approach relying on improved varieties, the use of chemical fertilizers, and other improvements in the management of staple crops. Although this technology has succeeded spectacularly in parts of Asia and Latin America, it is believed by some to have little chance of success in sub-Saharan Africa.

Though far from unfounded, the skepticism seems exaggerated, as the Sasakawa-Global 2000 Agricultural Projects have demonstrated. Working in various parts of the continent with different crops and under distinct circumstances, project staff have confirmed that, if farmers gain access to technologies already developed by national and international research programs, they can double and even triple their crop yields.

Previous workshops focused more narrowly on the technical dimensions of agricultural development in Africa. In 1991 we decided to broaden our scope and tackle the much tougher issue of sustaining this development in the 1990s. The outcome was a far more diverse program (encompassing governance, environmental management, community development, and other areas) than one is accustomed to seeing at agricultural meetings. And yet the highly varied content of the papers contained in this publication reflects quite accurately the broad challenge that agriculturalists face today. My sincere hope is that these proceedings will provide readers with useful guidance in exploring the complex relationships between agricultural development and the other challenges dealt with here.

The success of any workshop is the result of the effort and dedication of numerous people working behind the stage. In concluding, therefore, I would like to express my gratitude to Mesdames Gertrude Monnet, Anna Rweyemamu, and Véronique Hayoz and to Messrs. Patrick Orr, Shaila Mauladad, and Antoine Biéler, among others. My heartfelt thanks also to all the officials of the government of Tanzania and of the city of Arusha who were involved in this event.

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Workshop Summary

*Christopher R. Dowswell and Nathan C. Russell**

If an epigraph were chosen for this publication, a good candidate would be Polybius's law of ecology—the notion that everything is connected to everything else—which Dr. William Foege cites by way of introduction to his remarks on health policies and their relationship with agricultural development in Africa.

In eight plenary sessions, some 180 participants reviewed the Sasakawa-Global 2000 (SG 2000) Agricultural Projects and examined the connections between agricultural development, governance, the environment, health, education, and the community. All of these topics are tied to the workshop's central theme: the sustainability of agricultural development in sub-Saharan Africa during the 1990s. Provided below is a brief summary of workshop participants' main lines of thinking on this subject, as documented in the papers that follow, plus recommendations that came out of the workshop's final session.

Transfer of Agricultural Technology

The workshop was focused to a large extent on the transfer of agricultural technology to farmers in sub-Saharan Africa. One of the major purposes of the meeting was to review progress toward that objective through the agricultural projects supported by the SAA and Global 2000 in six countries. Though not based on a "single blueprint," these programs do, as Dr. Norman Borlaug and other SAA staff point out, have certain elements in common, particularly their emphasis on raising the productivity of staple food crops through the dissemination of improved seed, fertilizer, and complementary crop management practices.

The key premise underlying the SG 2000 Projects is that a large reservoir of appropriate food crop technologies is already available in Africa. More often than not, these technologies have failed to reach African farmers, especially small-scale producers, because of ineffective technology-transfer models and government price policies that discriminate against agricultural producers. SG 2000 seeks to remedy this shortcoming by demonstrating an effective model for technology transfer and by influencing the policy-making process related to agricultural technology delivery systems. The SG 2000 programs for demonstrating agricultural technology are conducted through local extension services and are aimed at training farmers in improved crop management practices.

The importance of mobilizing extension and resolving problems in technology delivery systems, especially seed and fertilizer distribution, is reinforced through policy dialogues with government leaders and officials from international development organizations. The central message in these exchanges is that agricultural

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development cannot be achieved unless farmers have greater access to the products of science-based agriculture, namely improved varieties, chemical fertilizers and crop protection products, and improved crop management practices. As Yohei Sasakawa, president of the Sasakawa Foundation points out, "there is no justification for a situation in which only African farmers . . . have such limited access to the techniques of modern agriculture."

Tanzania—The session on agricultural development in this country was opened by Hon. Anna Abdallah (M.P.), minister of agriculture, livestock development, and cooperatives. She outlines her government's current strategies for promoting agricultural development and its policies on key issues, such as land tenure, agricultural markets, and input supply. In commenting on the workshop's theme, she suggests that it should be possible to achieve and sustain agricultural development in Africa "but with the heavily loaded proviso that various conditions be satisfied."

The SG 2000 Project in Tanzania, which started in 1989, is helping the country achieve many of the development imperatives she cites, especially through its emphasis on "harnessing [the] underused capacities" of the small-scale farmer. In a report on their activities, project staff note that during the 1990-91 season small-scale farmers grew more than 10,000 one-acre Management Training Plots (MTPs), mostly maize, and that in the previous season the MTPs consistently yielded two to four times more than farmers' traditional plots. In addition, more than 90% of the farmers who had been loaned the inputs needed to grow their MTPs during 1989-90 repaid these loans in cash after harvest. "The high rate of loan recovery," say project staff, "reflects the highly favorable economic returns received by growers who use the MTP technology."

While expanding the MTP program modestly (in terms of total trial numbers and the crops and cropping systems included), the project will concentrate on improving its collection of yield data and on shaping its recommendations more closely to conditions in particular regions. Project staff will also step up their support of farmers associations that wish to serve as local input distributors for their members. In addition, a training and demonstration program on storage technology is planned mainly for past participants in the MTP program.

"There is no justification for a situation in which only African farmers . . . have such limited access to the techniques of modern agriculture."

Ghana—The SG 2000 Project in Ghana, begun during 1986, shows what can happen when optimism about the possibilities for accelerating food production is carried to the extreme. After several years of notable success, an overambitious expansion in the field program occurred in 1989, when Production Test Plots (PTPs) were increased to nearly 80,000 from a base of only 16,000 the year before. As a consequence, the PTPs were transformed from an extension demonstration activity into a commercial production

program. This placed the extension officers, who were made responsible for managing input distribution and subsequent loan collection in addition to their purely extension education duties, in an untenable position. The result, according to a team that reviewed the project early in 1991 (see the condensed version of their report in these proceedings), was a high rate of default on loans made to participating farmers. More than 50,000 of the 1989 PTPs were financed by the Ministry of Agriculture and several public sector banks. The high rate of default thus had a sobering effect on Ministry officials as well as SG 2000 staff.

In 1990 the PTP program once again became a technology demonstration program and returned to more manageable proportions (17,000 plots). Several new initiatives have been launched as well. A seed industry development program was established to support the Ghanaian government's new policy of deferring to private sector leadership in input delivery. In addition, various government organizations developed an extension training and demonstration program designed to introduce improved grain storage structures and methods at the farm level.

Despite the unfortunate consequences of mistakes made in 1989, the SG 2000 Project in Ghana has had many positive effects. Over a five-year period, national maize production increased by 40%. Apart from the "increase in grain output," say the review team, "[SG 2000] has opened new vistas to thousands of small-scale producers."

This impression is supported by the results of a survey conducted during 1990 under the Ghana Grains Development Project (the findings of which are presented in this publication). Researchers found that one in four farmers surveyed were graduates of the PTP program. Participation in the PTPs and field days has dramatically increased farmers' knowledge of how to employ recommended technologies; the technical knowledge of women farmers has increased relatively more than that of men. In Ejura District, an important maize-producing area where SG 2000 has been very active, researchers found that "the use of improved varieties and fertilizer has approximately doubled . . . in three years," and they attribute much of this increase to the project's efforts. The project has also played a significant role in the diffusion of nationally developed disease-resistant maize varieties among Ghanaian farmers. In addition to benefitting farmers, according to V. Atsu-Ahedor, deputy secretary for agriculture in Ghana's Volta Region, "the project has helped improve the effectiveness of the nation's extension services, and even the negative experience in 1989 has provided valuable lessons about extension's role."

Sudan—Initiated in 1986, the project in this country has concentrated mainly on wheat and sorghum production in areas irrigated by the Blue and White Nile Rivers. These areas have tremendous potential for bolstering the nation's food production and its food security, which is threatened by sharp fluctuations in cereal production under rainfed conditions.

The project has strongly promoted wheat production, which received little attention from Sudan's agricultural policy makers during the early 1980s and consequently shrank to a very limited area. Much to everyone's surprise, according to Ahmed Ali Genief,

minister of agriculture and natural resources, the Global 2000 Project has shown that it is possible to achieve quite respectable wheat yields in the irrigated areas, in spite of difficult climatic conditions. As a result of vigorous efforts to demonstrate improved wheat technology, note Borlaug and his staff, "the area planted to wheat has expanded rapidly; average yields have increased by 23%; national production has expanded three-fold; and the national wheat deficit has been cut in half.

Through an extensive PTP program in the irrigated areas, project staff have demonstrated the possibilities for doubling or tripling sorghum yields with the hybrid variety Hageen Dura-1, which has the added benefit, they note, of "unusually good flour-making properties." According to the results of recent milling and baking tests, "good quality bread can be made using a mixture of flour from Hageen Dura-1 . . . with bread wheat flour. Wide acceptance of this genotype could further help the country to reduce its dependency on imported wheat grain and flour."

Zambia—The Global 2000 Project in this country reached the end of its planned five-year phase in 1991 and is being brought to a close. The main reason, according to Borlaug and project staff, is lack of funds for a second phase. This is unfortunate since the program has found excellent opportunities for raising maize and sorghum yields and has demonstrated convincingly the efficacy of the MTP approach, especially in training small-scale farmers in improved crop technologies. If the extension service continues to apply the MTP model, the prospects for improving maize and sorghum production among small-scale producers in Zambia are good, particularly in view of the country's excellent seed industry and the government's recent moves (described by N.E. Mumba, permanent secretary of agriculture and water development) away from pricing policies that discriminate against producers and inhibit agricultural development.

Benin and Togo—The project in these countries is the most recent SG 2000 initiative; it was begun during 1989 in Benin and 1990 in Togo. Both nations have production environments similar to ones in neighboring Ghana and Nigeria, but they lack those countries' array of improved varieties and on-farm research capacity. From the start the Benin-Togo project has emphasized the formation of farmers' associations in villages as a means of strengthening producers' access to inputs and their collective bargaining strength in marketing surplus production. In fact, say project staff, "farmers [in Benin] cannot take part in the PTP program unless they belong to an organized group." Improved implements for use with animal traction are being promoted in areas where farmers are accustomed to using animals for land preparation and weed control.

The international research system—In reviewing the progress and impact of the SG 2000 Agricultural Projects, it is important to note that they build upon more than two decades of work within a global agricultural research system that embraces international centers, scores of national programs, and many other organizations. As a result of this partnership, notes Dr. Donald L. Plucknett, scientific advisor to the Consultative Group on International Agricultural Research (CGIAR), "there is no need for any country to go it alone in developing new agricultural technologies for its farmers." Plucknett places the

current status of this work in the context of world agricultural development over the last century or so and examines evidence that, where governments have given agricultural development high priority, the yields of major staples have approached a kind of "take-off point."

Though agricultural development in sub-Saharan Africa depends heavily on staple crops such as maize, sorghum, and roots and tubers, there is no doubt an important role for nontraditional crops such as soybean. Dr. Kiyoaki Katoh, of Japan's Ministry of Agriculture, Forestry, and Fisheries, argues that active promotion of this crop is an essential step for ensuring that future nutritional requirements in sub-Saharan Africa can be met, and he reviews recent experience in attempting to identify types of soybean preparations that are acceptable to African consumers.

International and National Governance

The SG 2000 Projects do not confine their activities strictly to the realm of technology transfer through extension programs but pursue their development aims within the context of national and international governance. In fact, both the SAA and Global 2000 make a deliberate effort to influence governments and international development agencies in ways that favor agriculture, especially the small-scale farmer. For that reason two sessions of the workshop were devoted to issues in the political arena.

In addressing some of these, Jimmy Carter, former president of the USA, develops the idea of "competent governance" as a key factor in the success of development projects and outlines some of the major challenges for government leaders in African countries. A central one is to work toward the resolution of armed conflict, which acts as an impediment to sustained economic development. In 1990, Carter noted, 17 major conflicts were under way in Africa; all were civil wars. Another challenge, says Carter, is to learn the value of "working at the micro level" in rural areas and then to strengthen ties between government and village by initiating the "democratic process." In doing so African leaders must find locally engendered democratic forms that give villagers grounds for believing "the government is theirs" and that provide leadership with a means of learning "what farmers and other groups in society really need."

General Olusegun Obasanjo, former head of state of Nigeria, gets at much the same point from a different direction by describing the ruinous effects of "overcentralization of political power." Apart from the problem of "official corruption," this tendency has made agriculture highly vulnerable to instability in government and to frequent shifts in policy. While urging the "decentralization of . . . access to resources" and "devolution of authority," Obasanjo still argues for a significant government role in agricultural development but one based on a "joint effort between farmers and their leaders" and on accessible and accountable local government institutions that are not "a mere appendage of the central or state government."

Dr. Elliot Berg, vice-president of Development Alternatives, Inc., carries the decentralization theme much further by examining arguments both for and against government giving up certain

responsibilities altogether. In doing so he focuses on three main types of government interventions in agriculture: 1) floor prices for farm products and price stabilization, 2) fertilizer subsidies, and 3) state-owned enterprises or parastatals. During the 1980s each of these forms of public sector involvement came under fire, and it appears that significant inroads have been made against them. Nonetheless, as Berg points out, "many observers, including numerous African policy makers, are unhappy about these changes, which they believe to be misguided."

Berg concedes that in the short and intermediate term some degree of government intervention to encourage stabilization of food grain prices and increase fertilizer use may be justified on equity, environmental, and food security grounds. Nonetheless, he presents fairly persuasive reasons for concluding that over the longer term all three of the interventions listed above are unworkable and ineffective. In considering the role of parastatals, for example, he points to the "strong inherent advantages" of the private sector in establishing "economically efficient institutions," which are a clear prerequisite for sustainable agricultural growth. "It is hard to think of any society," he says, "that has modernized its agriculture in the absence of a class of intermediaries—traders, transporters, artisans, bigger farmers—who could play leading roles in the process. . . . How quickly and smoothly the new equilibrium will be reached," he concludes, "depends substantially on the policies of Africa's external partners, . . . [whose] aid programs have enormous impact on the evolution of agricultural institutions."

Lest we believe that competent national governance and a growing private sector will bring quick prosperity to African countries, Louis Emmerij, president of the Development Centre of the Organisation for Economic Co-operation and Development (OECD), delivers a rather sobering message about the powerful and often malevolent influence of national policies in the economically advanced countries. "Exogenous factors," he notes, "have shaped entire societies" in Africa and have not ceased to be "a crucial and very concrete influence on national policies" in the region.

Of the seven major factors he describes, few of them bode particularly well for sustained agricultural development in Africa. In speculating about the implications for the developing world of Europe 1992, for example, Emmerij concludes that "the Lomé Convention countries, which previously were allowed relatively easy entrance in the European market, will essentially be thrown to the wolves." Likewise, with respect to recent events in eastern Europe, he comments that some countries (specifically Italy and the USA) "have already transferred part of their development assistance from the South to the East," an outcome that leaves no one happy, since the few million dollars being taken "from the pot of the developing countries" is hardly enough to make much headway against the huge problems of eastern Europe. Given the unfavorable international conditions for economic development in Africa, Emmerij commends the efforts of African leaders to achieve self-sufficiency in food.

Hidero Maki, senior vice-president of the Japan International Cooperation Agency (JICA), sounds a more positive note, pointing to the rapid expansion of Japanese aid to the region. In particular,

JICA seeks to promote "effective and environmentally friendly measures . . . to solve the problem of water," which greatly limits "the expansion of arable land. . . . At the same time," he notes, "it is necessary to achieve more intensive, continuous agricultural production on the land now under cultivation through closer integration of crop production with animal husbandry." Japanese aid will focus on solutions to these and related problems.

Environmental Issues

Agricultural development is largely dependent upon what farmers do with the knowledge and resources available to them. That this element has been undervalued in development planning is a central concern expressed by Lloyd Timberlake, director of external affairs, International Institute for Environment and Development (IIED). There has been a tendency in Africa, he asserts, "to undervalue the importance of local environmental variables and the body of knowledge that farmers have devised to cope with those variables."

The antidote, however, is not necessarily the environmental purist's solution of defending traditional farming systems against change and thus postponing agricultural development. "Many environmentalists," says Timberlake, "both inside and outside Africa, often suggest approaches that would degrade African development." The misuse of pesticides and fertilizers in industrialized countries, for example, have created resistance to the application of these materials in Africa. "The truth," though, says Timberlake (quoting an article in *The Economist*) is "'that both science and traditional agriculture can help future farmers.'" The challenge then is to find ways of securing farmers' participation in both raising crop yields and achieving better management of natural resources through a combination of new knowledge and old.

The two other speakers on environmental issues also supported Timberlake's thesis that agricultural development and the preservation of natural resources need not be viewed as conflicting goals. Richard Leakey, director of the Kenya Wildlife Service, outlines a bold plan for reconciling the two in his country's efforts to protect its unique wildlife and environmental resources. Among the main elements of this initiative are schemes for sharing revenue generated by wildlife areas with the rural communities surrounding them. Whereas local people have tended to view the conservation of wildlife as a cost (exacted to a large extent through the loss of land for grazing livestock), Leakey hopes they will come to see it as a substantial benefit that can help finance rural development.

Björn Lundgren, director general of the International Center for Research on Agroforestry (ICRAF), headquartered in Nairobi, describes another approach that defies the nature-culture antithesis so thoroughly ingrained in Western thinking (and imposed on Africans by the colonial powers). Agroforestry, he explains, offers a means of using "one kind of natural resource, in the form of undomesticated trees, . . . to manage other natural resources (soil and water) within [farming] systems." It thus represents an important departure from the idea that crops and livestock (the products of human culture) are necessarily in opposition to trees in natural forests.

Agroforestry also provides, according to Lundgren, one means of helping to overcome the fragmentation along disciplinary lines that characterizes modern agricultural research institutions. This circumstance, he says, has made them ill-suited to "addressing the agricultural and environmental problems . . . of Africa today." Lundgren concludes with a plea for stronger support of "initiatives leading to more integrated approaches in land development."

Agroforestry also provides one means of helping to overcome the fragmentation along disciplinary lines that characterizes modern agricultural research institutions

Health, Education, and Community Development

Certainly, one of the major requirements for improving the human condition in sub-Saharan Africa is a sustained attack on the region's numerous and severe health problems. Apart from the misery and loss of life they cause, a number of these, according to Dr. William Foege, executive director of the Carter Presidential Center, are known to have "a direct effect on productivity" in agriculture. A further hindrance to food production is malnutrition, which results, Foege says, not just from "limited caloric availability," but from diseases that cause people to essentially waste the calories they do ingest. Greater success in controlling these diseases would thus have a direct effect on Africa's long-term prospects for agricultural growth.

Another way in which Foege relates health to agriculture is by drawing lessons in disease control that are relevant to the improvement of food production. Noting that public health professionals are also faced with a sustainability challenge, he underscores the importance of steady advances in science, strong political commitment, social mobilization, and effective project management.

One thing that enables public health to command the attention of so many people is its focus on children. Sustained agricultural development should be an equally compelling issue, because it too is about the next generation and the one after that. In his welcoming address, Tanzania's President Mwinyi points to the need for enlisting young people in his nation's effort to realize its "enormous agricultural potential." This theme is taken up again by Hon. Fay Chung, Zimbabwe's minister of education and culture, and Ester Afua Ocloo, winner of the 1990 Africa Leadership Prize for a Sustainable End to Hunger. Chung describes her country's efforts to make a sharp break with educational traditions inherited from the colonial era and to provide the young with knowledge and skills that are "closely linked to the realities and problems that Africans face today and in the long term." She goes on to mention a number of specific measures and programs whose purpose is to engage the nation's students with

the agricultural and environmental imperatives of today and tomorrow.

While acknowledging the important role of government in education and community development, Ocloo concentrates more on what African people can do for themselves, particularly by working in groups that draw upon the continent's rich indigenous tradition of collective action. One such initiative, the FAO-sponsored People's Participation Program, has provided a model for the farmers associations that are beginning to feature importantly in the SG 2000 Agricultural Projects. Another is the Sustainable End of Hunger Foundation, established recently by Ocloo, which is working to encourage unemployed youth to take up farming.

Conclusions and Recommendations

This workshop went far beyond the technical dimensions of increasing agricultural productivity in Africa to explore the related factors of governance, management of natural resources, community development, rural education, primary health care, and the role of women in agricultural development.

In general, the efforts of the SG 2000 Agricultural Projects were praised. It was suggested that they explore alternative technologies that can reduce or complement the present emphasis on chemical fertilizers as the central component in soil fertility management and that they adopt a broader farming-systems perspective in their efforts to promote technology transfer.

SG 2000 cannot pretend to solve the myriad agricultural development challenges facing Africa. Most of the problems will ultimately have to be solved in Africa by Africans. The need for enhanced collaboration among development organizations—both governmental and nongovernmental—was stressed repeatedly by workshop participants. In particular SG 2000 was urged to cooperate more closely with indigenous NGOs seeking to strengthen grass roots farmer organizations.

The role of women in African agriculture came up frequently in the discussions. Research has shown that increased literacy and education for women bring both them and their families better health and nutrition and help them take advantage of new economic opportunities. Since 60 to 80% of African farmers are women, it is especially important to find ways of empowering them to bring about change if agricultural development strategies are to succeed.

SG 2000 was urged to help improve the status of women by including a larger proportion of women farmers (at least one third of all participants) in field testing and demonstration programs, thus assuring their access to new technology. It was also recommended that gender analysis be integrated into project development, both in training extension officers to work with participating farmers and in evaluating project impacts.

Welcoming Address

Al Haj Ali Hassan Mwinyi
President of the United Republic of Tanzania

I would like to take this opportunity on behalf of the government and people of Tanzania and on my own behalf to welcome you to Tanzania. We are greatly honored to have with us today President Jimmy Carter, Mr. Yohei Sasakawa, and Dr. Norman Borlaug, three very special people, who for many years have been deeply involved in the development of mankind.

President Carter, during your term of office as president of the USA, you maintained friendly ties with poor countries. Tanzania still remembers your contribution to creating stronger bonds of friendship and cooperation between the American people and Tanzanians. You have given us great encouragement in our arduous journey toward economic development and invaluable help in our fight against hunger, poverty, and disease.

It is an equally great honor to have you with us, General Obasanjo. As Nigerian head of state, you worked tirelessly to build the excellent relations that exist between our two countries. Your contribution to Africa's liberation and economic development is highly appreciated. Many of us still recall the commendable work you did as cochairman of the Commonwealth Eminent Persons Group on Southern Africa. Today you continue to serve our continent as chairman of the Africa Leadership Forum.

Mr. Ryoichi Sasakawa has set a good example for the rich of the world, most of whom believe that the hardships of the poor are of their own making and theirs to endure alone. Contrary to such callous views, Mr. Sasakawa believes that the world is one and that we are all brothers and sisters. His conviction is that the rich should help lift the burdens overwhelming the poor and the disadvantaged. For this reason he has endeavored to help poor countries alleviate their problems of hunger, malnutrition, and disease. The presence of Mr. Yohei Sasakawa at this workshop and his contribution to finding solutions for problems confronting the poor confirm the adage that like father like son. Mr. Sasakawa, the people of Tanzania are thankful to you for funding the Kilimo/Sasakawa-Global 2000 (SG 2000) Agricultural Project in Tanzania.

We are equally privileged to have with us here Dr. Norman E. Borlaug, a distinguished scientist known all over the world as the father of the Green Revolution. He has been a tireless exponent of the view that science should serve humanity, that rather than be satisfied with academic achievements alone scientists should put their knowledge to use by solving problems that affect us all. As president of the Sasakawa Africa Association, Dr. Borlaug is at the heart of the SG 2000

program, and his efforts have borne abundant fruit in Tanzania.

In January 1986 Tanzania received a very important visit from President Carter, Mr. Ryoichi Sasakawa, and Dr. Borlaug. Of such occasions we say in Kiswahili, "*Mgeni Njoo Wenyeji Wapone*," which means that the coming of a guest is a blessing to the host family. As it turns out, their visit heralded the birth of the Kilimo/SG 2000 Project in January 1989, which has proved to be a blessing to Tanzania indeed.

Most farmers participating in the program have achieved yield levels that previously were undreamed of.

The program started with 67 Management Training Plots (MTPs) in Arusha Region, each managed by a single farmer. The program chose smallholders as its clients—an approach that conforms to our own policies. In Tanzania smallholders contribute more than 80% of total agricultural production. Their limited means, however, have generally made them unable to purchase the inputs associated with improved packages of crop production practices, and thus the performance of the agricultural sector has remained poor. With the help of the Kilimo/SG 2000 Project, we can now see hope for drastic improvement.

Most farmers participating in the program have achieved yield levels that previously were undreamed of. Some have managed to triple and even quadruple their yields of maize and sorghum in the three years since the program was started in Tanzania. As a result, the number of MTPs has increased from 67 during the 1988-89 season to over 10,000 MTPs this season. My government will strive to consolidate this striking achievement. We hope that the encouraging results of these first efforts will give rise to an expansion of the Kilimo/SG 2000 Project in Tanzania to include other areas and food crops. Certainly, it would be worthwhile to explore the possibilities with wheat, rice, potatoes, and legumes. My government will endeavor to work collaboratively with the project in exploring all avenues of agricultural development in Tanzania.

Packages of agricultural technology involve the use of improved genotypes to achieve higher levels of production. A strong seed industry is required to supply producers with high-quality seed in a timely fashion. In Tanzania seed supply comes under the mandate of the Tanzania Seed Company (TanSeed). The demand in our country for improved seed of various types is estimated to be 12,000 t, of which TanSeed is able to supply some 7,000 t or about 58% of demand. For improved maize seed alone, the potential demand is estimated at 30,000 t, while the total amount of seed planted in the country is around 130,000 t for all cereals. There is, therefore, a big gap between potential demand and supply. Plans are underway to revitalize the seed industry in Tanzania. In accordance with the new investment code, we are inviting and encouraging both local and foreign companies to invest in the seed industry.

Fertilizer availability is another problem affecting agricultural development in our country. Demand for inorganic fertilizers is about 180,000 t. Since the Tanzania Fertilizer Company (TFC) is able to produce only 25 to 30% of that amount, the rest has to be imported through our own financing, loans, and aid. Our main food-producing regions (Rukwa, Ruvuma, Mbeya, and Iringa) have high fertilizer requirements. Experience in these areas has shown that with judicious applications farmers can triple or even quadruple their maize yields. To help realize these gains on a large scale, my government is placing heavy emphasis on the production of fertilizers locally, while also seeking the support of friendly countries and international organizations in meeting fertilizer demand.

More than 85% of our population lives in rural areas, and agriculture is the livelihood of the vast majority of these people. Smallholders form the backbone of our economy, contributing more than 80% of agricultural production. Though our farmers use mainly traditional methods, the Kilimo/SG 2000 Project has demonstrated quite clearly that they are ready to adopt improved agricultural technology.

To do so, however, they will need information and financial assistance in acquiring inputs. For the latter purpose, it is imperative that we establish an efficient credit system. The National Bank of Commerce already has a full-fledged department for agricultural development credits, but our farmers have not enjoyed this facility fully for reasons beyond their control. My government is now in the process of streamlining the operations of our banks, so that they can cater more efficiently to farmers in meeting their credit requirements. Recently, our parliament passed a bill legalizing the establishment of private banks. Moreso, the new cooperative act, allows for groups to form their own savings and credit societies. We hope this will create a climate in which our farmers can enjoy easier access to farm credit for timely purchase of agricultural inputs.

Another important factor in the development of agriculture and of the economy as a whole is transportation. Without an efficient transportation system, it is difficult to deliver agricultural inputs to producers in a timely manner and to move farm produce to consumers. For a decade or so our roads have been in a dilapidated state. As a result, we have not been able to move maize from areas where it is relatively abundant to those where it is in short supply. Paradoxically, in some years we have imported maize to feed people in food deficit areas, even though in other parts of the country we had mountains of it. I am pleased to state that with the cooperation of friendly countries and international organizations we have launched a program to rehabilitate our trunk roads. The program will cost about US$900 million over a five-year period. My government is also exerting considerable effort to rehabilitate our railway system and feeder roads. We are optimistic that this undertaking will greatly accelerate the implementation of all agricultural programs.

Our goal is to sustain the food self-sufficiency attained during the past four years. Unfortunately, this season mother nature has not been very kind to us. The short rains have been very erratic, and the main rains too have been late and erratic. As a result, food shortage in our country is imminent this year. This

unfavorable situation has reminded us of the need to prepare ourselves for drought years by establishing an efficient storage system for maintaining food reserves. It is disappointing to note that in Tanzania more than 30% of our stored farm produce is ravaged by pests and rodents, mainly because our food storage facilities are inadequate and our farmers do not have the knowledge and skills to store their farm produce efficiently.

The government is doing all it can to improve farm produce storage structures at the national, regional, district, and even village levels. Improvement at the household level is also of paramount importance, since it would help our farmers store their own produce for longer periods and thus stabilize their food supplies. We are doing our best to educate our farmers about storage technology for food crops, and we hope that the Kilimo/SG 2000 Project will join hands with us in this important effort.

Our country has more than 40 million hectares of good arable land awaiting judicious exploitation. We are convinced that if our young people (among whom rising unemployment is a serious problem) can obtain the necessary technical knowledge and skills, they can better realize the enormous agricultural potential we have in this country, both for their own benefit and for that of the nation as a whole. I therefore consider it extremely important that we establish an agricultural training center that can effectively impart knowledge and skills to our youth. Such a center would help us solidify the benefits achieved by the Kilimo/SG 2000 Project and thus bring us closer to a green revolution in Tanzania. The center could also benefit our neighbors, with whom we have very good relations. The project may wish to consider the possibility of assisting us in the establishment of such a center.

Finally, I would like to express my deep appreciation to the Kilimo/SG 2000 Project staff now working with us. They have proved to be diligent, competent, and dedicated to working with our farmers. The people of Tanzania owe them a great deal, and my government will give them the utmost support. I would also like to congratulate our *bwana shambas* who have participated in the program for their outstanding performance. It is my sincere hope that they will continue to learn from project staff and become more effective extension workers. Similarly, I wish to pay tribute to the farmers taking part in the program. They have shown their neighbors that there is nothing magic about attaining high yields and that the secret rather is to adopt modern agronomic practices. I am delighted that almost all participating farmers have paid back their input loans to the Kilimo/SG 2000 Project. Once again I would like to thank you all for sparing your time to participate in this important workshop, which I now have the honor to declare open.

Introductory Comments

Jimmy Carter
Former President of the USA

I am thoroughly delighted to be attending this fine conference in Arusha. The last time I was in this beautiful place, I had just returned from climbing Mount Kilimanjaro with my wife, two sons, and three grandchildren. In fact, we reached the peak on the eighth day of the eighth month of the eighty-eighth year of this century.

My wife asked me to express her regrets. She would be here with me, except that she had a prior commitment to a program called Habitat for Humanity, in which she and I are both involved. Its goal is to provide homes for the poor; so far the program has reached 700 communities in 33 nations. This week my wife is joining a group of women in Charlotte, North Carolina, USA, to build the program's first home constructed with all-female labor.

Every year for the last two decades, the production of food grains per person in Africa has gone down. The real tragedy of this alarming statistic is that the average African citizen now has 70 fewer calories per day than 20 years ago. And even then the diet of many Africans was already inadequate. I want to devote a few moments to discussing some of the many reasons that food production on this continent has declined.

One has to do with the vicissitudes of the weather. Drought has severely hindered production in some years. An even more significant threat to sustained growth in production, though, is environmental deterioration. The damage has become particularly severe since 1973, when the cost of crude oil rose rapidly from US$2 per barrel to $25 or $30, approximately the current level. As the price of fuel oil increased, people turned more and more to wood as a source of fuel for cooking and in cold climates for heating their homes. The resulting deforestation in many areas of the world, including Africa, has led to desertification of much arable land. In addition, topsoil has eroded, streams have become clogged with silt, and fishing has become less productive. All of these problems have contributed to a general reduction in the quality of life for millions of people.

Another significant factor in Africa has been the large number of armed conflicts, some of them related to the lower quality of life brought about by other problems. Warfare is obviously more likely when people are frustrated in their efforts to meet even the most basic necessities of life. At The Carter Center, we continually monitor these conflicts. At the beginning of last month, we counted 111 around the world, 32 of which we classified as major wars (defined as conflicts in which more than a thousand people have died on the battlefield). Some of them, of course, are even more horrendous. In Ethiopia over a million people have died in the war between Eritreans and the government,

and in Sudan more than 260,000 people perished during 1988.

None of these 32 wars has arisen from disputes between nations. With the end of the Gulf War a few weeks ago, all the major conflicts taking place in the world were civil wars, a substantial number of them on this continent. In the Horn of Africa alone, there are three—in Ethiopia, Somalia, and Sudan. Civil war also continues in Angola, Liberia, and Mozambique. Apart from the tremendous damage that nations locked in civil war do to themselves, they reduce the productivity of neighboring countries by disrupting the movement of people and their goods. For that reason the peaceful resolution of these conflicts is a challenge not just for the combatants but for their neighbors and international organizations as well.

There is an exciting trend toward democratic, multiparty systems that provide some guarantee that government policies will be shaped substantially by the needs and aspirations of the people

Obviously, the postcolonial period in Africa has not been easy. Some difficulties have arisen from the revolutionary heritage of newly independent governments and others from second-generation revolutionary movements in many countries. Now, however, there is an exciting trend toward democratic, multiparty systems that provide some guarantee that government policies will be shaped substantially by the needs and aspirations of the people (as is already the case in Tanzania, for example). The process of democratization, now underway in many countries, should help to alleviate suffering and improve the quality of life in Africa.

In the midst of these positive developments, however, it is disappointing to consider how little interest the rich nations have shown in helping to deal with Africa's problems. As the colonial powers have departed, they have not looked back with an adequate degree of concern to repair damage done during the colonial period. Meanwhile, other countries like my own, the USA, which never had colonies on this continent, have not bothered to develop much of a relationship with Africa at all. As a result, funding from these countries is rather limited, and there is a lack of interest in sharing technology, finding trade opportunities, and developing a sense of partnership in general. The absence of such ties may explain why loans have been made to African countries with so little consideration for the devastating effects that debt burdens would exert on African economies. Many countries must now use a substantial portion of their sometimes meagre export earnings just to pay the interest on loans, and they are in no position to pay the principal. Debt servicing thus takes away valuable resources from countries that badly need these funds to improve infrastructure and increase productivity.

A further complication is that decreasing food production and resulting nutritional problems bring about a general deterioration in the health of African populations. Rising incidence of sickness in turn hampers productivity. One of the

most serious afflictions in many African countries is guinea worm, which affects about 10 million people. It commonly occurs among people who obtain their drinking water from ponds and is most severe during the cropping season. The disease keeps children from going to school and their parents from working in the fields. According to a study by the United Nations International Children's Emergency Fund (UNICEF), productivity losses caused by guinea worm in one small rice-production area of Nigeria amounted to US$20 million. The Carter Center now has a program in that country for eradicating the disease, and we are hopeful that it can be eliminated worldwide by 1995.

Rapid increase in population is also a serious problem that impinges on overall trends in agriculture. If food production were to grow at an annual rate of 2 or 3%, which would be a notable achievement in the richest countries with the most advanced technology, food production per person would still decrease if population expanded at 3.5%. Much experience in family planning (for which Tanzania has a very enlightened program) has shown that the best way to control population growth is to reduce the infant mortality rate. As contradictory as it may seem, the measures you take to bring down the infant mortality rate are exactly the ones you employ to teach women that their bodies can be their own and that they need not be just baby-producing machines. If the entire family is healthier, the parents feel less compelled to have as many children as possible just to guarantee their security in old age. No nation in the world has reduced its infant mortality rate without also seeing a commensurate decrease, sometimes even a greater decrease, in the population growth rate.

Perhaps the greatest difficulty of all is the gap between scientists who know about the benefits of improved varieties, fertilizer, and erosion control and farmers who need this information. The problem is hardly unique to sub-Saharan Africa. In my country and others, there is still a gap between the scientific knowledge available and its application in farmers' fields.

I am very proud to have been part of the initiative launched by Ryoichi Sasakawa, working with Jean Freymond, to examine the various problems I have mentioned and to seek effective means of addressing them. The initial planning was followed very quickly by visits to a few countries. Mr. Sasakawa, Dr. Borlaug, and I formed alliances with enlightened government leaders, like President Mwinyi, for working in harmony with small farmers in particular areas to bring about a green revolution in sub-Saharan Africa, just as Dr. Borlaug did in Pakistan and India.

Much has been accomplished toward this goal through the generosity of the Sasakawa Foundation, now under the able leadership of Yohei Sasakawa in consultation with his father. The Sasakawa Foundation's interests are of a global nature. In almost any country of the world, you can find the effects of Mr. Sasakawa's generosity. Programs sponsored by the Foundation in Africa, though, have been most notably successful, specifically in Benin, Ghana, Sudan, Tanzania, Togo, and Zambia. Even in a war-torn country like Sudan, we have managed in just three years to quadruple wheat production from 150,000 to 600,000 t, within range of the country's total wheat demand of about 900,000 t. This experience demonstrates what can be done, in spite of huge

obstacles, when scientists work closely with farmers under effective leadership and with adequate financial support.

We owe a great deal of gratitude to Mr. Sasakawa, the Sasakawa Foundation, Dr. Borlaug, the specialists he has recruited, and to the thousands of extension workers who are working with farmers. We must also give the farmers themselves much of the credit for successes achieved so far. As a farmer, I have been genuinely surprised to see how enthusiastically participants in our crop production programs have accepted and put into practice new ideas. Not only are these farmers convinced of what they can do if given a chance, but specialists in the World Bank, the United Nations Development Fund, Food and Agriculture Organization, and others have taken note as well.

Of course, we have had some setbacks, particularly in Ghana, where we tried to expand too rapidly. But overall the SG 2000 Agricultural Projects in Africa have been successful and should yield rich dividends in the future. The main objectives of this workshop are to analyze the accomplishments of these programs so far, to determine the reasons both for their notable successes and few failures, and to decide how we can best build upon this experience. There is no reason why African countries cannot make much further headway in improving food production and health care, in raising the quality of life, and in achieving peace for all people on this continent. These are the goals of the SG 2000 programs and of the specialists who have assembled to participate in this conference. I am glad to have a part in it and am confident that the projects will enjoy great success in the future.

Introductory Comments

Yohei Sasakawa
President, Sasakawa Foundation

I would like to take this opportunity to convey the warmest greetings from the Sasakawa Foundation. Also, on behalf of my father, Ryoichi Sasakawa, who unfortunately was unable to attend, let me express our heartfelt gratitude to the many people who have supported the activities of the Sasakawa Africa Association over the years. The Sasakawa Foundation has supported the SG 2000 Agricultural Projects since 1986, when persistent drought brought famine to almost 100 million Africans, creating a tragedy of such unprecedented proportions that its effects remain freshly imprinted in our minds to this day. At the height of the drought, we held a workshop in Geneva to identify the fundamental causes of stagnating food production in Africa and means of alleviating this problem. At about the same time, we sent emergency food supplies to Ethiopia. The SG 2000 program was the tangible outgrowth of that first gathering.

The USA is in the forefront of world agriculture and has a sizeable influence on international cereal markets. The country's advanced agriculture has become a knowledge-intensive industry with extremely high levels of productivity. It is regrettable that the technology responsible for this achievement is not yet equally shared among nations as a common asset of humanity. Instead, we see a hierarchy of productivity levels, in which the food producers of the developing countries, especially smallholders in sub-Saharan Africa, lie at the very bottom, separated by a huge distance from the producers that cater to international markets.

While leaving a more precise discussion of the problem to the experts assembled at this conference, I would assert that this huge productivity gap constitutes the fundamental cause of famine in Africa. Narrowing this gap is the primary aim of the SG 2000 projects. There is no justification for a situation in which only African farmers, who till the same earth as their counterparts elsewhere, have such limited access to the techniques of modern agriculture. Do they not have the same rights as farmers elsewhere to enjoy the benefits of improved yields?

I should point out that the SG 2000 Projects could not have been established so successfully without the dedicated efforts of Dr. Norman Borlaug, architect of the Green Revolution, in which he played a central role in helping Asia surmount its own perilous food production problems. From him we obtained the formula that underlies our undertaking in Africa. The Sasakawa Foundation dreams of a day when the flame of another green revolution will flare up on this continent. Our hope is that the small-scale farmers of Africa, who constitute 70% of the continent's entire population, will raise yields at least threefold, making agriculture a vital industry and an attractive

profession and putting African food producers at par with farmers elsewhere in the world. Dr. Borlaug and the staff of the Sasakawa Africa Association have proved to us that these aspirations are not mere flights of fancy. We extend our sincere thanks to Drs. Quiñones and Foster for their tireless efforts to achieve these goals in Tanzania.

Let me now turn to the great contributions being made by former US president Jimmy Carter. Any country that trebles the yield of its staple cereal must have the economic base to absorb additional domestic production. To establish this capacity constitutes a tremendous challenge for African governments. Unless they are able to cope with increasing supplies of agricultural produce, the dawning green revolution will quickly fade away. That is why the SG 2000 program attaches such importance to political dialogue. It is primarily in this area that President Carter has played such a vital role.

Even so, as impertinent as it may sound, my view is that African governments have not yet done enough at the policy level to assist food producers. Unless success in raising production is translated into tangible improvement in the quality of rural life, the small-scale farmers who form the foundation of the region's economy will quickly lose their determination. Thus, the task confronting the Honorable Anna Abdallah, Tanzania's minister of agriculture, livestock development, and cooperatives, and the other government officials present here is an extremely urgent one. Mr. Carter's attendance at this workshop indicates the importance he attaches to the policy aspects of our work to increase food production.

The financial resources of but one private foundation are far from adequate to address the array of tasks now before us. We have already secured annual funding of US$2 million from the government of Finland, and I can promise you that we will extend our hands to as many partners as are willing to join forces with us. The Sasakawa Foundation will devote its fullest energies to ensuring that the goals of our projects are met. I hope that this workshop will help build even more solid cooperative relationships between the government and small-scale farmers of Tanzania.

The Africa of the 21st century should be a food-producing continent, free of the tragedy of hunger and starvation. The only way to achieve this end is to launch a revolution in agricultural production and to establish a political system that favors cereal production and supports the small-scale farmers engaged in it. The seeds of this revolution have already sprouted and taken root in Tanzanian villages. It is my earnest desire that you will find the means of spreading this revolution to many others.

Tanzania's Strategy for Agricultural Development

Hon. Anna Abdallah (M.P.)
Minister of Agriculture, Livestock Development, and Cooperatives

I want, first of all, to join President Mwinyi in extending a very warm welcome to all our distinguished foreign guests assembled here for this important workshop. I hope you will find the environment in Arusha conducive to your work and that your brief stay in our country will be enjoyable. I wish also to take this opportunity to express my sincere gratitude to the workshop's organizers, the Center for Applied Studies in International Negotiations and the Sasakawa-Global 2000 Project. Before going on to outline Tanzania's strategies for agricultural development, I will venture an opinion about the theme of this workshop—the sustainability of Africa's agricultural development. In my view it can be sustained, but with the heavily loaded proviso that various conditions be satisfied.

Conditions for Sustainable Development

The first is that there be a clear recognition that agricultural production in most of Africa is primarily in the hands of small-scale farmers. Any agricultural development strategy that fails to focus on ways of harnessing their underused capacities is likely to prove unsustainable. In Tanzania our rural development planning has unfortunately tended to overlook the importance of improving small-scale production because of the obviously mistaken belief that this sector is incapable of making any major contribution to national development. Hence, most of the official government attention paid to agriculture has been directed almost exclusively to large-scale farming, including selected parastatal organizations. Recently, however, the government of Tanzania has acknowledged the crucial role of the smallholder, and in the 1990s its agricultural development policies have been reshaped accordingly.

A second necessary condition for sustainable agricultural development on this continent is that sufficient attention be paid to land-use planning. This involves the efficient distribution of activities over space and time in a given production area. One of the primary aims of this planning is to avoid major land-use conflicts, which can slow agricultural development. Such disputes may occur, for example, when population increases require that additional land—often, good agricultural land—be set aside for residential purposes. Another source of conflict over land use is competition between crop production

and livestock rearing. Such problems must be prevented early by establishing the type and size of each activity to be undertaken in particular villages.

A third condition is that agricultural development be based on the concept of people's participation. As former president of Tanzania, Mwalimu Julius Nyerere, once said, "People cannot be developed; they can only develop themselves. A man develops himself by joining in free discussion of a new venture and participating in the subsequent decision. He is not being developed if he is herded like an animal into a new venture." The concept of people's participation is based on a central fact of human nature, namely that people are most likely to value things that they themselves have helped create. People who become involved in a given enterprise take account of their own problems, needs, aspirations, and interests and argue that these be taken into account in project planning. If successful in making their case, people then feel obliged to guarantee the success of the project through effective implementation.

Obviously, effective communication is an important dimension of the concept of peoples' participation. The point is well illustrated by a story relating to the introduction of Pepsi Cola in Thailand. When the the company first began to sell its product in Thailand, it mounted an aggressive advertising campaign, using an American slogan: "Come alive, you're in the Pepsi generation." What the advertisers failed to realize, because of their lack of understanding of the local situation, is that in its Thai language version the slogan said, "Pepsi brings your ancestors back from the dead."

A fourth condition is that adequate recognition be given to the vital role of women in agricultural production. I add this condition not because I am a woman but because several scholarly studies, focusing on women's socioeconomic conditions here in Tanzania, have revealed that women perform up to 70% of the tasks involved in agricultural production. Research carried out in Arusha, Kigoma, Dodoma, and Coast Regions in 1980 confirmed that women are very heavily involved in both the cultivation and processing of crops. A major conclusion of this research is that, unless special provisions are made that favor women in agricultural production, it is quite possible that not enough food will be produced for rural families. In Tanzania's settlement schemes, for example, it has been established that the introduction of tractors, despite increasing the area under cultivation, resulted in an actual decline of production. The reason was that women were unable to weed the additional area, a task they did by hand and with no help from the men.

The concept of people's participation is based on a central fact of human nature, namely that people are most likely to value things that they themselves have helped create.

Policy Objectives

Tanzania's policies and strategies for agricultural development date back to the Arusha Declaration of 1967. One of its major components was the resettlement of the rural population into organized village communities. This approach facilitated the mobilization of rural communities for development activities, for the introduction of improved farming practices, and for the provision of social services.

In the early 1980s, the government adopted the National Agricultural Policy (NAP) and the National Livestock Policy (NLP), which provide fundamental guidelines and strategies for bringing about rapid growth in agricultural production. The specific objectives of the NAP are to:

- Develop an egalitarian agricultural community based on the policy of socialism and self-reliance
- Achieve national self-sufficiency in food production and raise the nutritional standards of all the people
- Through increased output, raise the standard of living for all Tanzanians
- Earn foreign exchange for benefitting the nation generally and for meeting the import requirements of agriculture
- Provide basic raw materials for the nation's industrial sector
- Develop an integrated agricultural sector, using technology appropriate to the particular crops, sizes of operations, and national resources
- Reduce the use of imported energy and the human burden by increasing the use of draft animals

Taking into account the objectives listed above, the NAP establishes the following targets:

- The output, variety, and marketing of food crops must be increased enough to provide food that is adequate in quantity and quality for the nation. Output must therefore continue to expand at a rate at least equal to that of population growth.
- A national strategic grain reserve must be built and properly managed.
- The efficiency of production, marketing, and processing of agricultural commodities must be greatly improved.
- Investment in the agricultural sector must be increased.
- The development programs of all other sectors (especially those of industry, water, transport, natural resources, education, and health) must be coordinated with the development of agriculture.
- The social and economic infrastructures in the rural areas must be strengthened and expanded.
- The different types of agricultural production must be coordinated and developed on the dual basis of maximum efficiency and the interests of the producers.

Policies on Key Issues

The ultimate aim of the NAP and NLP is to bring about a rapid recovery in agricultural and livestock production. Some of the key issues addressed by this policy are production organization, land tenure, priorities in crop and livestock production, agricultural prices and marketing, irrigation, research and extension services, input supply, agricultural mechanization, and input supply. What follows are brief summaries of our policies on each of these matters.

Production organization—The government is mandated to continue putting more emphasis on smallholder/village production. This is the predominant mode of agricultural production in Tanzania and must therefore be the focal point for efforts to raise agricultural output. Village production methods are to be modernized through the adoption of improved crop husbandry practices and appropriate technology. Large-scale farming, both public and private, are also to be encouraged.

Land tenure—Current policy provides for allocation of agricultural land on a long-term basis, with the minimum period being 33 years. Title deeds are to be issued to this effect. In the case of villages, title deeds will in practice be permanent, and the village will be able to sublet land to individual residents.

Crop production—Our short- and long-term objectives will be to achieve self-sufficiency in food production, secure an adequate supply of raw materials for the industrial sector, and increase our foreign exchange earnings. Agricultural output will be raised through both intensive and extensive measures, improvement and expansion of research and extension services, and provision of suitable storage facilities to minimize postharvest losses.

Livestock production—Policies affecting livestock production will focus on the traditional sector, which comprises over 99% of the national herd. Productivity will be raised through improved management practices and the introduction of high-quality stock. These measures will be accompanied by improved marketing incentives, support services, and infrastructure.

Agricultural prices—The government's policy is to ensure remunerative prices to producers, while at the same time employing prices to influence the type and pattern of production. Producer prices are to favor food crops that demand minimum foreign expenditure in production and export crops with a high capacity to earn foreign exchange.

Agricultural marketing—Our aim is to maximize efficiency by rationalizing and streamlining marketing institutions. High priority will be placed on infrastructure support services, particularly the construction and maintenance of regional, district, and village access roads as well as storage facilities.

Irrigation—Every effort will be made to exploit the country's sizeable irrigation potential, particularly for small-scale, labor-intensive village schemes but not to the exclusion of large-scale projects. Improvement and expansion of traditional furrow irrigation is to be undertaken.

Research and extension services—Our aim is to strengthen and expand these services through deployment of more resources. Research

programs must be problem oriented and must focus on agroecological zones. Coordination has to be maintained at all levels. Extension services are administered directly by the ministry responsible for agriculture, with the objectives of strengthening supervision and improving research, training, and extension linkages.

Agricultural mechanization—Our policy on this issue is designed to gradually liberate the farmer from the hoe and encourage the use of appropriate improved implements, with particular emphasis on the use of animal power.

Input supply—This activity is coordinated and monitored at all levels by the ministry responsible for agriculture. Local manufacturers and/or suppliers of agricultural inputs are responsible for distributing them to regional centers, from which the cooperative unions supply them to the farmers through cooperative societies, village shops, farmers service centers, farmers associations, and private traders.

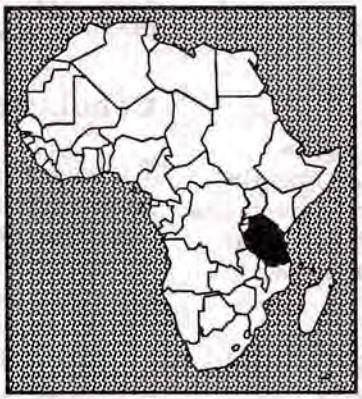
More recently, environmental issues have started to feature importantly in our strategies for agricultural development. A lack of serious concern about these issues and their linkage with agricultural activities has led to extensive deforestation and soil loss. In an effort to limit further damage, the Tanzania Forestry Action Plan (TFAP) aims at promoting sustainable agricultural production.

Conclusion

The scope for raising agricultural production through the application of appropriate scientific knowledge is enormous. That point is clear from experience in many parts of the world and from much of the information reported at this workshop. What is needed now is the development and application on a case-by-case basis of improved technical packages suitable for different socioeconomic and political environments. Because this conference has brought together specialists in various areas of agricultural and rural development, it offers a rare opportunity for the exchange of ideas and experiences. It is my sincere hope that this conference will develop recommendations aimed at establishing a pragmatic, sustainable program for agricultural production in the 1990s.

The Kilimo/Sasakawa-Global 2000 Agricultural Project in Tanzania

*Marco A. Quiñones, Michael Abu Foster, and N.P. Sicilima**



The Kilimo/Sasakawa-Global 2000 (Kilimo/SG 2000) Agricultural Project seeks to assist the government of Tanzania in raising production of the nation's staple food crops by helping small-scale farmers to adopt productivity-enhancing technologies. The project operates through the Tanzanian Ministry of Agriculture, Livestock Development, and Cooperatives (MALDC), often referred to as *Kilimo*, which means "agriculture" in Swahili. Project staff work mainly with the leadership and field personnel of MALDC's Department of Extension.

A Profile of Tanzania

Tanzania is located in East Africa between 1° and 12° south latitude and 30° and 40° east longitude The country has a total area of 94.5 million hectares, of which 240,000 comprise the islands of Zanzibar (Zanzibar Island, Pemba Island, and other small islets). Tanzania's lakes, principally Victoria, Tanganyika, and Nyasa (Malawi), cover 6.15 million hectares.

Climate—Tanzania's tropical climate can be divided into four categories based on temperature and elevation: 1) warm—less than 1,000 m above sea level (masl), with mean daily temperatures higher than 25°C; 2) moderately warm—1,000 to 1,500 masl, with mean daily temperatures of 20° to 25°C; 3) moderately cool—1,500 masl, with mean daily temperatures of 15° to 20°C; and 4) cool—higher than 2,000 masl, with mean daily temperatures of 10° to 15°C and some risk of night frost.

The seasonal rainfall pattern varies greatly from north to south. In the north the rains generally begin in late October and in the south from late November to early December. A bimodal rainfall pattern prevails in the north, with the so-called "short" rains occurring from October to January and the "long" rains starting in March and continuing through May-June. In the central and southern regions, the rainfall pattern is essentially unimodal; the rains occur from November-December to April-May, with a brief dry period in February.

Land use—Tanzania possesses vast, still undeveloped land and water resources to support future food production. Of the country's approximately 41 million hectares of potentially arable land, to date only 5.4 million have been brought into agricultural production (FAO 1990a). Though most of the agricultural area

* SG 2000 Country Director, Senior Scientist, and MALDC National Coordinator, respectively.

will continue to be rainfed, it is estimated that some 5 million hectares are potentially suitable for irrigation. Less than 200,000 ha are under irrigation at present.

Population—The population of Tanzania is estimated to be around 25 million (World Bank 1990). The rate of population growth was very high during the 1980s at 3.5% per year. Assuming a rate of 3.2% over the next several decades, Tanzania will have 55 million people in 2010 and 74 million in 2025. By the year 2010 the proportion of people living in rural areas will have declined to 65%, compared to roughly 85% at present. In 1988 about 80% of the 3.8 million people classified as urban dwellers lived in five cities—Dar es Salaam, Mwanza, Tanga, Zanzibar, and Arusha.

Education, health, and nutrition—Tanzania has one of the highest literacy rates in sub-Saharan Africa. Some 85% of the population can read and write Swahili. More than two-thirds of children (the proportion is equal for boys and girls) attend at least primary school. Infant mortality is lower (at 108 per thousand live births) than in most other sub-Saharan countries but still higher than in the low-income countries of Asia and Latin America. The number of people per physician is very large, and most people do not have access to health care services beyond the assistance of a midwife at birth. Per capita daily food intake is estimated to be about 2,200 calories—98% of the FAO recommended minimum—with 93% coming from vegetable products and the remainder from animal products.

Economic indicators—Tanzania's economic situation, according to World Bank statistics, is a difficult one. Between 1965 and 1988, per capita gross domestic product (GDP) dropped by an average of 0.5% per annum and stood at only US$160 in 1988. Total public and private external debt has grown steadily, reaching $4.8 billion in 1988, nearly twice the GDP of about $2.7 billion. The greatest economic declines have occurred in the industrial and manufacturing sectors. The government has had significant budget deficits and in 1988 depended upon foreign aid for about 30% of public expenditures.

Agriculture—This was one of the few bright spots in Tanzania's economy during the 1980s. Crop production grew at an annual rate of 4%, twice the economy's overall rate of growth. The major cash crops are cotton, coffee, tea, sisal, cashewnut, and cocoa, which account for more than 50% of national foreign exchange earnings. Production figures on the main food crops are given in Table 1.

Even though national food production has increased significantly since the mid-1970s, high rates of population growth have depressed gains in per capita cereal production to 1.9% per year (Figure 1). Maize production grew rapidly at 6.5% per year between 1973-77 and 1984-88 as a result of yield

Table 1. Production statistics for Tanzania's main food crops, 1987-89 averages

	Area (000 ha)	Production (000 t)	Yield (t/ha)
Maize	1,841	2,619	1.42
Pulses	804	382	0.48
Cassava	700	6,168	8.81
Sorghum	595	529	0.89
Rice (paddy)	349	610	1.75
Millet	297	290	0.98

Source: FAO (1990a).

increases and a significant expansion of area. In recent years Tanzania has been self-sufficient in maize production and has the potential to become an important exporter of this crop to other countries in the region. Production of rice and wheat, on the other hand, lag far behind demand, with the result that these two commodities account for most of the nation's food imports. In general, the adoption of improved germplasm has been limited, and crop yields remain quite low. In 1988 only about 10% of the maize area was planted to improved open-pollinated varieties (OPVs) and hybrids (CIMMYT 1990). Less than 8 kg of fertilizer nutrients are applied per hectare of arable cropland (FAO 1990b).

Infrastructure—Tanzania's transportation, energy, and telecommunications infrastructure is not well developed. Less than 1 person in 200 has access to a telephone. The country has some 3,000 km of railways distributed among three major lines that connect Dar es Salaam with major regional capitals and the hinterland. The Tanzania-Zambia line to Lusaka, built with assistance from China, is the most modern and best maintained; other lines mostly have old narrow-gauge tracks and are generally not well maintained. The country has some 100,000 km of roads, but less than 10% are paved and reasonably well maintained.

Government—Tanzania has a parliamentary form of government, with a president and prime minister. The nation is divided into 20 administrative regions, which are subdivided into districts, towns, and villages. The regional commissioner is the government's top representative in each region, and the district commissioner is its chief official in each of the several hundred districts. The regional agriculture and livestock development officer (RALDO) is the senior MALDC official in each region. As part of the senior regional government management

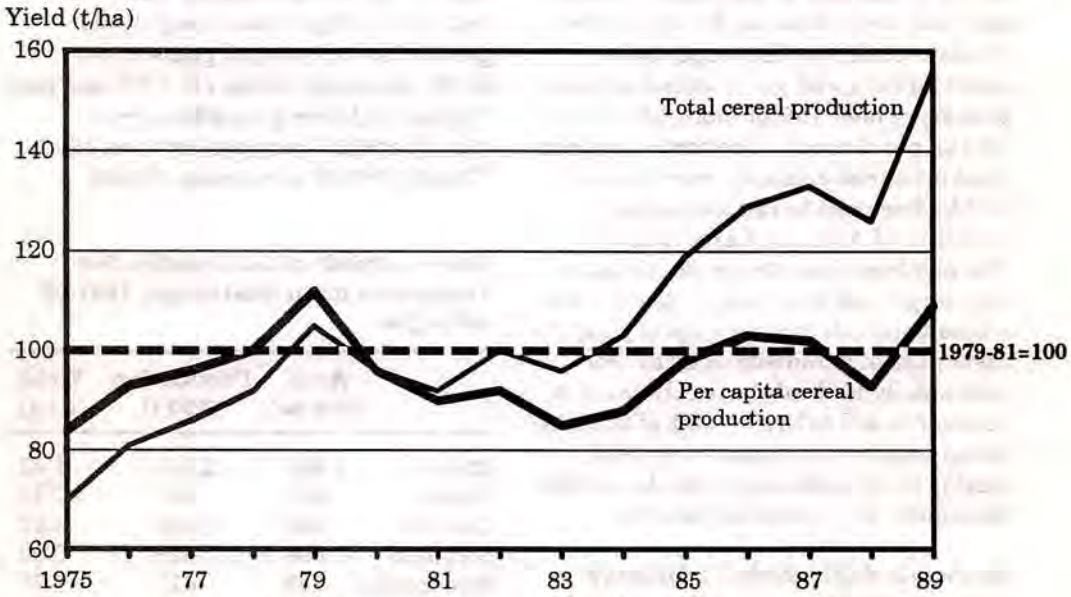


Figure 1. Cereal production indices for Tanzania.
Source: *FAO Yearbook: Production.*

team, the RALDO works with regional officials to coordinate MALDC programs in agricultural production and also has responsibilities in crop and livestock protection, extension, and the development of cooperatives.

The Kilimo/Sasakawa-Global 2000 Project

The Kilimo/SG 2000 Project was begun in 1989 by two internationally recruited staff—a director and a senior scientist—and a handful of locally hired support staff. In 1991 a third internationally recruited staff member was added to the team. The project has two principal offices—one in Dar es Salaam and the other in Arusha—both located in government office buildings. MALDC has appointed a senior extension official as national coordinator, who is the national counterpart of the Kilimo/SG 2000 country director. Regional and district coordinators have also been appointed by the Department of Extension in each of the six regions where the MTP program operates. The Kilimo/SG 2000 Project is currently working with approximately 300 extension officers, roughly 5% of the total number.

The project works with small-scale farmers to test and demonstrate improved food crop production technologies—first on a limited scale and, if the results prove promising, on a larger scale to build widespread farmer support. Parallel efforts are made to increase village-level availability of fertilizer, improved seed, credit, and market outlets. By these means the project seeks to act as a catalyst for strengthening the linkages between Tanzania's farmers and its agricultural research, education, production, and credit organizations (Figure 2). There is a need for greater integration of these public sector institutions (Foster et al. 1988). Private sector organizations also

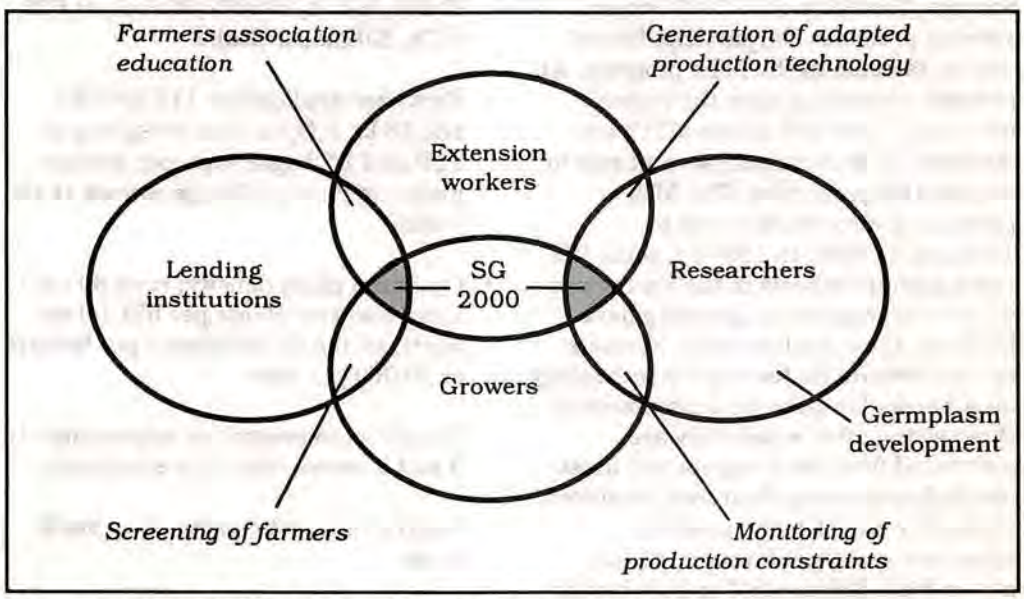


Figure 2. The SG 2000 Project's technology transfer model.

need to become more involved in national agricultural development.

Management Training Plots—The heart of the Kilimo/SG 2000 Project's strategy for technology transfer is the Management Training Plot (MTP), which is managed by the farmer and supervised by an extension officer. The cooperating farmer agrees to follow the recommended crop management practices and to involve at least 10 neighboring farmers in MTP operations during the growing cycle. Project staff believe that the relatively large size of the MTP (1 acre or 0.4 ha) is about the minimum for testing the improved technology on a realistic, commercial scale and for providing the participants with an immediate economic benefit. Both of these conditions are crucial for motivating farmers to adopt the new technology.

The project supplies each MTP cooperator with inputs—mainly fertilizer and improved seed. Village extension workers deliver inputs to the farmers, who are expected to pay for them after harvest. The Kilimo/SG 2000 Project actively promotes the participation of women farmers in the MTP program. At present, depending upon the region, between 20 and 25% of the MTPs are managed by women, and we continue to expand this proportion. The MTP program is also reaching out to Tanzania's youth. In 1990-91, some 122 rural primary schools in the six regions where the program is operating have MTPs on the school grounds. Farmers can participate (in testing the technology for a particular crop) for a maximum of three years, after which they are graduated from the program and must obtain inputs using their own resources. Once they have left the program, organized groups of farmers can get advice from Kilimo staff on how best to obtain inputs and market crops.

Recommended technology—The improved maize, sorghum, millet, and wheat technologies demonstrated in the MTP program have been developed by national research organizations, with the support of several international agricultural research centers, namely the International Maize and Wheat Improvment Center (CIMMYT), the International Crops Research Institute for the Semi-arid Tropics (ICRISAT), and the International Institute of Tropical Agriculture (IITA). The technologies have also been tested and verified by national researchers and extension officers in farmer-managed on-farm trials. The amounts of inputs recommended in the MTPs do not reflect some agronomic optimum level but rather an economic optimum that takes into consideration the risk farmers incur when they purchase inputs, such as fertilizers, improved seed, and pesticides.

The technology package recommended for maize MTPs consists of the following:

- An improved OPV or hybrid: H-614, H-625, H-511, H-6032, MH-41, H-632, UCA, Kilima, or Staha
- Fertilizer application: 115 kg N/ha and 58 kg P_2O_5/ha (one 50-kg bag of TSP and 1/2 bag of urea per acre at planting, plus 1-1/2 bags of urea at six weeks)
- Optimum plant density: rows 80 cm apart and two plants per hill, 50 cm apart, giving 50,000 plants per hectare or 20,000 per acre
- Timely weed control: at approximately 3 and 5 weeks after crop emergence
- Control of insects, particulary stalk borer

The recommended production package for sorghum MTPs includes:

- An improved variety: Tegemeo, Serena, or Weigita (a landrace)
- Fertilizer application: 57 kg N/ha and 29 kg P_2O_5/ha (1/2 bag of TSP and 1/2 bag of urea per acre at planting, plus 1/2 bag of urea at 4 weeks after the first weeding)
- Optimum plant density: rows 80 cm apart and two plants per hill, 25 cm apart, giving 100,000 plants per hectare or 40,000 per acre
- Timely weed control: at 3 and 5 weeks after crop emergence
- Control of stalk borer and shoot fly

The recommended production package for wheat MTPs includes:

- An improved variety: Selian 87 or Tausi
- Fertilizer application: 115 kg N/ha and 58 kg P_2O_5/ha in a single application at planting
- Optimum plant density: 150 kg of seed per hectare
- Insect control if required

Each year Kilimo/SG 2000 extension officials and national researchers review the results farmers obtain in using the MTP package. If there are problems, the package is modified. The component most frequently altered is the choice of variety. For example, in recent years we have actively promoted the maize hybrids or varieties that have shown the best husk cover. Similarly, the outstanding yield of a local sorghum landrace has prompted us to promote this fertilizer-responsive cultivar in the current MTP package.

Training extension officers—Training extension officers and workers to carry out the MTP program is a central activity of Kilimo/SG 2000 Project staff. In-service courses are held at four key stages in the crop cycle: 1) preplanting, 2) topdressing, 3) flowering, and 4) harvest. Each training session prepares extension workers to take technical messages to MTP farmers and to manage the logistics of the field program. In addition, travelling seminars are organized, in which extension workers from one region visit the MTPs in others. International travelling seminars are organized for higher level extension officers to visit SG 2000 programs in other countries.

Improving extension's mobility—Tanzania is a large country with more than 8,000 villages and towns connected for the most part by poor roads. Extension workers have had little access to vehicles for serving the large and dispersed agricultural population. The Kilimo/SG 2000 Project has sought to improve the mobility of the workers with whom it collaborates by providing them with various modes of transportation: four-wheel drive pickup trucks for regional coordinators, off-road motorcycles for district coordinators, and bicycles for village extension workers. Extension officers purchase the motorcycles and bicycles with an interest-free loan provided by the project. We also make funds available for vehicle maintenance and give the regional and district coordinators limited funds to cover the expenses they incur in supervising the MTPs under the care of village extension workers.

Training farmers—Once the extension officers have been trained, their task is to pass on information about the

recommended production packages to MTP farmers. According to the cluster system, in which at least 10 farmers are associated with each MTP, cooperators are called on to convene at an MTP site during each of the key crop stages listed above. After extension workers have discussed the principles and demonstrated the practices involved in the recommended technology, the MTP farmers then apply the crop production package on their own plots. Larger field days are organized at selected MTP locations to demonstrate the technology package. These events, which are generally well attended by neighboring farmers, serve to publicize the recommended practices and provide an excellent venue for question-and-answer sessions about variety performance and other aspects of the improved technology.

Organizing farmers—The Kilimo/SG 2000 Project actively encourages farmers in villages to organize themselves into associations that facilitate collective action. Most of the MTPs are organized on a village basis, with individual cooperators also serving as agents of technology diffusion. In its past efforts to organize small-scale farmers into groups, the government has taken a top-down approach, which generally has not proved successful. Our hope is that voluntary, grass roots associations of farmers will emerge in the various villages among cooperators that have been graduated from the MTP program. The development of such groups is a long-term process, but we hope to encourage it as much as possible by providing some assistance in acquiring inputs and production credit and in marketing surplus production.

Influencing agricultural policy—Improved technology is a necessary condition but not a sufficient one for transforming low-yielding, subsistence food-production systems into more commercially oriented, high-yielding enterprises. Appropriate policy measures must be taken to provide farmers with adequate incentives to adopt yield-increasing and cost-reducing technologies. Project staff and senior management of the Sasakawa Africa Association and SG 2000 Projects work with Tanzanian policy makers in addressing the issues of input delivery, credit for small-scale farmers, and grain market development. SG 2000 leadership also engages decision makers from multilateral and bilateral organizations to examine various research and development topics.

In 1990 the Kilimo/SG 2000 Project hosted a national workshop in Arusha to discuss prospects for increasing the productivity of staple food grains grown by small-scale farmers. Some 50 people attended the workshop, including SG 2000 senior management and staff from other country programs, Tanzanian agricultural policy makers and officials, representatives of credit and input-supply institutions, and scientists from several international agricultural research institutions, specifically the International Center of Tropical Agriculture (CIAT), CIMMYT, and ICRISAT. The workshop focused attention on policies needed to accelerate adoption of productivity-enhancing technology by Tanzania's small-scale food producers. The present workshop represents a further effort to encourage the development of effective policies for sustaining agricultural development in the coming decades.

Field Program Operations and Impact

The Kilimo/SG 2000 Project got underway during the 1988-89 season with the establishment of 67 maize

MTPs in Arusha Region. Three zones were selected for monitoring and supervising the field testing and demonstration program (Figure 3). During 1989-90 the program was reorganized into six regions and began to include sorghum and wheat MTPs (1,574 maize plots were grown, together with 190 sorghum plots). In 1990-91 we continued to work in six regions but involved a greater number of districts and villages. The number of MTPs grew to 10,350, and millet MTPs were added to the program (Table 2).

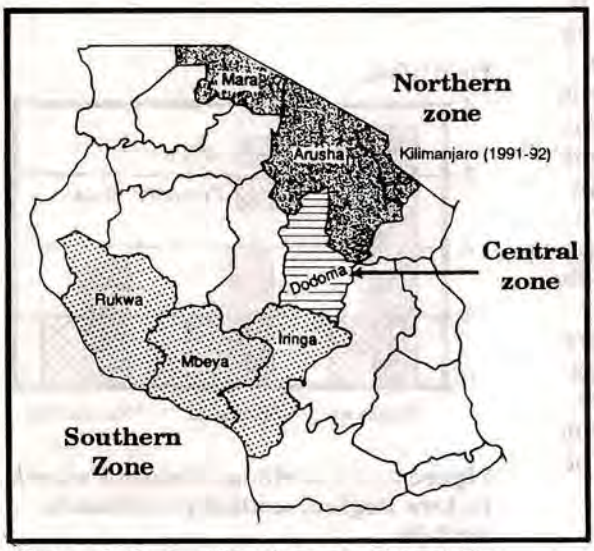


Figure 3. Operational zones of the SG 2000 field program in Tanzania.

The southern highlands—Field testing has been carried out in three regions of the southern highlands—Rukwa, Mbeya, and Iringa—where the elevation of MTP locations ranged from 1,800 to 2,400 masl. Average village MTP yields varied from 2.7 to 7.3 t/ha, with most villages recording mean yields in the range of 4 to 5 t/ha. Farmers' technology in the southern zone varies considerably. Many use improved seed and fertilizer and weed their fields twice; many also use an insecticide to control corn borers and fall armyworm.

Table 2. The MTP program, 1990-91

Region	No. of Districts	No. of Villages	Number of MTPs Maize	Sorghum	Wheat
Northern highlands					
Arusha	5	78	4,500	—	—
Mara	3	63	703	292	—
Central plateau					
Dodoma	3	22	79	586 *	—
Southern highlands					
Rukwa	2	23	895	—	15
Mbeya	3	19	985	—	10
Iringa	3	78	2,280	—	5
Total	19	283	9,442	878	30

* Of these, 201 are millet MTPs, in which the same agronomic practices were employed as in the sorghum MTPs.

Village mean yields of maize were 25 to 50% above the national average, reflecting the generally favorable production conditions in this zone.

In Rukwa region, where 100 maize MTPs were grown in 10 villages in 2 districts during 1989-90, average village yields in the MTPs ranged from 3.5 to 5.6 t/ha, compared to 1.5 to 1.9 t/ha on farmers' traditional plots (Figure 4). Mean village yields for wheat MTPs in this region ranged from 1.8 to 3.7 t/ha, compared to 0.8 to 1.5 t/ha for farmers' traditional plots (Figure 5). In Mbeya Region, where 100 maize MTPs were grown during 1989-90 in eight villages in two districts, mean village yields of the MTPs ranged from 2.9 to 6.2 t/ha, compared to 1.7 to 2.8 t/ha on farmers' traditional plots. (Figure 6). In Iringa Region, where 320 maize MTPs were grown during 1989-90 in 30 villages in two districts, average village yields of the MTPs ranged from 2.7 to 7.3 t/ha, compared to 1.8 to 3.0 t/ha on farmers' traditional plots (Figure 7).

The central plateau—During 1989-90 the Kilimo/SG 2000 Project began working in Dodoma Region on the central plateau, a dry area where

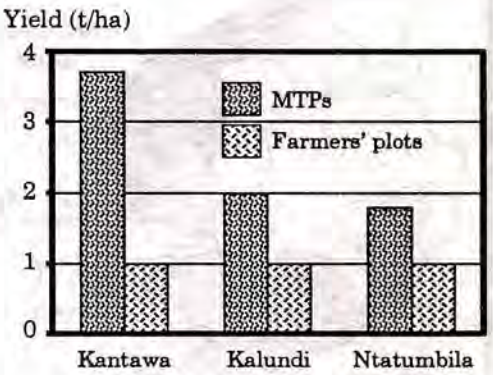


Figure 5. Mean village yields of wheat, Rukwa Region, southern highlands, 1989-90.

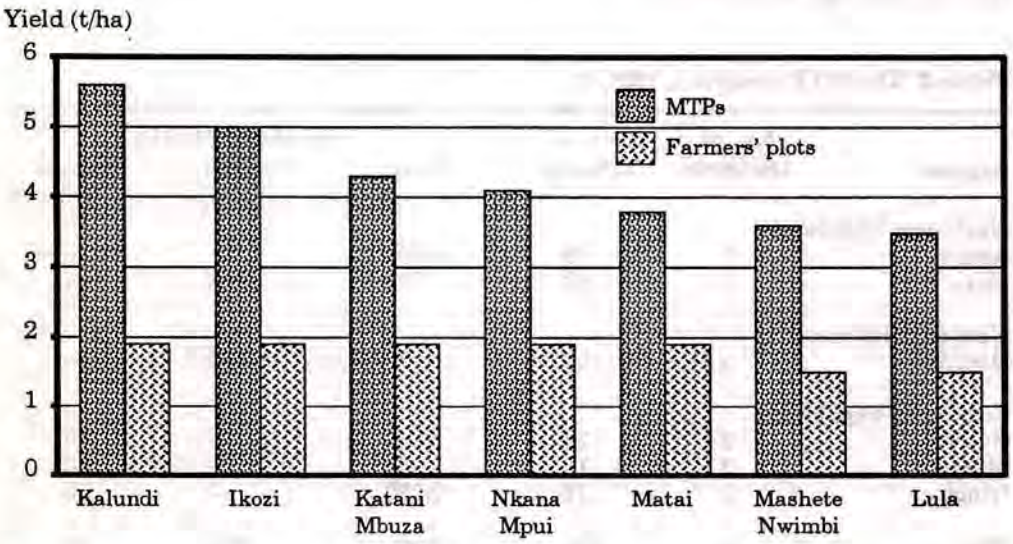


Figure 4. Mean village yields of maize, Rukwa Region, southern highlands, 1989-90.

improved sorghum production is being promoted. Some 90 sorghum MTPs were planted during that period in nine villages in two districts. Mean village yields for the sorghum MTPs ranged from 0.5 to 1.9 t/ha, compared to 0.3 to 0.4 t/ha for farmers' traditional plots (Figure 8).

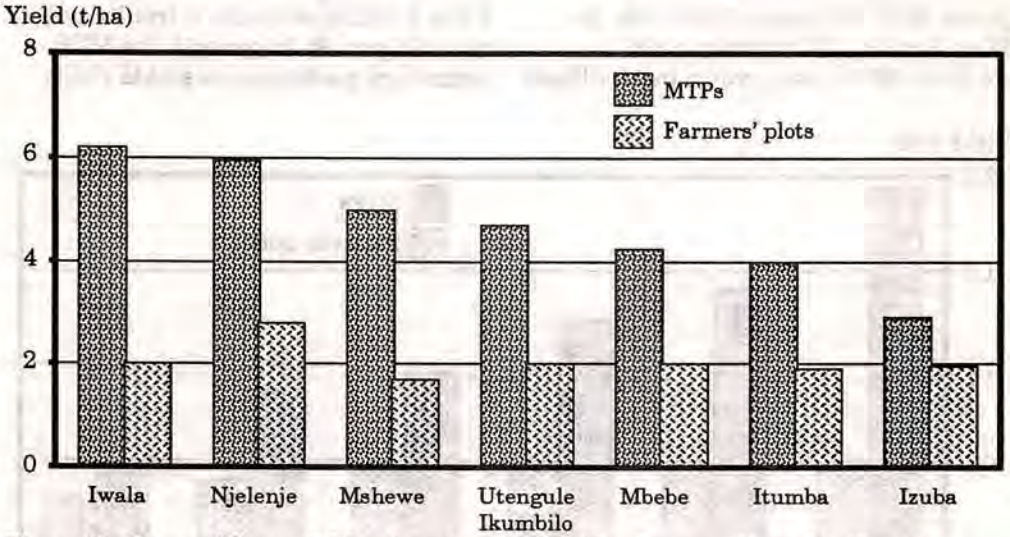


Figure 6. Mean village yields of maize, Mbeya Region, southern highlands, 1989-90.

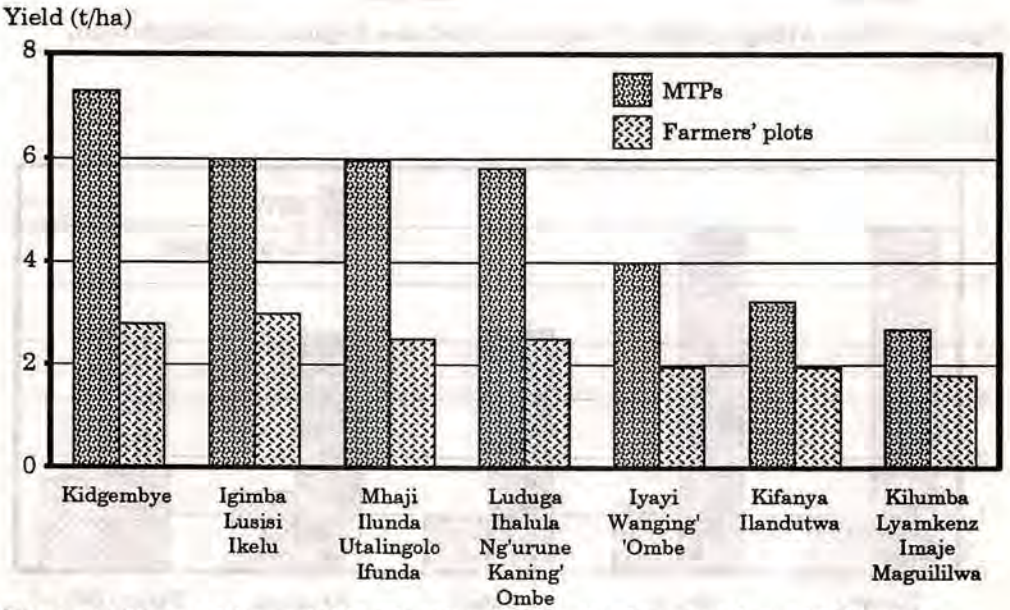


Figure 7. Mean village yields of maize, Iringa Region, southern highlands, 1989-90.

The northern highlands—During 1989-90 the project operated in two regions of the northern highlands, Arusha and Mara, where both maize and sorghum MTPs were established. In Arusha Region, 877 maize MTPs were grown in 37 villages in 5 districts. In Mara Region, 177 maize and 100 sorghum MTPs were grown in 24 villages in a single district. Maize or sorghum was monocropped in all of these plots.

Average district yields of the maize MTPs in both regions ranged from 4.1 to 6.0 t/ha during this period, compared to 0.9 to 1.6 t/ha for farmers' traditional plots (Figure 9). In general, the MTP technology package gave stable yields

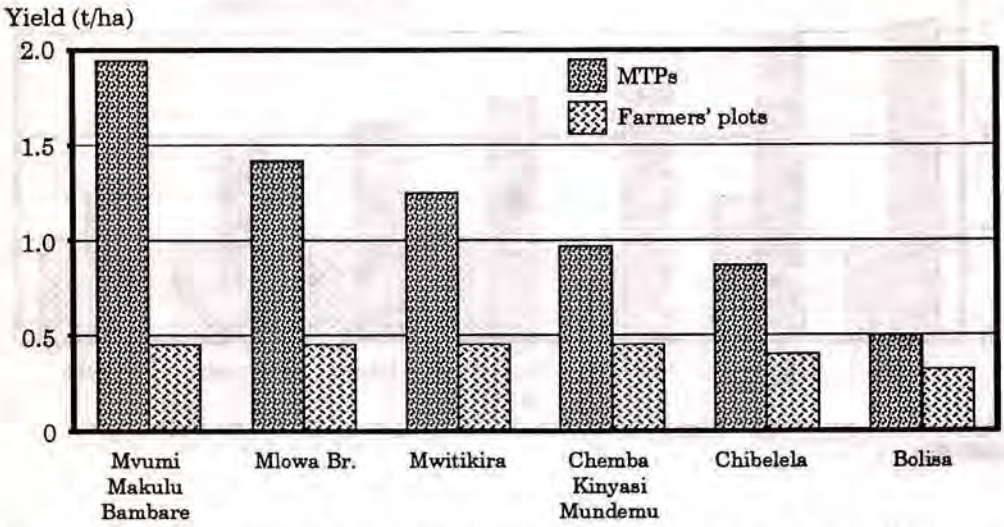


Figure 8. Mean village yields of sorghum, Dodoma Region, central plateau, 1989-90.

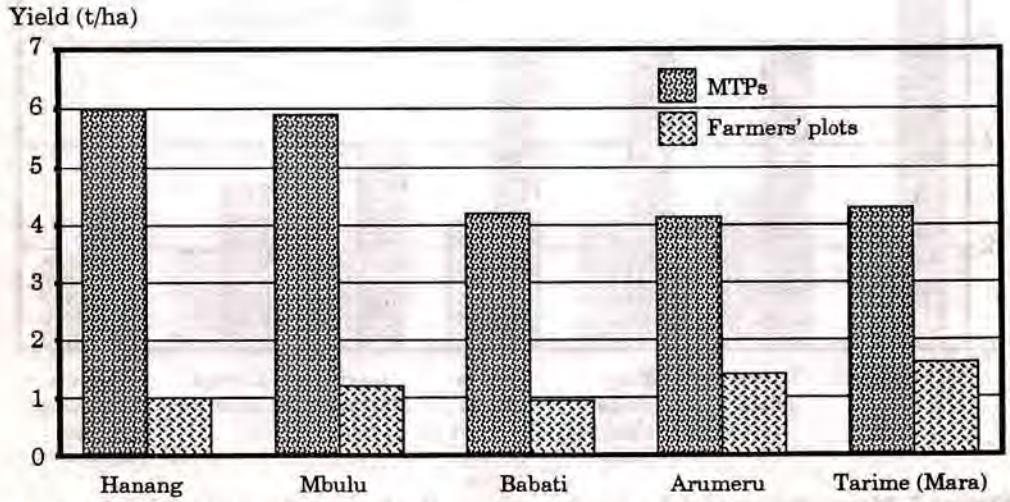


Figure 9. Mean district maize yields, Arusha and Mara Regions, northern highlands, 1989-90.

across regions. Variation in the mean district yields of the northern highlands reflects differences in precipitation. Thus, whereas Hanang District had 1,700 mm of rainfall, it was 1,200 mm in Daudi Subdistrict of Mbulu District. Within districts variation in village mean yields between MTPs and farmers' plots can be explained by differences in planting dates and by the higher plant populations of the MTPs.

Sorghum is grown in Mara Region at the transitional elevations along the shores of Lake Victoria. Mean village sorghum yields ranged from 0.5 to 1.8 t/ha for the MTPs, compared to a mean district yield of 0.3 t/ha for farmers' traditional plots (Figure 10).

Economics of the MTP packages— Economic analysis of the maize MTP package was performed using mean yield data from Mbeya Region (Table 3). At current prices this technology shows a highly profitable rate of return. The cost of the inputs in 1989-90 was only about $19/acre because of considerable subsidies. Fertilizer was selling at only about 30% of the international price (cif Dar es Salaam). Seed was also subsidized, especially that of hybrids, which are sold by the Tanzania Seed Company (TanSeed) at virtually the same price as an improved OPV. On the other hand, the minimum guaranteed price for maize in 1990 was about $67/t, roughly half the world price (cif Dar es Salaam).

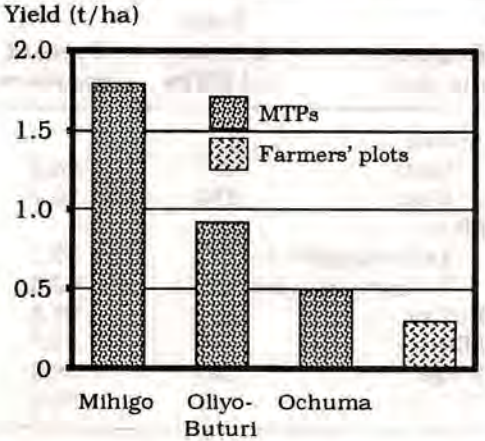


Figure 10. Mean sorghum, yields, Tarime District, Mara Region, 1989-90.

Table 3. Partial budget analysis of maize production technology in Mbeya, Tanzania, 1990

	Traditional	Recommended
Grain yield:		
kg/acre	800	2,200
kg/ha	2,000	5,500
Variable costs:		
Seed (shillings/acre)[a]	—	1,190
Fertilizer[b]		
Shillings/acre	—	2,500
US$/acre	—	13
US$/ha	—	33
Additional labor[c]		
Person-days/acre	—	10
@ 100 shillings/day	—	1,000
Total		
Shillings/acre	—	4,690
US$/acre	—	24
US$/ha	—	59
Gross value of output:[d]		
Shillings/acre	10,400	28,600
US$/acre	53	147
US$/ha	132	362
Marginal rate of return to additional investment (%)		288

[a] TanSeed hybrid or OPV, one 10-kg bag/acre.
[b] Two 50-kg bags of urea (@Sh 1,600) and one 50-kg bag of triple superphosphate (@Sh 900). Prices include a 38% fee for handling and transportation.
[c] For fertilizer application, harvesting, shelling, and transport.
[d] At the 1990 floor price of Sh 13,000/t or US$67/t.

The economics of the sorghum MTP package are also highly favorable at current prices, giving farmers an excellent return on their investment (Table 4). Since the recommended fertilizer dosage for sorghum plots is only half that for maize and sorghum seed costs much less, the total cost of the package is only about US$7.40/acre.

Repayment of MTP loans—Of the 1,761 farmers who received input loans during 1989-90, over 96% repaid them in cash after harvest (Table 5). Variation in recovery rates among districts and regions can been explained largely by natural phenomena, such as flooding and drought. The high rate of loan recovery reflects the highly favorable economic returns received by growers who use the MTP technology. Another factor was the manageable size of the MTP program. Experience in other SG 2000 Projects has shown that, when the MTP program becomes too large, it quickly turns into an easy credit program for commercial producers. As soon as that happens, the MTPs lose their teaching function, and extension staff become input distributors and credit officers rather than agents of technology transfer.

Table 4. Partial budget analysis of sorghum production technology in Dodoma, Tanzania, 1990

	Traditional	Recommended
Grain yield:		
kg/acre	180	480
kg/ha	450	1,200
Variable costs:		
Seed (shillings/acre)[a]	—	200
Fertilizer[b]		
Shillings/acre	—	1,250
US$/acre	—	6
US$/ha	—	16
Additional labor[c]		
Person-days/acre	—	5
@ 100 shillings/day	—	500
Total		
Shillings/acre	—	1,950
US$/acre	—	10
US$/ha	—	25
Gross value of output:[d]		
Shillings/acre	4,500	10,800
US$/acre	23	53
US$/ha	57	137
Marginal rate of return to additional investment (%)		223

[a] The improved variety Tegemeo or landrace Weigita, one 7-kg bag/acre.
[b] One 50-kg bag of urea and half of one 50-kg bag of triple superphosphate.
[c] For fertilizer application, harvesting, threshing, and winnowing.
[d] At the 1990 floor price of Sh 9,000/t or US$46/t.

Table 5. Recovery of input loans for MTPs in Tanzania, 1989-90 (as of April 1991)

Region/ district	Total number of MTPs	Percent recovery
Arusha		
East	466	94.3
West	354	89.7
Mara		
Tarime/highland	177	96.1
Tarime/lowlands*	100	69.8
Rukwa	100	97.0
Mbeya	100	98.0
Iringa	320	96.0
Dodoma	90	60.0

* Because of flooding, which is very common in this area, only 26 out of 100 sorghum MTPs survived.

Future Directions

The MTP program—In the 1991-92 season, the MTP program will expand to a seventh region—Kilimanjaro. We hope to have some 10,000 to 15,000 plots in all regions where the program operates, but the exact number will depend upon the availability of funds and the rate of loan recovery for the 1990-91 MTP program. While introducing MTPs in new villages, we have no plans to expand the program beyond the seven regions already designated. Our feeling is that the current size is about right, given the available human and financial resources.

We are taking a number of steps to fine-tune the MTP model for technology diffusion. It has become quite apparent that, if the MTPs are too numerous, managing them becomes a burden for village extension officers, especially in view of their still-limited mobility, sizeable responsibilities for input distribution and credit collection, and other demands on their time. Extension officers simply cannot devote full time to the field testing program.

The optimum number of MTPs for effective management varies from one area to another, depending on a number of factors, including the extension worker's degree of mobility and the level of organization among farmers in participating villages. In the first year or two of the MTP program, a village extension worker ought not have to manage more than 10 to 20 plots. In the next two years, he or she should be able to handle a fivefold increase in the number of plots, since the original farmer-cooperators can be expected to assist in training new participants. We have not yet determined the optimum number of MTPs within a given area. Certainly, there have to be enough to promote technology diffusion and encourage the formation of farmers associations for collective action. On the other hand, if the plots are too numerous within a village, farmers become overly dependent on the MALDC (expecting it to provide inputs on a continuing basis) and are thus discouraged from forming grass roots organizations for input supply.

The overall extent of the MTP program is another issue that requires further examination. If we attempt to work simultaneously in too many villages, districts, and regions, with relatively few plots per extension worker, it could become much more difficult to organize, implement, and finance the training programs and distribution of inputs. Nonetheless, our ultimate aim is to introduce the MTP model for technology transfer across the entire MALDC extension service. Doing so will require that we find ways of achieving an institutional multiplier effect, working with MALDC and international donor organizations.

A further challenge is to collect more comparative yield data from the MTPs and farmers' traditional plots. National research organizations should participate in gathering this information, since it provides them with feedback on the biological and economic suitability of the varieties and technology packages they are recommending to the extension service for promotion among farmers. A good database on yield performance will also be very useful to agricultural policy makers for defending increased investments in agriculture against competing commitments in other sectors of the economy.

At present the government of Tanzania intends to reduce—and perhaps eventually remove—the current

subsidies on fertilizers and improved seeds. As these policies are enacted, the economics of the MTP package will change. It will then be necessary to develop more area-specific recommendations on fertilizer use and other technology components to ensure that farmers are obtaining the economically optimum yields from their plots.

New crops and cropping systems—At the outset of the MTP field program, we focused primarily on improving maize productivity and secondarily on sorghum. While continuing to give these crops major emphasis, especially maize, we have also added new crops and cropping patterns to the program. Wheat was added in the 1989-90 season and pearl millet in 1990-91. In 1991-92, we hope to include blight-free Irish potatoes as well.

Groundnuts, cowpeas, and soybeans are also undergoing preliminary testing in certain districts of the southern highlands and may eventually be added to the MTP program. As improved technologies become available for other crops and cropping systems, the program will continue to evolve. Improved intercropping systems—especially between maize and grain legumes, such as field beans or cowpeas—have much to offer the small-scale, resource-poor farmer. They can increase food security for farm families, help maintain soil fertility, and contribute to integrated pest management. The incorporation of new crops and cropping systems into the MTP program will be carried out in collaboration with national and international crop research organizations operating in Tanzania. The Kilimo/SG 2000 Project will serve as a link between farmers and researchers in the on-farm adaptive research component of technology generation and validation.

Farmers associations—The Tanzanian government's past efforts to organize farmers into cooperative unions did not meet with much success. Part of the problem, as suggested earlier, was the top-down approach that characterized these organizations. Membership in the cooperative unions was compulsory, and they were the only means by which farmers in a village could obtain inputs and market crop surpluses. In the government's current strategies for rural and community development, participation in cooperative societies is no longer mandatory. Farmers are free to form associations with whom they wish and are free to market their surplus grain as they see fit. Even so, government policy does encourage farmers to organize themselves into voluntary associations and cooperatives for the purpose of developing local savings and loan societies and agricultural production services, with particular emphasis on input acquisition and crop marketing.

The Kilimo/SG 2000 Project considers collective action to be extremely important for the long-run development of small-scale agriculture, and we therefore support the development of voluntary farmers associations. MTP collaborators in a village are a potential nucleus for the formation of such groups. As we become more involved in promoting their development, we will most likely focus on providing technical advice and training in organizational management. Much of this work will probably be carried out in collaboration with other organizations with more experience in the development of farmers associations.

National technology delivery systems—Improved technology is a central prerequisite for accelerated agricultural development in Tanzania, but it is hardly the only one. In addition, the national systems for technology delivery and crop marketing must be modernized and strategies developed for integrating the small-scale producer more completely into commercial agricultural systems. SG 2000 Project staff believe that the MTP model must be at the center of MALDC's future activities in technology transfer and that it should be managed by the extension service. Well-defined rules must be established as to who can participate and for how long with a given technology or crop. Careful monitoring of yield data and the economics of the recommended package, along with input loan recovery, are also important elements in managing the MTP system.

The Kilimo/SG 2000 Project is interested in testing several organizational models for input delivery at the village level. One option is to rely on farmers associations or cooperatives. It remains to be seen whether such groups are capable of obtaining inputs and marketing crops on a collective basis. Another possibility is the private village distributor of seed, fertilizers, and agrochemicals. The project plans to test the viability of these two approaches in selected areas on a pilot basis. Both types of organizations will receive training and some financial support.

Extension training—Within MALDC some 6,000 individuals are involved in extension, of which nearly 4,000 are responsible for providing farmers with technical assistance aimed at improving the productivity of the resources they commit to crop production. Most of Tanzania's extension workers are certificate diploma graduates from an intermediate-level technical agricultural school. Continuing in-service training is essential for keeping these agents of technology transfer up-to-date on new research results.

Such training figures importantly in the MTP program. Extension agents receive instruction in the technical aspects of the recommended production package and in program management. Extension training can readily be integrated into the Training & Visit (T & V) system, in which extension workers attend periodic meetings and training sessions with subject matter technology specialists. Extension agents will frequently need training in data collection and analysis to ensure that these important tasks are performed reliably and systematically. Records of MTP yields and of the creditworthiness of participating farmers must be maintained in a database to guide future decision making in the program.

Research-extension-production links—The links between national research organizations and those involved in agricultural education and production are tenuous indeed in Tanzania. Though research budgets have always been meagre, in recent years funds permitting researchers to travel beyond the experiment station have all but dried up. As a result, researchers cannot conduct adequate on-farm research and technology validation trials or interact frequently with extension officers. The latter operate under severe financial constraints as well. A scarcity of funds for on-the-job training and travel expenses has greatly limited the ability of extension officers to visit farmers and carry out field demonstration programs. Nor are they able to visit researchers at the experiment stations and collaborate in on-farm research and technology

generation. Neither research nor extension organizations have adequate budgets and institutional linkages for providing feedback to input suppliers, who thus have no means of determining the demand for seed of specific genotypes, the type and quantity of fertilizer needed, and the requirement for agrochemicals to be used in plant protection.

Input delivery—At present two parastatal organizations—the Tanzania Fertilizer Company (TFC) and the Tanzania Seed Company—along with the private Tanzania Farmers Association (TFA) are responsible for virtually all production, procurement, and distribution of agricultural inputs. Marketing of inputs has been affected by distribution bottlenecks of several types. Parastatal input supply organizations lack the operating capital to transport sufficient quantities of inputs on a consignment basis to many regions. Moreover, though input distribution centers are found in the regional capitals and in a few district capitals, there are almost none in the smaller towns. Marketing of fertilizer and seed is also hampered by poor systems for forecasting demand at the regional level. In many regions inputs are often delivered too late because of competing demands to transport other higher value goods on the limited railroad and trucking systems from Dar es Salaam to the interior.

Quality control is another problem that has plagued the seed industry. In 1990 TanSeed had a maize seed inventory of approximately 10,000 t but was able to sell only 3,000 t, despite a considerable price subsidy. Farmers often complain that the seed of TanSeed hybrids and varieties is not true to type and has a low germination percentage. The possibilities for more effective distribution of improved seed are well illustrated by the experience of a transnational maize seed company, which started operating in Tanzania in 1989. Even though its maize hybrids cost twice as much as TanSeed hybrids (with equal or better yield potential), the private seed company was able to sell all of its seed production in 1990-91, while TanSeed carried forward a huge inventory. Admittedly, the quantity of seed produced by the private company was much smaller and was targeted for specific areas with high demand, but the quality of the privately produced seed was clearly superior.

Because of the combination of poor seed marketing systems and quality control with low fertilizer use, only 15% of Tanzania's total maize area is planted to improved genotypes, compared to 95% in Zimbabwe, 65% in Kenya, and 55% in Zambia. Until a more dynamic national seed industry is established in the country, many of the potential benefits from national and international plant breeding research will fail to reach farmers. The Kilimo/SG 2000 Project sees three ways of helping to support the development of Tanzania's seed industry. First, by demonstrating and promoting the use of new OPVs and hybrids under improved crop management, the project's MTP program can help increase commercial seed demand. Second, with their links through the extension service to farmers groups, project staff can help seed producers forecast the seasonal demand for seed, an essential step for developing a good seed marketing program. Third, the project could provide national seed producers with technical assistance and training in ways of improving quality control.

Grain marketing systems—As Tanzania increases its production of food crops, the national grain storage system will have to be expanded to handle

distribution of larger volumes of food grains. In the interests of national food security, the central government will have an important role to play in organizing large-scale grain storage at the regional and district levels. Private grain traders should be encouraged to expand their grain storage capacity as well.

Improvements must also be made in farm-level grain storage to reduce postharvest grain losses caused by insects, rodents, and diseases and to give farmers a longer period in which to market surplus grain. Holding part of the crop on the farm should reduce price fluctuations, especially just after harvest, when grain prices typically drop as surplus production is put on the market. In 1991-92 the Kilimo/SG 2000 Project expects to launch a training and demonstration program on postharvest grain technology mainly to assist former MTP participants in designing and building better grain-storage structures and in adopting procedures that will allow them to store grain longer without pest damage.

Conclusion

With its favorable climate and vast, still untapped land and water resources, Tanzania has great potential for agricultural development. To realize this potential, considerable new investments will have to be made in the nation's rural transportation and marketing infrastructure, and stronger links will have to be established in the chain of organizations, activities, and policies that comprise the technology delivery system.

Tanzania's new economic development strategy envisions a much expanded role for the private sector. Entrepreneurs are already becoming more involved in input supply, especially of improved seed, fertilizers, and crop protection chemicals. One private seed company has begun to operate in the country, and its products have been well received. Farmers are now free to sell their agricultural products to the highest bidder.

The government still has a central role to play in agricultural development. Agricultural research and extension programs for small-scale farmers will continue to be carried out in large part by public organizations. An important challenge for public officials will be to find ways of making these institutions more effective. Over the next few years, the Kilimo/SG 2000 Project will pursue its keen interest in helping MALDC to institutionalize the MTP model within the extension service as a key element in its strategy for technology transfer. The project also hopes to serve as a catalyst for mobilizing increased funding from national and international sources for agricultural development. We are convinced that through the joint efforts of many, a green revolution can take place in Tanzania.

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An Evaluation of the Sasakawa-Global 2000 Project in Ghana

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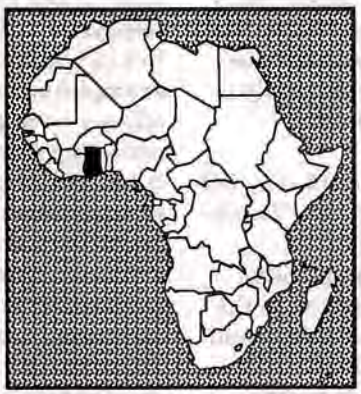

The Sasakawa-Global 2000 (SG 2000) Project in Ghana was started in 1986 at a time when there was prevailing pessimism about the state of African agriculture, especially food production. The purpose of the project was to facilitate and promote increased food production by testing, adapting, and applying many of the lessons that had been learned from successful transfer of technology to farmers in Asia. The project's goals and objectives have evolved as the project itself has developed. Initially, it was based on the hypothesis that African farmers, specifically small-scale farmers in Ghana, would respond to opportunities for increasing the production of food crops. For this to happen, though, a number of necessary conditions had to be fulfilled:

1. There had to be an appropriate technology that would permit farmers to break out of the traditional low-yielding mode of production. This technology had to be well tested and suitable for use by small-scale producers, and it had to give visible results.
2. There had to be a suitable technique for diffusing knowledge and a means of convincing farmers that the technology was feasible and profitable.
3. There had to be a system in place whereby farmers who used the technology could purchase whatever off-farm inputs were needed when and as they were required.
4. Farmers needed adequate incentives to accept technological change. This required a market in which any increased output could be sold at a price that would give producers a reasonable return for their labor.

The SG 2000 Project took the view that there was adequate technology for increasing yields of two important cereals—maize and sorghum—both of which were in short supply. This technology had been developed by Ghanaian scientists with support from the international community, especially the International Maize and Wheat Improvement Center (CIMMYT), International Institute of Tropical Agriculture (IITA)—both with support from the Canadian International Development Agency (CIDA)—and German Agency for Technical Cooperation (GTZ). Research in Ghana

* The authors are members of an evaluation mission that reviewed the SG 2000 Project in Ghana during January 1991. This paper is a much-condensed version of their report.

had shown that improved varieties of maize and sorghum, when used with fertilizers, could increase yields considerably. Even so, the technology was not widely used. The reason for this was believed to lie in the weakness of the process of diffusing knowledge and in the distribution of inputs. Consequently, the strategy of SG 2000 was designed to help the government extension service spread information and subsequently to help in the distribution of inputs.

The process of diffusion supported by SG 2000 was heavily influenced by a "hands-on" philosophy. Farmers who participated in the program agreed to cultivate part of their holdings with the recommended, improved technology and the remainder under traditional methods. The area farmed under the improved technology was designated a Production Test Plot (PTP), which was large enough (1 acre) to test the technology and provide a contrast with the area planted under the traditional method. The PTP was closely monitored for a season by extension officers, who advised the farmers on such matters as row planting and the timing of fertilizer applications. The contrast between the PTP and the traditional plot was intended to convince farmers that they should continue to use the recommended technology after the first year when support from the program ended. Where possible, a multiplier effect was to be obtained by developing "clusters" of farmers around a participant in the PTP program, in the expectation that these farmers, too, would adopt the recommended technology.

Many farmers who wished to join the program apparently did not have the means to acquire the inputs (mainly seed and fertilizer) involved in the technology package recommended by SG 2000. Consequently, the project became involved in arranging for banks to extend credit to selected farmers and provided funds from its own resources for this purpose as well. In addition, as the program evolved, SG 2000 arranged for delivery of inputs to selected farmers in remote areas. These activities were undertaken by extension officers. Repayment of loans for inputs could be in kind (initially two bags of maize, for example) or in cash. The extension officers were given responsibility for collecting repayments. When farmers opted to repay in kind (as was the case when relative prices of fertilizer and grain favored this option), then the extension officer and SG 2000 were responsible for storing and marketing the grain. In effect, SG 2000 worked with the extension service to fill a vacuum created by a lack of institutions providing credit and inputs to small farmers. Needless to say, the opportunity for access to credit and services added to the program's attraction and placed a great deal of authority in the hands of those who selected participants.

A Description of the Project

The Sasakawa Africa Association (SAA) is the umbrella organization for all the Global 2000 programs in Africa, including those in Ghana. The board of directors, which provides guidance and leadership, consists of representatives from the Sasakawa Foundation and the Global 2000 program at the Carter Center. Overall technical guidance is provided by the president of the SAA, who is also the senior agricultural advisor to Global 2000 and who resides outside Africa. Within Ghana responsibilities for the introduction and development of the program are allocated on a geographical basis by dividing the country into three zones: northern, central, and southern. Each

zone is headed by a senior agricultural scientist, and the program is coordinated by a country director. These four scientists are assisted by a support staff of 18, located in Accra.

A national advisory panel links the SG 2000 Project to relevant government agencies and organizations, including the Crops Research Institute, the organizations concerned with fertilizers and seed supply, and the rural banking system. In its operations SG 2000 cooperates closely with the Ministry of Agriculture and in the field works principally with the Department of Extension and more than 2,000 extension workers located throughout the country.

SG 2000's budget in Ghana was US$5.4 million for the project's first five years (1986-90), excluding the cost of SAA and Global 2000 headquarters management and support staff. The annual operating budget ranged from $591,000 in 1986 to $2.0 million in 1989 and $1.18 million in 1990 or an average of about $1 million a year. This budget covered expenses related to supplies, vehicles, local staff, and office support and included about $300,000 for a revolving fund to finance inputs for use on production test plots. SG 2000 also has a discretionary fund, which has been used to assist extension officers through the provision of field equipment, boots, grain-moisture testers, measuring tapes, and interest-free loans to buy bicycles and motor bikes. The budget has also been used to enable Ghanaians to attend seminars and conferences.

The Project's Performance

The program started in the northern zone in 1986. The following year it expanded to the Central and Southern zones. By 1988 the program was operating in all 10 of Ghana's administrative regions. As can be seen in Table 1, the number of participants in the program expanded very rapidly,

Table 1. Farmer participation in SG 2000, 1986-90

Zone/region	1986	1987	1988	1989	1990*
Northern					
Upper West	20	1,000	7,001	13,969	1,500
Upper East	—	365	3,200	10,000	1,500
Northern	20	125	1,561	10,977	2,000
Central					
Brong Ahafo	—	20	1,362	12,626	2,000
Ashanti	—	44	820	9,837	2,000
Southern					
Western	—	—	35	422	1,500
Central	—	25	475	6,369	1,500
Greater Accra	—	—	11	285	1,500
Eastern	—	44	569	3,713	1,500
Volta	—	21	700	10,000	2,000
Totals	40	1,644	15,734	78,218	17,000

Note: These data are based on SG 2000 records of farmers who received credit.
* Estimates.

rising from a modest base of 40 in 1986 to 1,644 in 1987 to over 15,000 in 1988 and then leaping to nearly 80,000 farms in 1989 before falling back to an estimated 17,000 farms in 1990.

While the number reached indicates the scale of the program, it says little about its effectiveness. The criterion used to assess the performance of the testing program was the impact of the technology on yields. As the program expanded, becoming more of a demonstration-development effort, and as the loan component assumed increasing significance, the loan-repayment rate became an additional measure of the success or otherwise of the program. No attempt was made to measure the impact of the technology on users' net incomes.

In 1986, the first year, when only 40 PTPs were planted, yields were measured by harvesting the whole plots. As the numbers expanded in subsequent years, it was impossible to harvest and weigh the whole plot, so yield was determined by means of a sampling technique, using three 10-m^2 plots per PTP. Over time the proportion of all plots sampled for yield dropped from 100% in 1986 to 84% in 1987 and to 60% in 1988; thereafter systematic recording of yields ceased, and no measurements of yields were made for 1989 or 1990.

In 1986 and 1987, an average of 15 farmers were under one field extension officer. This close supervision enabled extension staff to make regular visits to the PTPs and to organize field days for neighboring farmers; the PTP appeared to be a good vehicle for testing and disseminating technology. As shown in Table 2, yield increases in the PTPs in 1986 and 1987 were encouraging; with close supervision the recommended technology appeared to be capable of doubling the yields of maize and more than trebling the yields of sorghum. The yield increases in 1988 were based on less "representative samples" than those in 1986 and 1987; nonetheless, as can be

Table 2. Maize and sorghum yields in PTPs and farmers' plots, 1986-1988

Zone	Sorghum yield (t/ha)		Maize yield (t/ha)		No. of farmers whose yields were measured		
	PTP	Farmer	PTP	Farmer	Sorghum	Maize	Total
1986							
Northern	2.4	0.26	3.2	1.7	20	20	40
1987							
Northern					1,390	75	1,465
Central						60	60
Southern						90	90
Average	2.0	0.50	3.0	1.5	1,390	225	1,615
1988							
Northern	1.5	0.98	3.1	1.2	6,260	1,437	7,697
Central			4.3	2.5		993	993
Southern			4.1	2.0		938	938
Total					6,260	3,368	9,628

seen in Table 2, more than 9,000 reported observations indicated that there were substantial increases in average yields of both maize and sorghum, though these were lower than in the preceding two years.

Through 1986-88 credit recovery was also considered to be satisfactory (Table 3.) In 1986 and 1987, the rate was 100% and 95%, respectively, but then it dropped to 77% in 1988. This lower performance, largely confined to the northern zone, was attributed to mismanagement of loan recovery. Appropriate measures were taken to correct this situation, and the lower recovery rate was judged to be an aberration rather than a structural problem.

The initial increases in yields and the satisfactory rate of recovery inspired confidence in the appropriateness and profitability of the recommended technologies. Despite the misgivings of some of the SG 2000 staff that the delivery system would be unable to cope with a much enlarged program, it was agreed to include 80,000 farmers in 1989 and, all being well, to go beyond that—possibly reaching as many as 200,000 or more—in 1990.

Table 3. Credit recovery rate, 1986-89

Year	Zone	No. of farmers	Recovery rate (%)
1986	Northern	40	100
	Total	40	100
1987	Northern	1,490	94
	Central	64	100
	Southern	90	99
	Total	1,644	95
1988	Northern	11,762	73
	Central	2,182	81
	Southern	1,790	90
	Total	15,737	77
1989	Northern	34,946	66 *
	Central	22,463	17 *
	Southern	20,809	28 *
	Total	78,218	39 *

* As of January 1991.

The decision to enlarge the program modified SG 2000's initial purpose. From a field testing and demonstration program, it was to be changed into a substantial production campaign involving some 80,000 farms. Since the enlarged program exceeded SG 2000's operating budget, which authorized financing for only 25,000 plots in 1989, the Ministry of Agriculture and Ghanaian commercial banks were expected to assume the greatest share of responsibility for financing the purchase of inputs. This they did.

Because of the large number of participating farmers, SG 2000 was unable to monitor them closely or to measure yield increases. But the project did maintain records of the loans made, so the credit recovery rate is available as one quantitative, objective measure of performance. As shown in Table 3, the credit recovery rate dropped to 39% in 1989, a precipitous decline from previous years. To cover outstanding debts to banks, SG 2000 exhausted its revolving funds, built up from loan repayments in the previous year, and the Ministry of Agriculture incurred financial losses estimated to be about 272 million cedis or $800,000.

A number of reasons have been advanced to explain the low recovery rate; these vary by zone and region. The most frequently mentioned reasons have been bad weather, ranging from drought to excessive rainfall; postharvest grain

losses caused by inadequate storage; insufficient income resulting from low grain prices at harvesttime; and use of grain sales proceeds to cover family expenses rather than debt repayment. Some of these reasons—including rising costs of production—may well be valid, but there is every indication that the large 1989 production program strained the capacity of the national extension service and SG 2000 staff to manage the logistics of dealing with so many small-scale farmers. This was especially the case with debt collection, a task for which the officers were neither trained nor equipped.

After the disappointing results of 1989, it was decided to scale back the 1990 program to about 20,000 farmers. The size of the program took into consideration the existing infrastructure and institutional constraints and was more in line with the SG 2000 Project's ability to monitor a testing and demonstration program. At the time of the evaluation mission's visit in January 1991, it was reported that some 17,000 farmers had participated in the 1990 program, though final results were not yet available.

Financing the agricultural credit component of the program in 1990 became problematic. The Ministry of Agriculture abstained from financing any part of it. The SG 2000 Project, which had lost its revolving fund because of the poor repayment rate in 1989, sought funds from Ghana's Agricultural Development Bank (ADB) to finance the purchase of inputs. As of January 1991, out of the 192 million cedis borrowed in 1990, there remained an outstanding amount of 133 million cedis (around $400,000) due in March 1991.

Project Evaluation

The time frame of the SG 2000 Project in Ghana is too short to measure any sustained impact on production, but it has been long enough to highlight the potential for increased production and to emphasize the need to strengthen many rural institutions if that potential is to be fulfilled. Despite its brief life, though, it is clear that the project has already had a salutary impact on the attitudes and approaches to increasing food production in Ghana and elsewhere. The initial hypothesis has been tested in the field. There is indeed a technology that can increase yields of maize and sorghum. The project has demonstrated that small-scale food producers are responsive to opportunities and that they will adopt technological change when recommended inputs are available and when there is an adequate economic incentive for them to do so. The early results of the project have helped to dispel some of the pessimism about the potential for increased food production in Ghana and elsewhere in Africa. The project has encouraged several African governments, including that of Ghana, to take a very positive view about increasing investments in the smallholders food sector, particularly through support for the extension services.

The SG 2000 Project has also had a beneficial impact on the attitudes of major donors to Ghana. The World Bank, which has already supported Ghanaian agriculture, cites progress made under the project as an indication of the technological basis for future loans to help small-scale farmers increase food production. The Bank has also profited from lessons learned from the project in designing its agricultural loans to Ghana. In addition, the SG 2000 Project

has influenced the US Agency for International Development (USAID), especially in relation to its support of the rationalization of the fertilizer industry and distribution of fertilizer. The Canadian and German aid programs have also seen SG 2000 as an important factor in justifying the continuation of their support for agricultural research.

The technology transfer model—The SG 2000 Project's model for technology transfer appears to have been well conceived. The use of PTPs to promote the active participation of farmers in applying improved technology (under the direction of extension workers) has worked very well as a testing and demonstration/education tool. The size of the PTP (1 acre) appears to have been appropriate and acceptable to the farmers involved. The model seems to work most effectively when there is a ratio of around 1 extension agent to 10 or 15 farm families, thus making it skill intensive. The ratio, of course, is much improved when one extension agent deals with a single farmer, who in turn demonstrates the new technology to others. However, there is little substantive evidence that a large number of groups have benefited from this kind of arrangement. When the ratio of farmers to extension officers has increased or when agents have become too preoccupied with other activities, the model is reported to have been less effective, and the positive impact on farming has tended to decline.

There are four ways in which the testing and demonstration of this program could be strengthened. These are as follows:

1. *The methods used for sampling and measuring yields need to be improved, as does the standard of reporting data.*

Reports for the Central region in 1988 showed that the mean yields of maize were approximately 4.3 t/ha in the PTPs and 2.5 t/ha in farmers' plots. In the Southern zone, the corresponding figures were 4.3 t/ha and 1.9 t/ha. Yield increases, however, varied from less than 20% to nearly 500%, and the variation within districts seemed as great as that among them. Unfortunately, the reports do not give information on the cropping history of the plots, farming practices, land tenure, or other factors that would permit stratification of the results and provide a better understanding of the reasons for the wide variability in yields. These results can best be obtained by having sound subsampling of fewer plots but with better records.

2. *There is a need for greater flexibility in the design of the PTPs.*

Currently, the PTP is closely supervised by an extension agent for one season—too brief a period for testing production packages that should incorporate crop rotations and mixed cropping as part of a desirable program of improving soil fertility. This applies with particular force in the forest zone, where there is more mixed cropping than in the transition zone, with its emphasis on monocropping. A longer period of testing is also needed, both by farmers and their advisors, to determine the best way of using fertilizers in good years and bad. There is ample international experience to support this view.

3. *The recommendations for fertilizer application need refinement.*

Originally, a single fertilizer recommendation was used for all maize plots in all areas, and another blanket recommendation was used for sorghum. Yet many trials over the past four decades have shown marked differences in response, depending on the agroecological zone and previous cropping history. Though some modifications have been made in the fertilizer recommendations, there is now a need for further refinement, possibly on a district basis, as well as for experimentation with more concentrated fertilizers. This has become all the more imperative because of the very substantial increase in the cost of fertilizers and the urgent need to develop packages that give the greatest economic return.

4. *To serve more effectively as a testing program, the PTP model must include economic analysis.*

This is all the more necessary because of changes that have taken place over the life of the project as the government has restructured the economy. During 1986-90, the combination of devaluation and removal of subsidies has raised the price of a 50-lb bag of compound fertilizer from 780 cedis in 1986 to 4,200 cedis in 1990. The cost of the PTP package, which is largely determined by the price of fertilizer, has tripled over the past five years. In the case of maize, it rose from 5,440 cedis in 1987 to 9,200 cedis in 1988 and 12,385 cedis in 1989. The package was estimated to cost around 15,600 cedis in 1990. Use of the package gave yield increments of four to eight bags per acre, with an average of slightly more than five bags; however, the average price paid for maize in the main markets has hovered around 5,000 cedis per bag. Farm budgets and partial budget analysis, using "representative data" from experiment stations and other sources, show that farmers' returns should have been very high in the early years of the program, ample in 1989, and adequate in 1990, when the cost of the package was three times higher than in 1986.

However, experience has shown that budgets based on representative or hypothetical data are often confounded by real-life problems, such as breakdowns in the distribution of inputs and outputs, late rains, and postharvest losses. Thus far, though, there appear to be no budgets based on actual costs of production and marketing in the field in Ghana. Consequently, there is no hard evidence of the economic returns to producers in different parts of the country using different mixes of the package. Farmers may or may not be receiving good economic advice.

Economic validation of the packages recommended to farmers is complicated by the fact that their actual returns depend a great deal on when they sell their harvest. There is consistent seasonal variation in prices, whereby prices for maize are much lower—often by two-thirds—in October-November than they are just prior to the next harvest season. There are also postharvest losses as a result of ineffective storage. Economic analysis is needed to determine whether access to effective storage and some form of inventory control can be put in place to give higher returns than those produced by relying on the immediate, postharvest market. In addition, economic analysis of farming operations may well point to the benefits that might be gained from encouraging greater labor-saving inputs in a country that—unlike Asia—has no shortage of cultivable land. Such

analysis might well indicate the desirability of testing in PTPs the use of animal-drawn equipment or small-scale mechanization as means of increasing farm size beyond the limited area that a family can cultivate relying solely on human labor.

The expanded program—The attempt to change the nature of the SG 2000 Project as a testing and demonstration program was not a success. The notion that a modest program could be "scaled up" without any institutional changes was a mistake that has many precedents. The attempt to reach nearly 80,000 farmers without any organizational changes strained the capacity of existing institutions. At the field level, the ratio of farmers to supervisors rose as much as tenfold; agents with multiple responsibilities under the program could not maintain the same level of supervision as before, nor could they cope with the expansion. Similarly, the managerial staff of the SG 2000 Project could not keep abreast of the expansion, nor could they continue to monitor the program as closely as they had in the past.

The most important negative indicator has been the relatively high rate of defaults on loans made to farmers under this program. Repayment rates fell dramatically. Most of these losses were absorbed by the Ministry of Agriculture and SG 2000. The losses included a substantial transfer of government resources to those participating in the program. If the beneficiaries were small farmers, this in itself was not necessarily undesirable. However, the extent of the losses has had a chilling effect on the banking system (and the government, which withdrew from financing PTPs) and has depleted the small revolving fund established by SG 2000 to help finance loans to farmers. Some losses undoubtedly included transfers of the kind that might not have occurred if there had been closer supervision. More importantly, though, the losses incurred through defaults were inimical to the spirit of the current economic recovery plan, which is intended to inculcate a sense of accountability and financial probity in the recovery of advances made to farmers. Credit was to be seen for what it is rather than a government subsidy or subvention. This has not happened.

A related problem stems from the manner in which the expanded SG 2000 program worked with the extension service. When the program began, extension was expected to work in harmony with credit- and input-supply institutions. The former was to provide information and guidance to farmers, while the latter provided credit and inputs. The banks were not prepared to serve the farm community, nor did the fertilizer distribution system have the capacity to supply many farmers. Consequently, the extension service filled the void; agents became heavily involved in selecting farmers to qualify for credits, ensuring that they received inputs as needed (often by purchasing fertilizer on their behalf and delivering it to the farmgate), and subsequently in collecting repayments and marketing the repayment when it was in kind.

The activity of the extension service thus involved an intermingling of roles: giving advice, providing inputs, and dealing with credit—including the collection of loans. The extension service substituted for other institutions that were unable to perform these activities. However desirable this was, and however important it may have seemed to be, it

exposed the extension service to great pressures derived from conflicting roles. When the service is devoting its time to activities other than providing instruction, it cannot play the role of "friend of the farmers" and debt collector. Collection of debts requires skills and attributes that are familiar to few of the extension agents. Further problems arose from the fact that the agents had a hand in designating which farmers were to be accepted by the SG 2000 Project and given access to low-cost credit and fertilizer supplies. Some of the agents reported that they came under heavy pressure to serve the powerful in this context.

The World Bank is about to make a loan for expanding the extension services; it will help the government spread a version of the training and visit (T & V) system throughout the country. The T & V system holds very strictly to the line that extension agents should *not* be involved in arranging and managing credit programs or in the distribution of inputs. The SG 2000 Project should support this approach but ensure that suitable arrangements are made for helping farmers in its own programs. This might well involve using the extension services on an interim basis in a much smaller testing program as well as testing experimental approaches with existing institutions, such as selected banks, cooperatives, or other groups. At the same time, it is to be hoped that the government and the lending agencies will adopt policies and programs that will encourage the evolution of suitable institutional arrangements to assist small farmers.

The program should consider a wider range of activities, especially the promotion of artisanal seed production and of improved on-farm storage to help farmers reduce postharvest losses.

Conclusion

The SG 2000 Project has contributed directly to increased agricultural production, though it is too soon to determine its impact on sustained growth. In its first four years, the program has probably led to a direct increase of around 30,000 to 40,000 t of maize and a lesser amount of sorghum. Unfortunately, the available data and the difficulty in attributing cause and effect make it well nigh impossible to measure the cost-benefit ratios with any precision. In very broad terms, though, what can be said is that SG 2000 has been a very low-cost program by international standards and that it has opened new vistas to thousands of small-scale producers and has also contributed directly to an increase in grain output. More significantly, the program has contributed to a better understanding of the requirements for increasing production and has pinpointed other

important problems in agricultural development that require attention if there is to be sustained growth in food production.

It is strongly recommended that the PTP program continue as a testing and demonstration program. Its objectives should be refined and its management strengthened. The program should be confined to around 15,000 PTPs, a manageable number, and should continue to focus on maize and sorghum. However, the program should be deepened by testing different cropping patterns for different areas over a longer time, with a view to improving soil fertility and raising farmers' returns; special attention should be given to testing and demonstrating the most profitable use of fertilizers. In addition, the program should consider a wider range of activities, especially the support and promotion of artisanal seed production and of improved on-farm storage to help farmers reduce postharvest losses and capture the gains from interseasonal price fluctuations. If it is deemed feasible, there should also be a modest effort to test ways and means of strengthening the delivery and marketing systems. Finally, it is strongly recommended that attention be given to all aspects of the economics of the program.

A Study of Maize Technology Diffusion in Ghana: Some Preliminary Results

*Kofi Marfo and Robert Tripp**

Maize is Ghana's most important cereal crop (being grown on more than 500,000 ha), and improving the efficiency of its production is a key to the country's agricultural development. A considerable amount of effort has been devoted to maize research and extension in Ghana over the past decade.

The survey reported on here was carried out as part of the Ghana Grains Development Project (GGDP), which began in 1979. The goal of the project is to strengthen research and extension capacity in Ghana, with a focus on the development and demonstration of grower recommendations for maize and cowpeas. The Crops Research Institute (CRI) is the executing agency for the government of Ghana, and the country's Grains and Legumes Development Board (GLDB) and Ministry of Agriculture (MOA) are participating as well. Another executing agency is the International Maize and Wheat Improvement Center (CIMMYT), which has based one or two agronomists in Ghana since the project's inception. The International Institute of Tropical Agriculture (IITA) is represented on the management committee of the project and has a cowpea breeder/agronomist stationed in Ghana.

The GGDP has fostered a broad strategy for technology development and transfer. While supporting research at the experiment station on plant breeding and crop management, the project has placed particular emphasis on developing a capacity to carry out research on farmers' fields. CRI and GLDB staff have managed an exceptionally large number of on-farm trials in the course of the project. The most important result of this research is a set of practical grower recommendations for maize and cowpea that is promoted through the project's extension activities. The project has emphasized close links between on-farm research and extension and has promoted an extensive demonstration program managed by GLDB staff and MOA extension agents. The extension effort has included the development of production guides aimed at extension agents and farmers. Annual workshops are held to discuss project results among the collaborating institutions and to plan future work.

The recommendations developed by the project have been useful in other extension efforts as well. In its training and visit extension program, for example, the World Bank Volta Region Agricultural Development Project (VORADEP) has collaborated closely with the project. Diffusion of recommendations for maize has been substantially increased by the efforts of the SG 2000 Project, which began working with the Extension Services Department of the MOA in 1986. The SG 2000 Project introduced farmers to

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improved maize technology by establishing large demonstration plots—referred to as production test plots (PTPs)—on farmers' fields and by providing inputs with supervised credit (Martínez et al. 1990).

In examining the adoption of new maize technology, this paper focuses on three elements: variety, fertilization, and plant population. The technical changes promoted among farmers are summarized in Table 1. CRI maize breeders have developed a number of improved maize varieties, and these have been tested in farmers' fields, where they yield more than local maize varieties under a wide range of management conditions. On-farm trials were used to develop recommendations for fertilizer use on maize. The recommendations vary according to agroecological zone and field history and have been readjusted to take account of the changing relation between maize and fertilizer prices in Ghana. Current fertilizer recommendations include the application of compound fertilizer at or near planting and a topdressing of nitrogenous fertilizer six weeks after planting. On-farm experiments also helped develop recommendations for improving traditional plant populations, including line planting, closer spacing between hills, and fewer seeds per hill. More complete information on the recommendations is given in a production guide published by the project (GGDP 1990).

The 1990 Survey

Economists from CRI and GLDB have undertaken several surveys as part of GGDP activities. The objectives of these studies are to provide feedback to the on-farm research effort and to assess progress in technology diffusion. While previous surveys were confined to single areas, the one undertaken in 1990 covered six areas of the country, which were chosen to represent the range of environments in Ghana where maize is an important crop (Figure 1). It should be emphasized that, although the six areas are representative, the results of the survey cannot be used to derive national level statistics regarding the use of maize technology. The results reported here are from a random sample of about 330 maize farmers in the six survey areas.

Table 1. Maize technology included in adoption study

Technology	Traditional practice	Improved practice
Variety	Local unimproved varieties	Improved open-pollinated maize varieties: Dobidi, Okumasa, Aburotia, others
Fertilization	No fertilizer	Starter fertilizer and topdressing
Planting	Random planting; hills widely spaced; 3-4 seeds per hill	Row planting; 90-cm rows, 40 cm between hills; 2-3 seeds per hill

We are still analyzing the survey results and expect to make a full report available later in 1991. This paper points out highlights from the initial analysis. We begin by briefly reviewing some features of maize production in Ghana. We then consider the diffusion of maize varieties, fertilizer, and improved planting practices, followed by a summary of data regarding the role of extension in maize technology diffusion. The paper concludes by discussing the implications of these preliminary survey results.

Maize Farming in Ghana

Maize is planted under a wide variety of conditions in Ghana, from forest in the south to Guinea savanna in the north. The major agroecological region for maize, though, is the area referred to as the "transition zone," lying between forest and savanna (Figure 1). Rainfall in the transition and forest zones is bimodal, which makes two planting seasons possible. The major season begins in March or April and the minor season in July. Further north in the savanna, a single planting season begins in April or May.

Maize fields may be prepared by tractor, cutlass, or hoe. Maize is grown both as a monocrop and intercrop. In the forest areas, maize is often intercropped with cassava or other root crops, while in the north it may be intercropped with sorghum, legumes, or both. Whether monocropped or intercropped, all maize is weeded by hand. After harvest it is dried and stored on farm for use or sale.

Any analysis of the adoption of maize technology in Ghana must take into account the fact that maize is largely a commercial crop. For the majority of farmers in our survey, maize was either their first or second most important cash crop. More than 70% of the farmers surveyed sold more than half of their maize, mostly to traders. Many farmers store their maize for three to six months before selling it.

Maize is also consumed on the farm in a variety of preparations, including several types of steamed, fermented maize dough, porridges and gruels, and roasted green ears. Although maize is an important part of many farm household

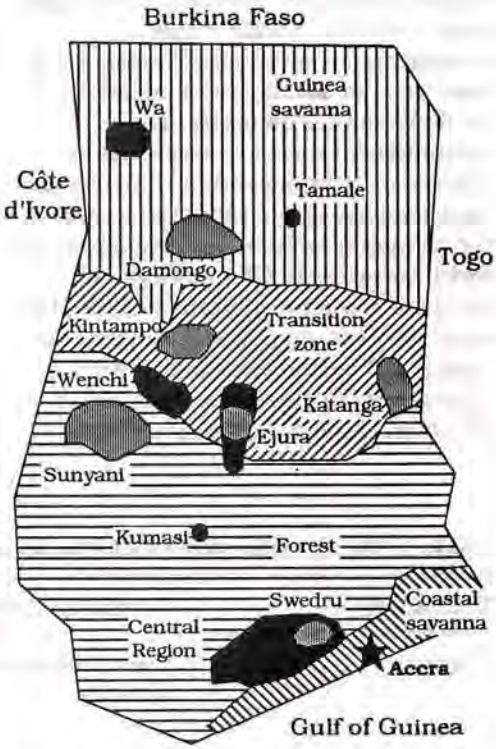

Figure 1. Location of farmer surveys carried out by the Ghana Grains Development Project.

diets, it is not as predominant as in many areas of eastern or southern Africa. In southern Ghana maize is complemented by crops such as cassava and plantain, while in the north it shares importance as a staple with crops such as sorghum and yam. Farmers rarely buy maize grain for household use; only about 11% of the farmers interviewed reported buying as much as 50 kg of maize grain in the past year. More than half of the households surveyed, however, reported that they regularly bought some type of prepared maize. Preparation of the most popular maize dishes requires wet milling, fermentation, and other operations that are difficult at the household level. These maize foods, particularly *kenkey* and *banku*, are popular convenience foods in Ghana's towns and cities and account for a major proportion of the maize that is marketed.

The following analysis thus looks at the adoption of maize technology by farmers for whom maize is an important source of cash income as well as an important element of their diet. Changes in maize production practices represent the results of more than 10 years of research and extension aimed at improving maize productivity in Ghana.

Maize Varieties

We estimate that in 1990 approximately 49% of the maize area in the survey was planted to improved varieties. The farmers surveyed reported that only 34% of their maize fields were sown to improved varieties in 1987. More than 58% of the farmers were planting an improved variety in at least part of their fields in 1990. When asked to name all of the maize varieties they were planting, farmers gave the responses indicated in Figure 2. In 43% of these instances, farmers gave the name of an improved variety, while in 15.4% they could not recall the name but referred to the variety simply as "agric" (i.e., from the Ministry of Agriculture). The remaining maize varieties are local unimproved materials, for which farmers often do not have specific names.

Figure 3 shows the source of seed of the improved varieties that farmers planted. Almost 40% of the seed was obtained from other farmers and another 30% from extension agents, in many cases those working with the SG 2000 Project. Less than 20% of the seed currently used was purchased from an official source. The low proportion of seed purchased through commercial channels is disappointing and indicates serious deficiencies in Ghana's seed system. Farmers can grow open-pollinated varieties for three or four years before having to buy fresh seed; 77.6% of the improved seed planted by the farmers surveyed is four years old or less. But given that much of this seed comes from

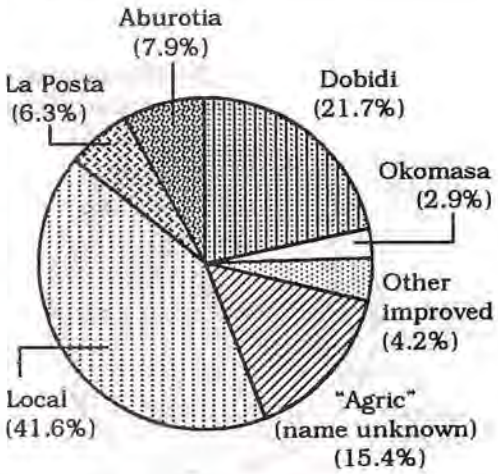

Figure 2. Instances of maize variety use (major and secondary varieties planted in maize fields).

other farmers' fields and that few of the farmers acquire fresh seed on a regular basis, much remains to be done in developing a viable seed industry that will enable growers to take advantage of the improved maize varieties produced by CRI.

Acceptance of improved maize varieties differs sharply among regions, as shown in Table 2. Farmers in the forest areas are much less likely to use improved varieties than those in the transition zone or savanna. Table 3 indicates farmers' reasons for not adopting or for rejecting the new varieties. The most important is unavailability of seed—further evidence of the inadequacy of the seed distribution system.

Farmers are also concerned about problems in marketing grain of improved varieties, particularly in Sunyani and Swedru, where acceptance of the new varieties is lowest. The principal impediment seems to be the belief that the new varieties do not make acceptable *kenkey*. There is evidence that at least in certain markets and at certain times of the year traders may favor local varieties over improved ones. Though various tests have shown that good kenkey and other maize preparations can be made from improved maize, further extension efforts and testing,

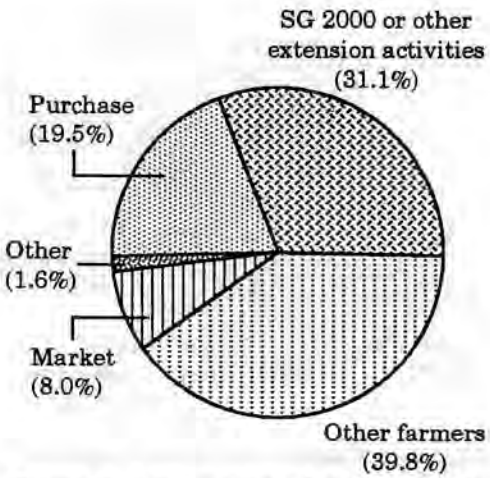

Figure 3. Source of seed of improved maize.

Table 2. Use of improved maize varieties, by location

Location	Zone	Percentage of area planted to improved varieties
Swedru	Forest	18.4
Sunyani	Forest	6.6
Kintampo	Transition	68.1
Ejura	Transition	73.4
Katanga	Transition	48.4
Damongo	Guinea savanna	82.4
Total		49.2

Table 3. Farmers' reasons for not using improved varieties

Reason	Never adopted (%)*	Adopted and rejected (%)**
Unavailability of seed	62.2	63.6
Lack of knowledge	28.6	0.0
Storage problems	26.5	39.4
Marketing problems	20.4	48.5
Cooking quality	8.2	6.1
Yield	2.0	6.1
(Number of farmers)	(98)	(33)

Note: The percentage total is more than 100% because farmers gave multiple answers.

* Farmers who have never used an improved maize variety.

** Farmers who used an improved maize variety at least once but were not using it in 1990.

involving *kenkey* makers, is required to satisfy their doubts about the cooking quality of the new varieties.

Another concern that farmers commonly express is that the new varieties do not store well. This is almost certainly related to their poorer husk cover, which allows weevils and other insects to enter the maize ears while they are still in the field. The strongest complaints about storage come from farmers in the more humid areas of the country. Further breeding, combined with adequate storage technology, should resolve this problem.

Finally, although the new varieties are grown under a wide range of conditions in Ghana, they are most likely to be found where maize is grown as a monocrop (or intercropped with other grains or legumes) and where other recommended production practices are followed (Table 4).

Fertilizer Use

When the GGDP was initiated, fertilizer use on maize was very low, despite a considerable amount of research and extension work intended to introduce farmers to fertilizer. The project developed further information on fertilizer responses in farmers' fields and then verified and demonstrated practical rates and methods of fertilizer application.

Most farmers in Ghana are familiar with chemical fertilizer; nearly 50% of those surveyed had experience in applying this input to maize. Figure 4 shows trends in the purchase of fertilizer for this crop over the past four years. The upward trend through 1989 is broken by a sharp decline in 1990. The principal reason is almost certainly the higher price of

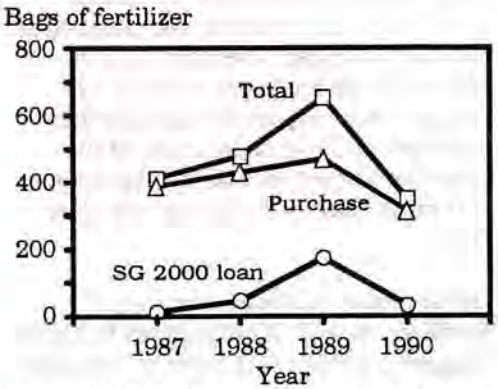

Figure 4. Fertilizer use, 1987-90 (bags of fertilizer used on maize by farmers who have grown maize for least four years).

Table 4. Use of improved varieties, by cropping system or practice

Cropping system or practice	Number of fields	Fields with improved varieties (%)
Intercropped with root crops	151	25.2
Intercropped with grains or legumes	75	78.7
Monocropped*	191	67.0
Random planted, no fertilizer	69	39.1
Random planted, fertilizer	9	88.9
Row planted, no fertilizer	28	82.1
Row planted, fertilizer	59	83.1

* Fields planted on ridges were not included.

fertilizer over the last two years, occasioned by a gradual removal of the government subsidy. Another reason is that the rains were erratic and late in 1990, making farmers cautious about investing in this input. Finally, it should be noted that a considerable part of the increase in fertilizer use in 1989 was due to SG 2000's credit program. When loans dropped sharply during 1990, the more limited availability of credit undoubtedly had an effect on fertilizer use.

Fertilizer use on maize varies significantly among the districts covered in the survey. Figure 5 shows the proportion of maize fields receiving fertilizer in each district and illustrates how fertilizer use is related to field history. In districts where fields are continuously cropped for long periods, fertilizer use is highest. In all of the districts where fertilizer use is common, it is most likely to be applied on older fields.

Other factors influence the use of fertilizer as well. Monocropped fields, for example, are more likely to be fertilized.

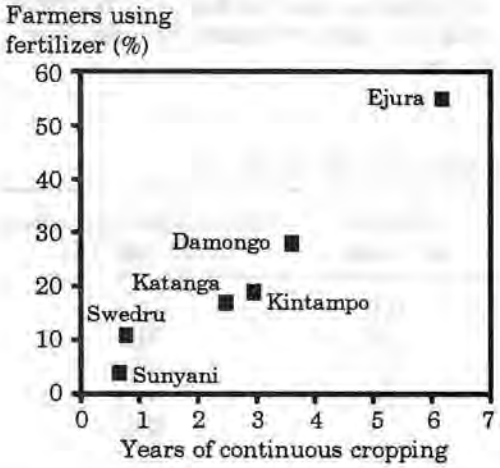

Figure 5. Fertilizer use on maize, by cropping history.

Sharecroppers are less inclined to use fertilizer, since they are generally responsible for purchasing all inputs but are obliged to give one-third of the harvest to the land owner. Fertilizer use is also related to other recommended practices. As indicated in Table 5, application on monocropped maize is almost nonexistent in fields that are random planted to local varieties. Farmers who use an improved variety, on the other hand, are more likely to apply fertilizer, particularly if they plant in rows (i.e., achieve adequate plant populations), making fertilizer application easier.

When farmers were asked why they did not use fertilizer, the two principal responses they gave were high cost and adequate soil fertility (Table 6). In 1990 the price of fertilizer (in terms of maize) was about twice as high as it was in 1987 because of the removal of subsidies on this input. A number of farmers claimed that they are not using fertilizer because their fields do not require it. For farmers who have experience with fertilizer, this response did in fact correlate with fields that have recently been in fallow.

Table 5. Fertilizer use, by planting practice (monocropped maize)

Planting practice	No. of fields	Fields receiving fertilizer (%)
Random, local variety	43	2.3
Random, improved variety	35	22.9
Row, local variety	15	66.7
Row, improved variety	72	68.1

Note: Fields planted on ridges were not included.

Our initial analysis of fertilizer practices shows that farmers tend to follow the recommendations with respect to type, timing, and rate of application. The principal exception is a tendency to apply starter fertilizer more than two weeks after planting. Many farmers prefer to wait until they are certain of having a good plant stand and adequate rainfall.

Planting Practices

In order to take advantage of improved varieties and fertilizer, it is important that farmers achieve adequate plant populations. The GGDP has developed recommendations for plant spacing and simple methods for making rows (using strings or sighting poles) and measuring distances (using a cutlass). In this analysis row planting is used as a proxy for improved planting practices, the aim of which is improved plant populations. This survey confirmed that farmers who row plant use fewer seeds per hill and previous surveys have shown that in row-planted fields the distances between hills are smaller.

In analyzing the adoption of row planting, we have eliminated farmers (particularly in Damongo and Kintampo) who traditionally prepare their fields by forming ridges with a hoe. Of the fields included in the survey, 36.3% were row planted. This practice is most often applied in monocropped fields and fields with longer cropping histories. These two factors are related. Row planting is easier in fields that have been cropped continuously and are free of stumps and other obstacles. As mentioned above, row planting is often associated with fertilizer use and improved varieties.

Farmers who were not planting in rows were asked why they had not adopted this practice (Table 7). Those who had never adopted it cited lack of knowledge and extra labor. Among those who had experience with row planting, the principal reason for abandoning the practice was the extra labor involved, which is mainly a result of the larger number of hills made. Though many farmers learn row planting and use the technique to their advantage, obviously the extra labor involved has discouraged others.

Table 6. Farmers' reasons for not using fertilizer on maize

Reason	Never adopted (%)*	Adopted and rejected (%)
Cash/price	50.7	53.0
Soil is good	29.0	29.9
Unavailability	2.9	7.7
Lack of knowledge	12.3	0.9
Other	5.1	8.5
(Number of farmers)	(138)	(117)

* See notes on Table 3.

Table 7. Farmers' reasons for not row planting maize

	Never adopted (%)*	Adopted but rejected (%)
Too much work	38.8	65.0
Lack of knowledge	41.3	2.5
Difficult with intercrop	9.9	7.5
Other	9.9	25.0
(Number of farmers)	(121)	(40)

* See notes on Table 3.

Extension

Considerable progress has been made in the diffusion of new maize technology among Ghanaian farmers. This progress is due both to a practical, well-focused research strategy and to the efforts of various extension programs. To determine the contribution of extension, we asked farmers how they first learned about the recommended practices. As is apparent from Table 8, extension has played an important role in introducing farmers to new technology. Farmers also learn a great deal from one another, however, especially about improved varieties.

The extension services have promoted maize recommendations through a wide range of activities, including demonstrations and field days organized by extension officers who have received training from the GGDP, SG 2000, and other projects. We asked farmers a number of questions that tested their knowledge of the recommendations and ranked their responses on an eight-point scale. The results indicate that there is a clear relationship between extension activities and farmers' knowledge. Those who have either attended a demonstration or participated in the SG 2000 Project have much higher scores than those with no extension contact.

We were also interested in seeing if extension was reaching women farmers, who are very important in Ghanaian agriculture. In analyzing the knowledge scores of men and women farmers generally, we found that women scored significantly lower than men. But when we compared scores of men and women who had participated in the same extension activity, the difference in knowledge was not nearly so great (Table 9). When we further considered only farmers who practice monocropping (a system in which new practices have been widely adopted), we found no difference in knowledge scores between men and women. Our principal conclusion is that continued effort is needed to include women maize farmers in all extension activities.

Finally, the survey gives evidence of the particular impact of the SG 2000 Project. It is quite impressive that in a random sample of maize farmers in six areas of Ghana approximately one in every four

Table 8. How farmers first learned about new technology

How learned	Variety (N = 241)	Row planting (N = 199)	Fertilizer (N = 158)	Fertilizer application (N = 149)
		Percentage of farmers		
Extension demonstration	16.6	30.2	22.2	30.2
Told by extension	29.0	23.6	40.5	34.9
Other extension method	2.5	2.5	5.1	2.0
(Total extension)	(48.1)	(56.3)	(67.8)	(67.1)
From another farmer	48.1	35.7	28.5	26.8
Other or don't know	3.7	8.0	3.8	6.1

farmers had had contact with the project. Extension agents working with the project have been an important source of seed of new varieties. We estimate that about 20% of the improved seed planted in 1990 came directly from SG 2000, and certainly some of the seed that farmers obtained from their neighbors was originally introduced by extension officers working with the project. It has also been responsible for introducing a large number of farmers to fertilizer. Moreover, as pointed out above, participation in SG 2000 is associated with high scores for knowledge about the recommendations.

As one example of the project's impact, it is interesting to compare results obtained from the present survey in Ejura with those from a survey carried out in the same area during 1987. Ejura is an important maize-growing district, and the SG 2000 Project has been very active there. We found that the use of improved varieties and fertilizer has approximately doubled in this district in three years, and much of the increase is undoubtedly due to the project's efforts.

There are some concerns, however, about the sustainability of this work. As SG 2000 expanded, particularly in 1989, the credit component of the program became much more difficult to manage. In addition, as the project began working with very large numbers of farmers, less attention was paid to targeting the extension message. Between 40 and 50% of the farmers participating in the SG 2000 program were already familiar with one or more of the recommended technologies. There were also fewer opportunities for follow-up; of the farmers who learned about fertilizer through participation in the SG 2000 Project, only 28.9% continued using it in 1990. Even so, it is important to take advantage of the enthusiasm created by SG 2000 to ensure that the extension service continues to achieve broad coverage of Ghana's maize farmers and is able to advise them on the use of new technology.

Conclusion

As pointed out above, the results discussed here represent only a preliminary analysis of the 1990 maize producer survey. Further work will certainly give us more insight into the diffusion of new maize technology. Nevertheless, from the initial results, we can draw conclusions in three areas: agricultural research, institutional requirements, and the place of maize in the Ghanaian economy.

Table 9. Knowledge score of farmers, by gender

	Total population	Participated in demonstration or SG 2000	Monocrop and participated in demonstration or SG 2000
Males	3.54	5.49	5.47
Females	2.36	4.67	5.27
(Probability T-test)	(.001)	(.05)	(NS)

Substantial investments in agricultural research have helped bring about significant changes in the maize production practices of Ghanaian farmers. The development of appropriate maize varieties, for example, was made possible by good plant breeding capacity at CRI and by a system of on-farm testing that allowed interaction among farmers, researchers, and extension agents. Even so, important challenges remain. One concern is the uneven adoption of new technology; little progress has been made where maize is intercropped with cassava, for example. The GGDP has invested considerable effort in generating recommendations for maize/cassava intercropping, but more work must be done to improve our understanding of this cropping system and to raise its efficiency.

Farmers' progress with new varieties, enhanced fertility, and improved plant stand management raises questions about further opportunities for improving maize production, which will probably require longer term research efforts. It is likely that farmers who have already adopted the new technology available will now have to turn their attention to better weed control if they expect to achieve further increases in yields. Farmers understand the importance of weed control but have trouble mobilizing labor for timely completion of this task. About two-thirds of the farmers surveyed use hired labor in weeding their maize fields. Alternative weed control methods will have to be tested carefully and applied in a form that farmers can manage. The diverse weed populations affecting maize in Ghana present a significant challenge to research.

Long-term fertility is another item on the research agenda that should receive high priority. Though farmers are now familiar with fertilizer, changing prices and difficult growing conditions make it unlikely that use of this input for maize in Ghana will increase substantially in the near future. Any additional use of fertilizer will almost certainly be concentrated in areas where the soils and crop management make it most profitable. In the meantime, much maize is planted on fallow land, and fallow periods in most cases are becoming shorter. Alternative methods for maintaining and improving soil fertility are urgently required.

Ghana's strong research system needs to be complemented by significant changes in other institutions. Evidence from this survey leaves no doubt that as long as the country lacks an effective seed system Ghanaian farmers will not be able to take full advantage of advances in maize breeding. Local seed production and extension programs that help distribute seed may help in the short term, but they are no substitute for commercially viable seed enterprises.

The fertilizer distribution system also requires attention. Previous subsidies on fertilizer were so high that they represented a significant drain on the nation's resources and a disincentive to the rational use of this input. As the subsidy on fertilizer is removed and the MOA relinquishes responsibility for fertilizer distribution, however, there is a danger that neither farmers nor private traders will be able to adjust quickly enough to the new conditions. The road to fertilizer privatization is a difficult one (Shepherd 1989), and careful thought is needed to guide the transition.

Another important element in strengthening Ghanaian agricultural institutions is the extension service. From its first days, the GGDP emphasized the importance of strong links between research and extension. More recently, the SG 2000 Project has provided clear guidelines for a national extension approach that includes well-conceived demonstrations, generates farmer commitment, promotes community involvement, and focuses attention on inputs and credit. Future development of the extension system will demand more of these same elements: close collaboration between research and extension and a well-defined extension strategy that stresses the delivery of clear and relevant messages in the context of Ghana's highly variable farming conditions.

The SG 2000 Project has provided clear guidelines for a national extension approach that includes well-conceived demonstrations, generates farmer commitment, promotes community involvement, and focuses attention on inputs and credit.

The issue of agricultural input supply requires urgent attention. A small-farmer credit program would nicely complement an improved input system, but there are serious obstacles to this goal. Such a system would have to be economically viable, with an efficient strategy of loan management. Previous small-farmer credit programs in Ghana have shown high rates of farmer repayment but prohibitively high administrative costs (Owusu and Tetteh 1982). Everyone would welcome an efficient credit system in the service of Ghana's small farmers, but much basic work remains to be done before such a system can be realized.

Finally, it is important to place maize in a broader context. It is a key crop for Ghana and has been the focus of intensive work both by GGDP and SG 2000. The need to continue devoting research and extension resources to maize is undeniable. Even so, farmers will be able to take full advantage of new technology for increasing maize production only if there is a market for surplus grain. Currently, most of the grain sold is used to make food preparations that are sold in towns and cities. Maize is an important staple in Ghana but not the predominant one. Unless new markets for the crop are developed—involving feed, food, and industrial uses—it is unlikely that farmers will go on producing ever larger quantities of maize.

Thus, continued advances in maize production in Ghana depend on a wide range of factors. It is well known that agricultural development requires simultaneous efforts in research, extension, input supply, and marketing (Wortman and Cummings 1978). Ghana's research and extension services need continued support. Adequate systems for supplying agricultural

inputs need to be established. And maize marketing and demand, as well as the place of maize in the Ghanaian food system, all require further study. It would be counterproductive to focus exclusively on one or another of these factors, and for any of them a "quick fix" is neither feasible nor desirable. Both Ghanaian and donor institutions should be prepared for a comprehensive and long-term commitment.

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Effects of the Sasakawa-Global 2000 Project on Ghanaian Agriculture

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Volta Region, on behalf of Comodore S.G. Obimpeh (Rtd.),
PNDC Secretary for Agriculture

Ghana occupies approximately 290,000 km², roughly the same area as the UK. Its population is 15 million (1990) with a growth rate of 3.2% per annum (1984-91 estimates). Approximately two-thirds of the people live in rural areas, and the majority are engaged in agriculture, mostly on smallholdings. Agriculture accounts for about 55% of the country's gross domestic product (GDP), and more than 90% of this production comes from holdings that range from 0.4 to 1.6 ha (1 to 4 acres). The most important crops are cocoa, which is a major foreign exchange earner, cereals (maize, sorghum, millet, and rice), roots and tubers (yam, cassava, and cocoyam), and plantain. Other crops produced are groundnut, oil palm, cotton, and tobacco. Besides cocoa, Ghana exports gold, diamonds, timber, and various nontraditional export crops. At independence in 1957 and thereafter, the economy was fairly strong largely because of relatively low population with higher per capita income, coupled with a good world price for cocoa. By the 1970s, however, it had become clear that the policies pursued by successive governments were stagnating economic growth. Between 1971 and 1983, per capita income shrank from an estimated 640 cedis to 400 cedis. During this period Ghana lost its hold on the world cocoa trade. Its share of the market fell from 37% in 1965 to 12% in 1982.

These were among the primary circumstances that led the PNDC government to launch its Economy Recovery Program (ERP). The program attracted support from the World Bank and the International Monetary Fund (IMF) and other donors, including organizations such as the Sasakawa Africa Association and Global 2000. The details and success of the ERP are best left for full discussion at a forum of economists and financial analysts. Suffice it to say that the prudent policies pursued by the government after the ERP was launched resulted in an economic growth rate of 5% per year in 1983. By 1990, though, a complex of factors had reduced growth to around 3%. Agriculture's contribution to this growth was quite appreciable, partly because of favorable weather but also because of currency devaluation and structural reforms in the economy. Policy and institutional changes helped create an environment that was conducive to the establishment of the SG 2000 Agricultural Project.

A Brief Description of the Project

Crop production technology in Ghana is largely traditional and indigenous. The main inputs continue to be land and labor, even though improved technology is available from organizations such as the Crops Research Institute and Ghana Grains and Legumes Development Board. The major barriers to adoption of improved technology have been:

- Unavailability of inputs
- Lack of credit for farmers to purchase inputs
- Ineffective extension services
- Unrealistically low producer prices
- Absence of an effective market
- High input prices (after the removal of subsidies)

The SG 2000 Project was initiated mainly to test and transfer technology to smallholders, using a kind of doing, seeing, and believing strategy. Credit for the purchase of inputs was extended to participating farmers. Though the number of participants was quite small initially, good rates of loan recovery during the first two or three years encouraged a major expansion of the scheme, as shown in Table 1. There is no doubt that the project has achieved its objective of demonstrating to smallholders the benefits of improved production technology. In that respect the SG 2000 Project in Ghana has been a resounding success.

Table 1. Expansion of the SG 2000 Project in Ghana

Year	Number of farmers	Recovery rate (%)
1986	40	100
1987	1,490	94
1988	15,737	77
1989	78,218	39
1990	17,000	n.a. *

* n.a. = Data not available.

Effects of the Project

The availability of credit enabled many smallholders to see and handle (for some it was the first time) the components of improved technology, including seed of high-yielding varieties, fertilizers, and insecticides for postharvest grain protection. Diffusion of this technology has been rapid, since farmers participating in the project were encouraged to involve neighbors in the application of inputs on their Production Test Plots (PTPs).

This multiplier effect and the sizeable impact of the extension services is plainly evident in areas where the project operates. Some farmers begin by adopting only certain elements of the technology package, such as row planting or fertilizer, though perhaps applying the latter at less than the recommended rate. Even so, the majority of farmers strive to procure all of the inputs involved in the improved technology. Many have been able to do so because of the availability of credit through the SG 2000 Project. The resulting surge in demand for extension services has had a notably beneficial effect on this institution. The SG 2000 Project has demonstrated quite thoroughly that, if provided with adequate incentives, smallholders are prepared to contribute effectively to the development of the economy. Their main limitation is restricted access to credit.

Ghana's involvement in the project has given us the opportunity to learn a number of valuable lessons. Perhaps the most instructive experience was the

sudden increase in the number of participants from 16,000 to 80,000 in 1989, an overly ambitious move that led to the following difficulties:

1. Extension officers were unable to supervise the large number of participants properly.

2. Inadequate supervision made it impossible to monitor utilization of the inputs distributed and the yields obtained.

3. Many participants took advantage of loose supervision to default on their input loans. Some may have even sold their inputs to neighbors.

4. The extension service was used inappropriately as an institution for administering credit.

5. It became evident that storage and marketing deficiencies are major impediments to programs for expanded crop production.

Medium Term Agricultural Development Project (MTADP)

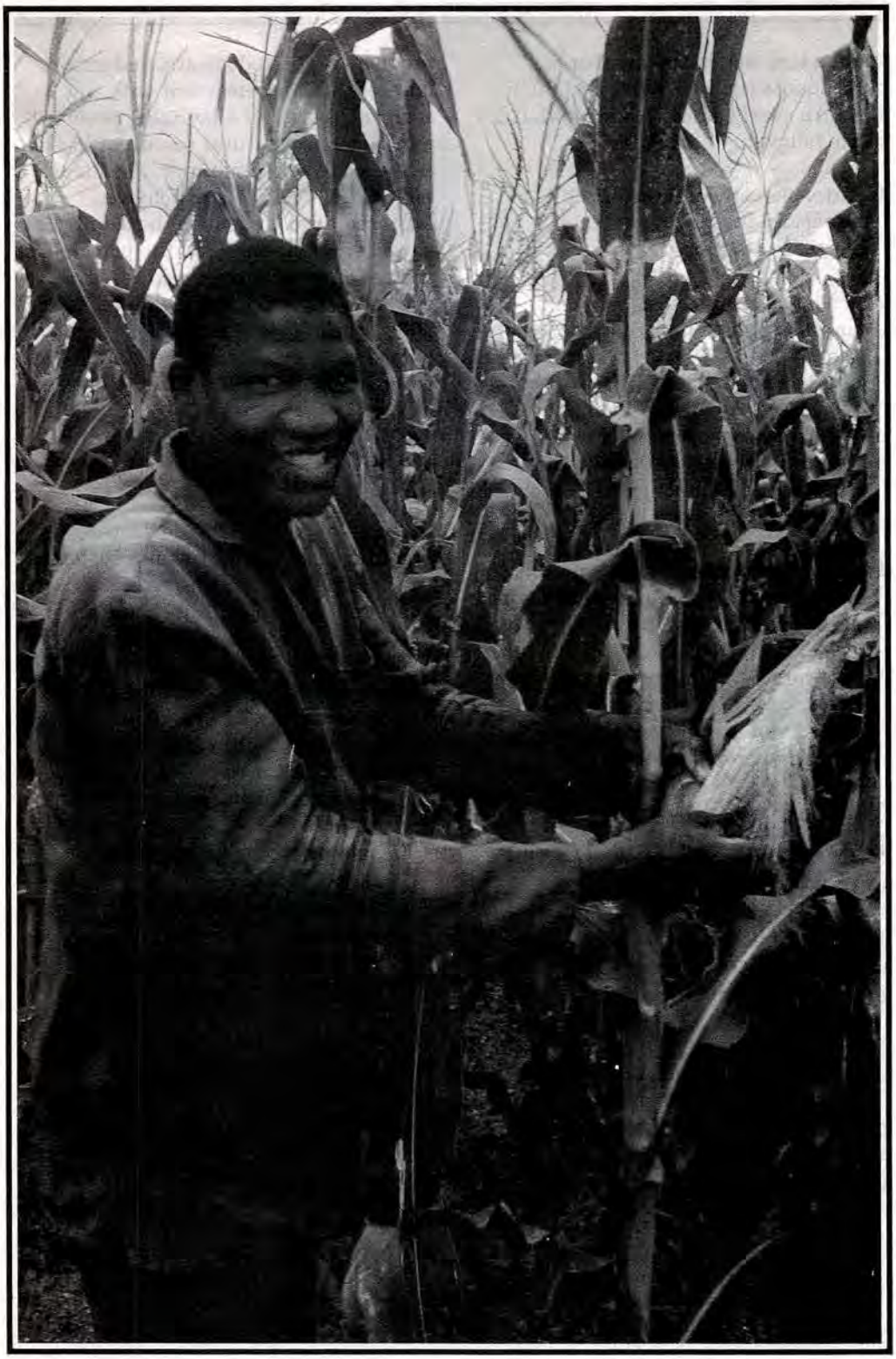
The problems listed above have been taken into account in the Medium Term Agricultural Development Project (MTADP), which is Ghana's agenda for sustained agricultural development to the year 2000. The MTADP seeks to create an agricultural environment that promotes growth and development, encourages private sector involvement, permits more efficient and competitive cultivation of essential agricultural products for both domestic and export markets, and is consistent with the social objectives of alleviating poverty and managing natural resources in an ecologically sound manner. A central aim of the MTADP is to achieve balanced development in the country's various regions based on the principle of comparative advantage and resource endowment. Lessons drawn from the SG 2000 Project over the last five years have helped us in developing the MTADP and will continue to guide us in the future.

The Future of SG 2000 in Ghana

Our challenge now is to develop a program with greater continuity, based on the experiences of the project's first phase and on opportunities being created in the private sector through the economic policy initiatives of the PNDC government. In collaboration with the Extension Services Department of the Ministry of Agriculture, the SG 2000 Project will in the next few years address the following areas:

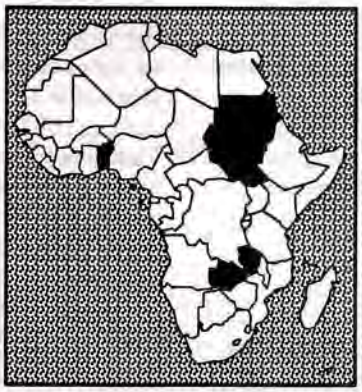
- Crop production but not limited to cereals
- Seed production and seed industry development
- Postharvest technology
- Quality protein maize promotion

Finally, I wish to express our appreciation for the very useful association we have had with the SG 2000 Project. The experiment has been a very successful one, and we hope that this kind of international effort to meet the needs of the rural poor will continue.



The Sasakawa-Global 2000 and Global 2000 Agricultural Projects in Sudan, Zambia, Benin, and Togo

*N.E. Borlaug, J.A. Valencia, R.P. Jain, and M. Galiba**



In this paper we provide a brief overview of the work and progress of the Sasakawa-Global 2000 (SG 2000) and Global 2000 Agricultural Projects in Sudan, Zambia, Benin, and Togo. Omitted from this discussion is an account of the SG 2000 Projects in Tanzania and Ghana, which are covered in other reports presented at this workshop. For more details about all of these projects, refer to *Feeding the Future: Agricultural Development Strategies for Africa*, the proceedings of the CASIN/SAA/Global 2000 workshop held at Accra, Ghana, 1-3 August 1989.

The projects reported on here operate under two organizational frameworks. One arrangement is represented by the SG 2000 Agricultural Projects in Benin and Togo, which are joint ventures of the Sasakawa Africa Association (SAA) and Global 2000 (attached to the Carter Presidential Center). Funding for this work is provided primarily by the Sasakawa Foundation (formerly known as the Japan Shipbuilding Industry Foundation). In 1990 the government of Finland also became a donor to SAA for these projects.

Support for the Global 2000 Projects in Sudan and Zambia is organized somewhat differently. From 1987 to 1990, the project in Zambia was funded by the Bank of Credit and Commerce International (BCCI) through its local subsidiary BCC Ltd. and the BCCI Foundation (Zambia) for New and Emerging Sciences and Technology (NEST). Since mid-1990 financial support has been provided by the Abu Dhabi Investment Authority. Between 1986 and 1990, the Sudan project was operated as an SG 2000 venture with SAA funding. But since May 1990 it has been a Global 2000 activity, with funding from the governments of Norway and Sweden.

The SG 2000 and Global 2000 Agricultural Projects do not all follow a single blueprint, but they do share the following common elements:

- All are concerned with improving the productivity of staple food crops grown by small-scale, resource-poor farmers.

* President, SAA; Sudan Agricultural Director, Global 2000; Zambia Agricultural Director, Global 2000; and Benin-Togo Agricultural Director, SG 2000, respectively.

- All are quite small in staffing and budgets. Two to three internationally recruited scientists are assigned to each country project, where they work with counterpart staff from national agricultural extension, research, and production organizations.

- In all of the SG 2000 countries, we believe that good research products and information have been generated and that they are ready for widespread application. We are not waiting for the "perfect" technology before trying to help small-scale farmers.

Sudan

Sudan is Africa's largest country in terms of area, with 10 times more land than the UK. About 65% of the country's 26 million people are engaged in agriculture. The staple food crops—sorghum and millet—are grown on 5 to 8 million hectares, depending on the year. Livestock are also very important in the agricultural economy. Sudanese herders tend more than 35 million goats and sheep, 20 million cattle, and 3 million camels. Cotton accounts for 45% of the nation's foreign exchange earnings, gum arabic for 15%, sheep and lambs for 10%, and sesame for 8%.

The Global 2000 Agricultural Project in Sudan began in May 1986, with an initial emphasis on improvement of sorghum and millet production during the summer season in both irrigated and rainfed zones. During the 1987-88 cropping season, wheat was added to the field demonstration program during the winter season. After the 1988-89 cropping season, work in the rainfed, arid western regions of the country and on millet was discontinued, and project staff concentrated on wheat improvement during the winter season and sorghum improvement during the summer season in the irrigated areas adjacent to the Blue and White Nile Rivers and their tributaries.

Over the past five years, three international staff have been posted to the project. Dr. Ignacio Narváez served as director during 1986-90; Dr. Marco Quiñones served as senior scientist during 1987-90; and José Antonio Valencia served first as a senior scientist (starting in 1987) and has been project director since 1990. The project works through the Ministry of Agricultural and Natural Resources (MANR) and various irrigation districts, especially the Gezira Board. Project activities are guided by a Management Coordinating Unit (MCU), which includes officials from the government's principal agricultural research, extension, production, and credit organizations. The project has made a considerable effort to strengthen the extension service mainly by providing improved transportation (motorcycles and pickup trucks) and in-service training.

The heart of our strategy for technology transfer is field testing and demonstration through Production Test Plots (PTPs), whose purpose is to test and demonstrate an improved package of production practices. During phase I of the project (1986-90), SG 2000 staff and national extension officers worked with Sudanese farmers to plant more than 6,500 sorghum, wheat, and millet PTPs. Most of these have been sorghum and wheat PTPs grown under irrigation in Central Region. We also attempted to establish millet and sorghum PTPs in the low-rainfall Western Region but discontinued them after two years in part because of social unrest in the area.

Sorghum improvement—Sorghum is Sudan's main food staple, with national demand estimated to be about 1.8 million tons in 1990. The crop is produced mostly under rainfed conditions and in poor soils. The limited area that is irrigated (about 7%) accounts for about 10% of the country's total sorghum production in normal years. In years of severe drought, such as 1989 and 1990, irrigated sorghum production can account for 25% of national production. Total sorghum area and production fluctuate considerably from year to year, depending mainly on rainfall. Scarce rainfall in 1989 resulted in a 32% decrease in area and a 66% drop in production from 1988 levels. In 1989 and 1990, sorghum production was only a third—at about 1.5 million tons—the size of the 1988 harvest of 4.4 million.

In some years more than 2 million hectares of sorghum are grown under rainfed conditions in large-scale, mechanized schemes in Eastern Region. These projects were established during World War II on land owned by the government and farmed by tenants. Some of the tenancies are as large as 8,000 to 10,000 ha. At the onset of the rains, the land is cultivated, and the crop is sown by tractor-drawn machinery. Fertilizer, herbicides, and insecticides are not used. An army of casual labor is employed for thinning, weeding, harvesting, and threshing. Sorghum yields in these schemes average only about 600 kg/ha in years of normal rainfall. Such low productivity results in large part from a lack of appropriate varieties and suitable agronomic practices for low-rainfall conditions. Though much could be done to improve productivity in these areas, the very large tenancies dissuaded Global 2000 from mounting a technology program there.

The project has concentrated instead on improving sorghum and wheat production in the irrigated areas. The Gezira Board manages the largest irrigation scheme, comprising about 900,000 ha. Also important are the White Nile, Blue Nile, and New Halfa Corporations. There are many constraints of sorghum and wheat production in these irrigated areas. The main causes of low yields (about 1.2 t/ha) are depleted soil fertility, use of old varieties, excessive or inadequate plant populations, late planting, and water stress caused by poor irrigation management.

The sorghum PTP program—The sorghum technology package being demonstrated was developed by staff of Sudan's Agricultural Research Corporation (ARC), with support from the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT). The PTP package is designed for irrigated areas and includes application of moderate amounts of fertilizer (88 kg/ha of N and 44 kg/ha of P_2O_5), use of a high-yielding sorghum hybrid (Hageen Dura-1), and improved plant populations (approximately 160,000 plants per hectare). In 1989 we introduced "block" PTPs, which include a land preparation component. These range in size from 17 to 34 ha and involve groups of 8 to 15 farmers. The hybrid being tested is not only very high yielding but also has unusually good flour-making properties. Recent milling and baking tests conducted by a cereal technology consultant from the US Department of Agriculture (USDA) show that good quality bread can be made with a mixture of flour from Hageen Dura-1 (20%) with bread wheat flour. Wide acceptance of this genotype could help the country reduce its dependency on imported wheat grain and flour.

The yields of the sorghum PTPs grown in the Gezira Scheme have been highly satisfactory, averaging two to three times greater than that on farmers' traditional plots in the irrigated areas (Table 1). In 1990 the average sorghum yield for 478 PTPs was 2.9 t/ha, compared to a mean of 1.3 t/ha for the entire 210,000 ha planted to this crop in the Gezira Scheme. Yields in the PTPs varied considerably from one area to another (Table 2). The northwest PTP group recorded both the highest yield (6.5 t/ha) and the lowest (0.9 t/ha). In most cases low PTP yields were caused not by poor crop management but problems of irrigation that were beyond farmers' control.

Apart from demonstrating the possibilities for obtaining higher sorghum yields, the Global 2000 Project has been instrumental in promoting seed production of Hageen Dura-1. Enough seed of this hybrid was produced in 1990 to plant 10,000 ha, an amount that still falls far short of the demand among tenant farmers in the Gezira Scheme. Much more seed must be produced of Hageen Dura-1 and of other hybrids now in the research pipeline. Because of the seed production bottleneck, the Global 2000 Project has worked with ARC in on-farm testing of two experimental open-pollinated varieties (OPVs), seed of which farmers can save for replanting the following year. On the strength of trial results—yields of 3,952 and 4,226 kg/ha for the two new OPVs—MANR has given high priority to seed multiplication of these materials, a task to be carried out in collaboration with the Gezira Seed Propagation Administration.

Wheat improvement—In the northern region of Sudan near its border with Egypt, irrigated wheat cultivation during the winter season dates back to ancient times. During this century production has moved progressively

Table 2. Yield variation in sorghum PTPs, Gezira Scheme, 1990

Group	Yield of PTPs (kg/ha) Highest	Lowest	Mean
South	5,048	1,905	3,882
Center	4,523	3,095	3,531
Massalamia	4,286	1,333	2,812
West Habouba	4,762	1,905	2,660
West Shair	4,583	1,619	2,768
Northwest	6,476	857	2,224
Mikashif	4,190	2,286	2,991
El Huda	6,222	1,587	3,084
Matoug	3,929	2,222	3,046
Mansi	3,746	2,286	2,676
Tahameed	4,524	1,905	3,262
Matouri	3,556	889	2,290
Gamousi	4,069	2,032	2,506

Table 1. Yield performance of sorghum PTPs in the irrigated Gezira Scheme

Year	No. of farmers	Total area (ha)	Mean yield (kg/ha) PTPs	Gezira	Percent increase
1986	36	39	3,520	1,476	138
1987	450	722	3,029	1,191	154
1988	703	1,085	3,295	1,200	175
1989	390	790	3,193	1,258	154
1990	478	1,082	2,929	1,262	132

southward into the irrigated areas between and adjacent to the Blue and White Nile Rivers. National wheat area expanded during the 1960s and 1970s, reaching a total of 250,000 ha. During the 1980s, however, production of this crop was not encouraged, so the area steadily declined to a low of 48,000 ha in the 1984-85 season.

Because of low wheat yields and opportunities in high-value export crops such as cotton, MANR and the Gezira Board were about to discontinue wheat production among tenant farmers in the irrigation districts. This decision had been reached about the time the Global 2000 Project began operating in Sudan during 1986. The project has helped increase government leaders' awareness of the potential for increasing wheat productivity and for making the country more self-reliant in this important food grain. Project staff have played a key role in Sudan's wheat success story. All had considerable experience with irrigated wheat production in the Sonoran desert of northwest Mexico. Though they did not originally plan to include the crop in the PTP program, field staff realized after the summer-cycle harvest of sorghum and millet PTPs in 1986 that they could add winter-cycle wheat.

Government leaders credit the Global 2000 Project for the subsequent reversal in national wheat policy. Wheat PTPs grown during 1987-88 and 1988-89 provided evidence that average wheat yields in the irrigated areas could be increased by two or three times with improved production packages. The mean yield of the test plots over four years was 2,575 kg/ha, compared to about 1,250 kg/ha on farmers' traditional plots. As a result of the Global 2000 demonstration program, in which nearly 2,000 Sudanese farmers have participated since 1986-87 (Table 3), the area planted to wheat has increased rapidly (Table 4); the national wheat deficit has been cut in half; and average yields have increased by 23%. The rise in average national wheat yields is clear evidence that farmers are adopting Global 2000 wheat technology. In some PTPs they are achieving yields of more than 6 t/ha, a remarkable accomplishment given the hot temperatures and relatively short growing season for wheat (Table 5).

Despite the demonstrated yield potential of wheat in Sudan, production is constrained by various crop management problems. Frequently, seedbed preparation is inadequate because of the

Table 3. Performance of wheat PTPs in the irrigated districts of Sudan

Year/ district	No. of farmers	Total area (ha)	Mean yield (kg/ha)*
1986-87			
Gezira	19	41	2,931
Kosti	6	31	1,577
1987-88			
Gezira	386	1,051	2,169
Kosti	66	105	986
1988-89			
Gezira	351	975	3,174
Kosti	178	120	2,391
1989-90			
Gezira	784	1,635	2,781
Kosti	144	267	2,552
El Duiem	29	61	2,949
Rahad	9	40	2,062
Total	1,972	4,326	2,575 *

* For all four years.

poor service provided by public-sector organizations responsible for mechanization. Inputs often arrive too late, and government wheat combines are often unavailable at the appropriate time, resulting in heavy losses from grain shattering in fields where the wheat is left standing until it is overripe. From 1986-87 through 1989-90, grain losses caused by shattering have ranged between 10 and 20% of total national production.

Tenant farmers in the irrigation districts depend mainly on government services for land preparation, credit, input supply, grain harvesting, and marketing. The organizations responsible for providing these services are plagued by management problems. The canal systems are in serious disrepair, as evidenced by silting, heavy weed infestation, damage caused by animals, and broken auxiliary pumps. A major effort will be needed to rehabilitate them, and maintenance programs will have to be established to avoid similar deterioration in the future. A challenge for the government of Sudan is to improve the effectiveness of public organizations responsible for supplying tenant farmers with field mechanization services, improved seeds, fertilizers, and agrochemicals.

Zambia

Zambia has a population of some 8 million, about 50% of which lives in rural areas, and a high population growth rate of about 3.5% per year. The country has great potential for food production, with 41 million hectares of arable land, of

Table 5. Yield performance of wheat PTPs in Sudan, 1989-90

Region	Regional mean	Highest	Lowest
		kg/ha	
Gezira	2,781	6,191	190
Kosti	2,552	5,714	1,786
El Duiem	2,949	4,572	1,143
Rahad	2,062	n.a. *	n.a.

* n.a. = data not available.

Table 4. Wheat situation and outlook in Sudan

Year	Area (ha)	Yield (kg/ha)	Production (t)	Deficit (t)
1983-84	141,000	1,116	157,000	384,000
1984-85	48,000	1,636	79,000	534,000
1985-86	151,000	1,316	199,000	486,000
1986-87	118,000	1,326	157,000	593,000
1987-88	144,000	1,256	181,000	599,000
1988-89	165,000	1,496	247,000	563,000
1989-90	258,000	1,586	409,000	439,000
1990-91*	420,000	1,550	650,000	231,000

* Estimates.
Source: Ministry of Agriculture and Natural Resources.

which only 12 million have been brought into production. Of this cleared land 4.9 million hectares are used regularly, with about 2 million under cultivation in a given year and 2.9 million in fallow. Another 7.1 million hectares are used for shifting cultivation. The soils are relatively fertile, and rainfall is adequate for a successful crop during November-March, except in the lower elevation areas of Southern, Lusaka, and Western Provinces, where drought stress occurs frequently.

Zambia's roughly 1 million farms can be divided into several groups based on size and the type of technology used. Approximately 90% have less than 5 ha and are operated with family labor, using few if any purchased inputs for production. On another 8%, with 5 to 20 ha, farmers are more likely to use animal and/or machine traction, hire occasional labor, and purchase inputs such as fertilizer and improved seed. The remaining 2% are large-scale, mechanized operations of more than 20 ha, on which a much fuller range of modern inputs is used. At the top of this last category are some 5,000 commercial farms (many operated by families that date back to the colonial period), which account for some 20% of the nation's agricultural production.

Maize is the staple food of over 80% of Zambia's population and is grown in almost every part of the country. During 1988 and 1989, some 800,000 ha were planted to the crop, and national production was about 1.9 million tons (FAO 1990). The average national yield during this two-year period was 2.3 t/ha, the highest in sub-Saharan Africa. More than 50% of the total maize area is planted to improved seed, mostly hybrids. Many farmers use fertilizer.

The main objective of the Global 2000 Zambia Agricultural Project is to increase agricultural productivity through the transfer of improved technology to small-scale farmers. The project works closely with the Ministry of Agriculture and Cooperatives (MAC), specifically the Department of Agriculture's Extension Service, providing improved transportation and an extensive program of in-service training. The project has been led by two senior international staff—Drs. Jain and Foster during 1986-89 and Drs. Jain and Berhe during 1989-91. They have been ably supported by two national coordinators appointed by MAC—Messrs. M.M. Chiinda during 1986-88 and C. Masi during 1988-91—and by hundreds of extension officers, who have worked tirelessly to bring the benefits of improved technology to small-scale, resource-poor farmers.

The heart of project activities is a field testing and demonstration program. Its primary tool is the approximately 1-acre Management Training Plot (MTP), which serves to demonstrate improved crop production methods and facilitates training of extension workers and farmers. In five years the MTP program—focusing almost exclusively on maize, with very minor emphasis on sorghum—has been extended to five provinces.

The MTP program—During the 1989-90 cropping season, the Department of Agriculture and Global 2000 Project held 17 training courses for extension officers on management of the MTP program. Thousands of farmers participated in 305 field days. Global 2000 staff also participated in 44 on-farm adaptive research trials to evaluate new varieties and cropping systems. These activities

have proved to be effective ways of forging stronger linkages between researchers, extension officers, and farmers.

The performance of the 764 MTPs grown in 1989-90 was excellent, with the maize MTPs giving average yields of 4.0 to 5.5 t/ha, compared to 0.4 to 2.7 t/ha for farmers' traditional plots (Table 6). During this same period, project field staff surveyed the maize yields of farmers who had graduated from the MTP program to determine the extent to which they had adopted the recommended production practices. Once they had to obtain inputs with their own resources, farmers frequently reduced the amount of fertilizer applied. In Eastern Province average district yields in the fields of farmers who had adopted the technology were much improved, ranging from 2.3 to 3.0 t/ha. For Eastern Province as a whole, the average MTP yield was 4.7 t/ha, compared to 2.6 t/ha among farmers who have adopted all or part of the recommended technologies.

In Copperbelt Province, where no MTPs were grown during 1989-90, a follow-up survey was conducted to see how farmers previously involved in the program have fared since. Though this was not a detailed study measuring the full extent of technology adoption, it did indicate that farmers formerly involved in the MTP program who had continued to apply the basic production recommendations obtained an average yield of 3.9 t/ha, compared to 2.2 t/ha before they became involved in the program.

The yield performance of the sorghum MTPs was also excellent during 1989-90. Approximately 517 plots were established in three provinces, where average MTP yields ranged between 1.4 and 3.8 t/ha, compared to 180 and 630 kg/ha on farmers' traditional plots (Table 7). In addition to MTP yields, we sampled sorghum yields on plots grown by previous participants in the MTP program in Gwembe North District of Southern Province. The mean yield for those farmers was 1,152 kg/ha, compared to a forecast of 180 kg/ha reported by the Planning Division of MAC.

Table 6. Yield performance in maize MTPs and farmers' traditional plots, 1989-90

Province/ district	No. of MTPs	Avg. yield (kg/ha) MTPs	Traditional	Percent gain
Eastern				
Nyimba	112	5,475	905	505
Petauke	256	4,398	426	903
Katete	203	4,169	1,317	217
Central				
Mkushi	43	4,807	2,662	81
Serenje	120	3,999	2,398	67
Lusaka				
L. Rural East	30	4,686	1,490	214

On-farm research—Global 2000 staff were actively involved in adaptive research trials conducted in collaboration with national crop researchers from the Mount Makulu and Msekera research stations. The objective of these trials was to evaluate the relative performance of new varieties of maize, sorghum, and pearl millet, various levels of fertilization, different tillage and planting methods, and the economics of maize-bean intercropping. The results helped us identify superior maize hybrids and sorghum varieties for future demonstration and promotion among farmers. Information from the tillage studies confirmed the benefits of planting maize on ridges (compared to planting on the flat) for overcoming problems of waterlogging in poorly drained soils.

Conclusion of the project—With the 1990-91 cropping season, the Global 2000 Project in Zambia is being brought to a close. In this final season, nearly 1,300 maize and sorghum MTPs are being grown in five provinces (Table 8). Some 374 of these plots are being financed with funds obtained through recovery of MTP input loans provided during 1989-90.

Table 8. The MTP field program in Zambia for the 1990-91 cropping season

Province/ district	Maize	Sorghum	Total
Eastern			
Nyimba	147	—	147
Petauke	92	—	92
Katete	181	—	181
Lusaka			
L. Rural East	20	—	20
Kafue	20	50	70
Central			
Mumbwa	200	—	200
Mkushi	130	—	130
Serenje	300	—	300
Copperbelt			
Copperbelt Urban	90	—	90
Southern			
Gwembe North	—	55	55
Total	**1,180**	**105**	**1,285**

Table 7. Yield performance in sorghum MTPs and farmers' traditional plots, 1989-90

Province/ district	No. of MTPs	Avg. yield (kg/ha) MTPs	Traditional	Percent gain
Central				
Mumbwa	30	3,832	630	508
Lusaka				
Kafue	60	1,902	239	696
Southern				
Gwembe North	417	1,396	180	676
Total	507	1,600	214	648

The conclusion of the project at the end of its planned five-year phase has been prompted by several factors. Certainly, a major one was the decision of the original donor, BCCI, in mid-1990 that it could no longer fund the project. Global 2000 was able to acquire sufficient bridging funds from the Abu Dhabi Investment Authority to finance the fifth year of the project. Even so, management elected to end the project at the end of phase I rather than continue operations on a year-to-year basis with uncertain funding. The two senior Global 2000 international staff in Zambia, plus the many national collaborators from MAC, believe that the objectives of the program continue to be relevant and complementary to the country's efforts to increase the production, resource efficiency, and income opportunities of small-scale farmers.

In his letter informing the permanent secretary of the National Commission for Development Planning that the Global 2000 Project would end on 30 June 1991, Mr. N.E. Mumba, permanent secretary of agriculture and water development, offered this summary of Global 2000's contributions:

> You may wish to note that output performance of this project has been particularly successful as determined by the monitoring database. Implementation of Phase I has induced enthusiasm among agricultural extension officers and farmers. Productivity and production of maize per hectare in the Global 2000 operational zones has by far outstripped the national per hectare average. The net benefit per hectare from employing the maize technological package recommended by Global 2000 has significantly increased household income levels for project farmers. The Program has further demonstrated that small-scale farmers have the capacity to obtain high yields that are comparable to those of commercial farmers given adequate producer support programs and incentives.

This summary reflects Global 2000's own assessment of project activities in Zambia. With the successful completion of thousands of MTPs and the exposure of as many as 140,000 farmers to improved technology through numerous field days held in five provinces, the original goals of the project, as outlined in Mr. Mumba's letter, have been accomplished. The project has clearly demonstrated that small-scale farmers in Zambia are able and willing to increase their productivity and that outstanding hybrids and varieties and improved production packages are available for helping them achieve this end. The country has the capacity to expand its commercial agricultural sector and possesses one of the most effective national seed industries of almost any country in sub-Saharan Africa.

Senior management of Global 2000 believe that the major problems holding back agricultural development in Zambia, especially among small-scale farmers, are of a policy nature. The government's long-term policy of heavily subsidizing consumer food prices in support of urban dwellers has resulted in distortions in the relative prices of many goods and services and has served as a disincentive for agricultural modernization and development. Until changes occur at the policy level, the effect of technical efforts to accelerate agricultural development will remain quite limited.

Global 2000 hopes that MAC will continue to conduct a technology transfer program for small-scale farmers based on the MTP model. Much remains to be done at the grass roots level to bring the benefits of improved technology to resource-poor farmers outside the commercial agricultural sector. With a clearer view of the possibilities, government decision makers now face the challenge of implementing policies and programs that will make a reality of Zambia's good prospects for a green revolution.

Benin and Togo

SG 2000 Agricultural Project activities were begun in Benin during 1989 and in Togo during 1990 by staff from the SG 2000 Project in Ghana. In 1991 the Togo and Benin projects are under the leadership of a director, Dr. Marcel Galiba, who is based in Benin, and a senior scientist, Dr. Mathias Akposoe, who is stationed in Togo.

Activities in Benin—The SG 2000 Benin Agricultural Project is being carried out in collaboration with the Ministry of Rural Development and Cooperative Action and currently operates in five regions of the country through the extension service. The project's main activities are to transfer appropriate technology and promote farmers organizations. Recommended packages of improved agricultural production practices are tested and demonstrated in PTPs of about 0.5 ha according to an approach described in other SG 2000 reports. The project in Benin is putting much greater emphasis than other SG 2000 programs on the development of farmers groups and associations. In fact, farmers cannot take part in the PTP program unless they belong to an organized group or form one.

PTPs in Benin—In 1990, 1,651 maize PTPs and 87 sorghum PTPs were grown in five regions of Benin (Table 9). About 85% of the farmers involved were land owners; only 6% rented land, and the remainder were cropping government land free of charge. Most of the land on which PTPs were grown had been planted the preceding year to maize, another cereal grain, or some other crop. Only 14% of the PTPs in Atacora Region and 27% in Atlantique Region were planted on land that had been in fallow the previous year.

Table 9. The PTP program in Benin, 1990

Region	No. of PTPs		Preceding crop (% of PTPs)			
	Maize	Sorghum	Cereals	Cotton	Cassava	Legume
Atacora	342	60	37	29	—	29
Borgou	374	27	—	100	—	—
Atlantique	180	—	66	—	10	
Mono	185	—	—	—	—	—
Oueme	170	—	30	60	10	—
Zou	400	—	n.a. *	n.a.	n.a.	n.a.
Total	1,651	87				

* n.a. = data not available.

Row planting, improved varieties, use of chemical fertilizers, timeliness of husbandry, and improved postharvest grain storage are the main components of the PTP extension program. The recommended fertilizer dosage for maize is 74-46-28 kg/ha in a split application, and the recommended rate for sorghum is 60-23-14 in a split application. Eight white-grain maize varieties of varying maturity were used in the 1990 PTP program. All are OPVs released by the national research organization and contain germplasm from the International Maize and Wheat Improvement Center (CIMMYT) and International Institute of Tropical Agriculture (IITA). Based on yield data from the 1990 season, several of these varieties will be dropped from the program. In the 1991 PTPs, two varieties from IITA will be promoted: TZB-SR, an intermediate-maturing variety with resistance to streak virus and TZ ESR-W, an early maturing variety with resistance to downy mildew and streak virus. In the sorghum PTPs, only one variety was used—Toko-bessenou, the result of mass selection in local genotypes. It is very late maturing (180 days), tall, and photosensitive and is not responsive to increased fertilizer use.

Average yields in the maize and sorghum PTPs grown during 1990 are given in Table 10. Rainfall during the growing season was erratic. Though sorghum plots experienced the greatest moisture stress, it was also considerable in maize PTPs planted to late-maturing varieties, such as La Posta and Sekou (120 days). The maize PTP package proved to be reasonably profitable, while that for sorghum was not.

Input loan recovery in Benin—The recovery of PTP input loans from 1990 was very encouraging; overall, 85% of the 1,737 loans made had been repaid by April 1991, compared to 100% for the 63 farmers who participated in the 1989 PTP program. In 1991 some 3,000 farmers will be involved, and loan recovery will be closely monitored. All funds recovered from the PTP program will be channelled into a revolving fund for future use in support of SG 2000 field activities.

Table 10. Yield performance in PTPs and farmers' traditional plots in Benin, 1990

Region	Maize yield (kg/ha)			Sorghum yield (kg/ha)		
	PTPs	Trad.	% gain	PTPs	Trad.	% gain
Atacora	3,227	1,000	223	1,460	n.a.*	—
Borgou	2,870	891	222	1,215	n.a.	—
Atlantique	2,420	650	272	—	n.a.	—
Mono	2,549	738	245	—	n.a.	—
Oueme	2,568	770	334	—	n.a.	—
Zou	3,035	700	334	—	n.a.	—
Mean yield	2,800	800	250	1,337	—	—

* n.a. = data not available.

Farmers associations in Benin—Organizing farmers into groups, associations, or cooperatives has been a major activity of the Benin project. More than 120 groups involving 1,737 farmers have been organized. Members are required to buy a social share at 2,000 F CFA ($8) and pay an enrollment fee of 500 F CFA ($2). By the end of April 1991, participating farmers had paid 49% of their social shares and 65% of their enrollment fees. To assist farmers in managing these organizations, group leaders are given training in simple accounting and administration, and members receive instruction in reading and writing local languages. We estimate that in 1991 3,000 farmers belonging to these groups will be involved in the PTP program. Further efforts will be made to improve farm-level grain storage and provide farmers groups with organizational and literacy training.

Activities in Togo—The SG 2000 Project in Togo started in May 1990. A PTP program was established in three regions, involving 73 farmers (Table 11); 32 technical officers from the Ministry of Rural Development participated in training courses and field supervision of PTP farmers. The average size of the PTPs was one acre (0.4 ha). The recommended packages of practices for maize and sorghum were similar to those used in the Benin project.

Table 11. The PTP program in Togo, 1990

Region	No. of PTPs	
	Maize	Sorghum
Kara	28	2
Plateaux	32	—
Maritime	11	—
Total	71	2

In the maize PTPs four improved varieties were used: NH1, Ikenne, Pirsabak 7930, and Poza Rica 7843, none of which gave outstanding yields. More recently developed varieties with resistance to maize streak virus will be introduced in 1991. Improved varieties from Ghana's national maize program are logical candidates for further testing and evaluation. IITA's early maturing maize variety, DMR-ESR-W, also appears to be a good alternative for the savanna areas. No improved sorghum variety was available, so farmers used an unimproved, tall local variety in the sorghum PTPs. During this first year of testing, farmers planted companion plots, using their traditional technology, adjacent to the PTP. Average yields of the maize MTPs were variable from region to region (Table 12). Based on overall mean yields, the PTP technology was marginally profitable for maize but not for sorghum.

During 1991 about 500 maize PTPs will be planted in Togo, and we will start organizing farmers into groups, using the same model as that employed in the Benin program during 1990. The sorghum PTP program will be discontinued until a suitable improved variety is identified.

Conclusion

The experience of the SG 2000 and Global 2000 Agricultural Projects in Africa has demonstrated several important points. First, for areas with generally adequate moisture, improved

technology is now available that can double, triple, and even quadruple yields over those with traditional technologies on most small farms. Second, small-scale farmers are ready and willing to adopt productivity-enhancing technologies, provided that the inputs are made available on time, a market exists for the increased production, and sufficient economic incentives are provided to make it profitable for farmers to modernize production. Third, agricultural extension services, when given adequate transportation and budgets to operate farmer-oriented field testing and demonstration programs, can become effective agents for the transfer of improved technology.

We must also add that there are still formidable obstacles to the development of adequate systems for delivering improved seed, fertilizers, and crop protection agrochemicals, and for providing vital services, including credit, grain marketing, and storage. Eventually, the private sector will play an important role in the development of input-supply systems. But in the meantime, continuing efforts are needed to make public sector organizations function more effectively in serving small-scale farmers. Even with increased private and public sector initiatives to develop national organizations for input supply and grain marketing, these services will probably be deficient at the grass roots level in most sub-Saharan countries for some time to come.

Thus, the battle to keep total food supplies expanding faster than population in sub-Saharan Africa will continue to be an extremely difficult one. In view of the relatively abundant land resources in most countries of the region, more thought must be given to agricultural development strategies that will allow farm families to cultivate

Table 12. Yield performance in PTPs and farmers' traditional plots in Togo, 1990

Region	Maize yield (kg/ha)			Sorghum yield (kg/ha)		
	PTPs	Trad.	% gain	PTPs	Trad.	% gain
Maritime						
Lacs	2,800	1,000	180	—	—	—
Plateaux						
Amou	1,450	1,100	32	—	—	—
Kloto	3,400	1,400	143	—	—	—
Kara						
Assoli	1,800	600	200	1,200	800	50
Binah	2,400	1,600	50	—	—	—
Koza	2,450	1,335	84	—	—	—
Dafelgou	3,200	1,500	113	—	—	—
Mean yield	2,498	1,204	107	1,200	800	50

more land. A way must be found for small-scale farmers to move beyond cultivation systems that depend on the hoe and cutlass to ones in which animal-drawn implements are used for land preparation and planting. Greater use of draft animals will also add milk and meat to the diets of the rural poor, representing an important nutritional gain.

The expansion of animal traction in sub-Saharan Africa has been constrained by animal health problems, such as trypanosomiasis, which is transmitted by the tsetse fly throughout the forest zones of tropical Africa, and East Coast fever, which is transmitted by ticks in East Africa. A more concerted effort is needed to control these diseases, so that animal traction can permit the transformation of small farms of 1 to 2 ha into more viable economic units of 5 to 10 ha. Even doubling and tripling yields on a 2-ha farm will not generate enough additional income to allow farm families to improve their standard of living.

Work at the International Laboratory for Research on Animal Diseases (ILRAD), the International Livestock Centre for Africa (ILCA), and in a number of excellent national livestock research programs will be extremely important in developing methods of disease control and improved animal husbandry. Because these are such vital prerequisites for expanded use of animal traction, this work should be given high priority by funding agencies concerned with agricultural development in sub-Saharan Africa.

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Perspectives on the SG 2000 and Global 2000 Agricultural Projects in Sudan, Zambia, Benin, and Togo

Presented below are the comments of government ministers from the above-listed countries on current agricultural developments and on policies as they relate to the SG 2000 and Global 2000 Agricultural Projects.

Sudan
Ahmed Ali Genief
Minister of Agriculture and Natural Resources

Agriculture forms the basis of Sudan's economy, contributing around 34% of its gross domestic product, accounting for more than 90% of its exports, providing a livelihood for more than 80% of its population, and serving as a source of raw materials for its industry. Though the country's agriculture is mainly rainfed, we have roughly 4 million acres under irrigation. On our approximately 20 million acres of rainfed area, a wide variety of crops are grown, including millet, sorghum, cotton, sesame, wheat, millet, sugarcane, vegetables, and fruits.

As in other African countries, declining per capita food production over the last decade has dictated that we reexamine our agricultural policies and strategies. We have begun to do so, taking into consideration the numerous economic, political, environmental, and social changes that have taken place in Sudan since the country achieved independence in 1956. In our current agricultural strategy, high priority is assigned to food security, and this is reflected in the crop mix that we emphasize in both the irrigated and rainfed sectors. Whereas previously cash crops received most attention from planners, economists, and politicians, the country now has a policy of concentrating more on self-reliance in food production. This change in emphasis accounts for the high priority we now place on wheat, for example.

It also implies significant adjustments in some of our earlier initiatives, specifically the large-scale agricultural schemes, in which huge areas are under central management. One of these—encompassing some 2 million acres of irrigated land—is probably the largest agricultural scheme of its type in the world. This particular scheme was established to produce cotton for export. Now, however, in line with our new agricultural strategy, we are working to expand the irrigated area under food crops, such as wheat. Within the last three years alone, we have increased the area committed to food production by 300% and are making progress in raising yields and production.

Sorghum, which is a key stable food crop in Sudan, figures very importantly in this effort. It is generally grown in the rainfed areas and previously was found only rarely in the irrigated sector. Under our new policies, though, sorghum is treated as a major crop both in irrigated and in rainfed agriculture. Similar shifts have been made with other enterprises. Livestock production, for example, which before was confined mainly to the

traditional rainfed areas, is now being introduced in the modern irrigated sector. To accommodate livestock production, changes have been made in the crop rotations of the irrigated schemes.

Wheat, however, provides an especially encouraging example of the possibilities for raising Sudan's food production. The area that is witnessing the greatest expansion in wheat production is the central part of the country. Because of the short winter in this region, we previously considered it to be marginal for wheat. Nonetheless, it possesses the country's best agricultural infrastructure and includes most of our irrigation schemes. Contrary to our expectations, wheat has proved to be quite successful in central Sudan, and we have come to view it as an important wheat-producing area.

The success of wheat production there was made possible by research aimed at developing a production package that is appropriate for the region's agroecology. The package includes suitable wheat varieties with some degree of heat tolerance. The research leading to their development was characterized by good cooperation between our national research institute and the international research system. Appropriate cultural practices were developed locally through our own research system. Successful promotion of the technology package by the Global 2000 Project has created confidence that farmers can achieve good wheat yields in central Sudan and that production of this crop need no longer be confined to the country's northern region with its more favorable climate. This achievement has also given us greater confidence that our national agricultural system now has a strong base for helping achieve sustainable agricultural development.

Our emphasis on food security requires, in addition to changes in the crops we emphasize, a strategy that takes into account the difficult environmental circumstances in Sudan and other countries of sub-Saharan Africa. In spite of our vast agricultural potential, we continue to experience food deficits, because our food production takes place mainly under rainfed conditions and is subject to drastic reductions caused by drought. In response we in Sudan intend to increase markedly the proportion of our food production that is under irrigation so as to create a better balance between the rainfed and irrigated sectors and strengthen and stabilize the country's food production capacity.

Already, we have considerably expanded the area under irrigation, mainly for food crops such as wheat, sorghum, various legumes, and now maize. Last year, for example, we had only about 700,000 acres of sorghum under irrigation, but now the figure is 1.5 million. Assuming that appropriate cultural practices are employed, including fertilizer application, then we should be able to meet most of our demand for sorghum as food from the irrigated area.

We need to take similar measures with respect to livestock production. To reduce the effects of losses in areas or seasons of severe drought, we need to expand this enterprise in the irrigated areas and are now taking steps to do so. We intend to do likewise with crops other than sorghum whose production is made unstable by drought. Again, our overall aim is to establish a stronger base for food production. Toward this

end we have greatly expanded the capability of our irrigation systems over the last two years through a vigorous program of rehabilitation.

One problem we are facing is environmental degradation, which resulted from poorly planned development, especially in the rainfed areas. During the mid-1940s, for example, mechanized farming was established in Sudan in ecologically unsound ways. The removal of trees brought about the desertification of vast areas of the country. Just last year we began to evaluate the damage and to seek ways of reversing it as much as possible. Now we are implementing a plan for reclaiming land in the hopes of demonstrating practical measures of achieving sustainability in our agriculture. Our plans include the use of crop rotations and extensive tree planting in agricultural schemes in rainfed areas.

Agricultural development in Sudan has been aided by economic policies implemented in the country over the last two years, with the aim of encouraging crop production. Previously, policies were biased toward nonagricultural areas. Because of the negative results of that approach—which were investigated in a review conducted by the National Economic Salvation Conference two years ago—economic policy was sharply redirected in favor of agricultural production. In Sudan's three-year economic plan, it is stated quite explicitly that the salvation of the economy will be based on agricultural development. Accordingly, our investments and laws are being reviewed and reoriented to this goal, and a sizeable share of our resources are being directed toward agriculture. In particular high priority is being given to providing farmers with inputs. As minister of agriculture, I have been encouraged to find a great interest in crop production on the part of business people, particularly as the prospects of other economic activities have diminished. Thus, there is now a very positive attitude in the country about our heightened emphasis on agriculture in economic development. This orientation is also reflected in investment loans for Sudan.

In placing agriculture at the center of our development strategy, we have adopted a policy of encouraging small-scale farmers specifically. By increasing our support to this group in the different regions of our country, we hope to broaden the base of production and encourage development based on self-reliance. Our experience has shown that, by directing resources and assistance to small-scale producers, we can expand agricultural production remarkably.

We have also established policies with respect to marketing of agricultural production. Just before coming to Arusha to attend this workshop, I declared in a press conference the liberalization of marketing and prices of agricultural commodities. I believe this measure will give a real boost to agricultural development in Sudan.

In conclusion I will make just a few remarks about sustainable development in agriculture. In my view the first requirement for reaching this goal is political commitment. The second is agricultural policies that work in the farmers' favor. And the third is a strong agricultural research institute that can provide a continuous flow of new

technologies for improving production. In Sudan we have come a long way toward fulfilling these three requirements. We definitely have political commitment to agriculture and are directing the country's resources toward its improvement under our national economic program. We have also adopted appropriate policies, including the liberalization of markets for agricultural commodities. And, finally, we have a strong national research institute, established in 1904, whose capabilities are well illustrated by our recent achievements in wheat production.

As desperately as we need increased production, we must realize that to achieve this goal at the expense of the environment will jeapordize sustained agricultural development.

Zambia
N.E. Mumba
Permanent Secretary of Agriculture and Water Development

In order to achieve sustainable agricultural development in Africa during the 1990s, we must work simultaneously on a number of critical tasks. One of these is to continue developing improved genotypes along with crop management practices that can enable farmers to obtain optimum yields from the new genotypes. At the same time, we must conserve and even improve the natural resource base of agriculture. As desperately as we need increased production, we must realize that to achieve this goal at the expense of the environment will jeapordize sustained agricultural development.

While working toward increased production, we must also improve food storage at the local level. Present technologies are barely adequate for storing food from one season to the next. As we observed during our visit to management training plots here in Tanzania, technologies are available for raising yields dramatically. An unacceptable share of the increased production will be lost, however, unless we do something about the second-generation problem of local grain storage.

In addressing these issues, it seems to me that more attention should be paid to the views of local experts. My experience has shown that, where their advice has not been taken into account fully in project planning, the result very often has been poor implementation. The involvement of local people should form an integral part of our development strategies, because without their active participation in the formulation and implementation of development programs the effectiveness of these programs cannot be assured.

I will now turn for a moment to the situation in Zambia. We have been informed that the Global 2000 Project in our country will be terminated at the end of next month because of financial reasons. We are deeply disappointed that this decision has been taken at a time when we are most in need of the program. In September 1990 we adopted a policy of liberalization with respect to the one crop, maize, for which marketing was still being controlled by the government. Moves toward liberalization were begun last year, and the process should be complete by 1993. I am afraid, however, that by then—even though agricultural policies will favor maize production—we will not, in the absence of the Global 2000 Project, have the capacity to pay adequate attention to the needs of small-scale farmers. For this reason we appeal that the second phase of the Global 2000 Project in Zambia be continued.

I have brought with me a copy of a newspaper article on the Global 2000 Project in our country, which appeared in *The Sunday Times of Zambia* last week. It says that the program has been highly successful and that farmers will be very disappointed if the program comes to an end this year.

Benin
Mama Adamou-N'Diaye
Minister of Rural Development and Cooperative Action

The agricultural sector in Benin provides the basis for the country's development strategies. It accounts for 40% of gross national product and involves 70% of the population. Benin has an estimated 7 million hectares of arable land, of which less than 15% is cropped annually. Good rainfall throughout most of the country and highly varied environmental conditions should allow greater crop diversification in the future. Because of our ample water resources, particularly the coastal lakes, fishing is an important activity, and there is good potential for irrigation. Benin still has 2.7 million hectares of forest despite the destruction wrought by both man and animals. All in all, our land and other resources are such that future agricultural production could be more important and more diverse than today's. As for human resources, Benin's population is estimated at over 4.5 million inhabitants living in an area of 112,600 km^2.

Two-thirds of the country's total agricultural production consists of roots and tubers and cereal crops. The remainder is accounted for by diverse livestock enterprises (22%), fishing (3.5%), and forestry (7.5%), including firewood, timber, and game. In the past 30 years, the value of this production has increased by an average of only 1.4% annually and is still very low.

The mean cultivated area per rural inhabitant is 1 ha. Three-fourths of the total cultivated area is planted to basic food crops (maize, sorghum, millet, yam, cassava, sweet potato, etc.), 9% to secondary food crops, 8% to groundnut, and 8% to cotton. The distribution of annual crops varies from one region to the next. Palm groves, which serve as cover for the annual crops, occupy most of the southern part of the country.

Though Benin as a whole is self-sufficient in food production, some areas are still at risk, posing a threat to the country's overall food security. Production is largely rainfed and is

subject to sharp fluctuations between years. This makes it difficult for an initiative such as the SG 2000 Project to contribute to raising yields. Farm income is low throughout the country, ranging from 30,000 to 90,000 F CFA (US$100 to 300) a year per rural inhabitant. Greater use of draft animals offers one means of increasing this income.

Traditional agriculture predominates in Benin, accounting for 98% of gross national farm production, and the modern sector is declining. In livestock production particularly, there is a striking contrast between the active traditional sector and the state's deteriorating and often bankrupt modern sector. Traditional modes of livestock production, whether sedentary or nomadic, have survived economic fluctuations by adapting to changing circumstances, while the state's model farms have been unable to achieve their production objectives, much less serve as an example for others.

The situation is much the same in fishing. In so-called industrial fishing, production has dropped from 20,000 t to less than 1,000 t a year. Similarly, most firewood is gathered from the existing cover, and few plantations are set aside for this purpose. There is considerable destruction of wild game as a result of poaching and brush fires. Added to these problems are difficulties in supplying the rural sector, along with a lack of credit and marketing facilities. Fertilizer use is insufficient for meeting productivity objectives and restoring nutrients depleted by cropping. One reason for low use of this input is that so far Benin has had no reasonable credit policy for production of basic crops.

All sectors of Benin's ailing economy are in need of rehabilitation. The World Bank and International Monetary Fund are helping the country to meet this challenge within the framework of a structural adjustment program initiated in 1989. Fortunately, the agricultural sector was not entirely destroyed by the Marxist military regime and was in fact the only sector that successfully withstood its pernicious effects. Even so, the agricultural sector is not as productive as it should be, considering its assets and the technical and financial support it has received from the international community. For this reason and in order to rebuild the domestic economy, which depends heavily on farming, it is necessary to define an agricultural strategy.

Benin's rural development policies are part of a broader national effort to achieve democratization of public life and economic restructuring, with emphasis on the balance of payments and public finances. These goals were established following a historic conference held in Benin during February of 1990, in which the country chose democracy and a multiparty system. The stability that now prevails in Benin should encourage foreign investment and foster more active cooperation with other countries.

The farming sector offers ample opportunities for development. The principal objective of our agricultural development policy is to improve the people's standard of living. The main elements of this strategy are as follows:

- Improving the ability of Benin's products to compete in international markets

- Increasing and stabilizing rural incomes and upgrading rural services and infrastructure

- Developing an early warning system to anticipate food shortfalls, disseminating price information, ensuring village supplies, and developing a network of rural roads

- Protecting the natural resource base and developing a plan aimed at achieving proper resource management in keeping with our commitment to future generations

Test plots established by the SG 2000 Project have given encouraging results throughout the country, leading to widespread interest in the project among farmers. During the 1989-90 growing season, when the project was initiated, there were only 63 test plots covering 31.5 ha. Today there are more than 3,000 plots, and many more are expected to be sown in the future.

The government of Benin is strongly committed to helping ensure the success of the SG 2000 Project, and this is reflected in the country's 1990-95 plan for supporting agricultural production and farmer organizations. The establishment of democratic government in Benin has created favorable conditions for investment, especially in agriculture. Consequently, it should be possible to integrate project activities with work funded by other development agencies.

In a recent meeting with high-ranking officials of my ministry, Dr. Marcel Galiba, country director of the SG 2000 Projects in Benin and Togo, explained the projects' philosophy and potential for progress. It was proposed that project activities be conducted in close cooperation with other initiatives. In the future actions we hope to make progress toward the following aims:

- Making rural areas, especially the most productive ones, more accessible to facilitate the distribution of inputs and marketing of farm produce.

- Processing of agricultural products on the farm to increase their value added and improvement of storage facilities through low-cost technologies that are adapted to local conditions. These actions could go a long way toward assisting women, who often are neglected in agricultural development programs.

- Creation of an agricultural promotion center for helping unemployed youth get established in farming.

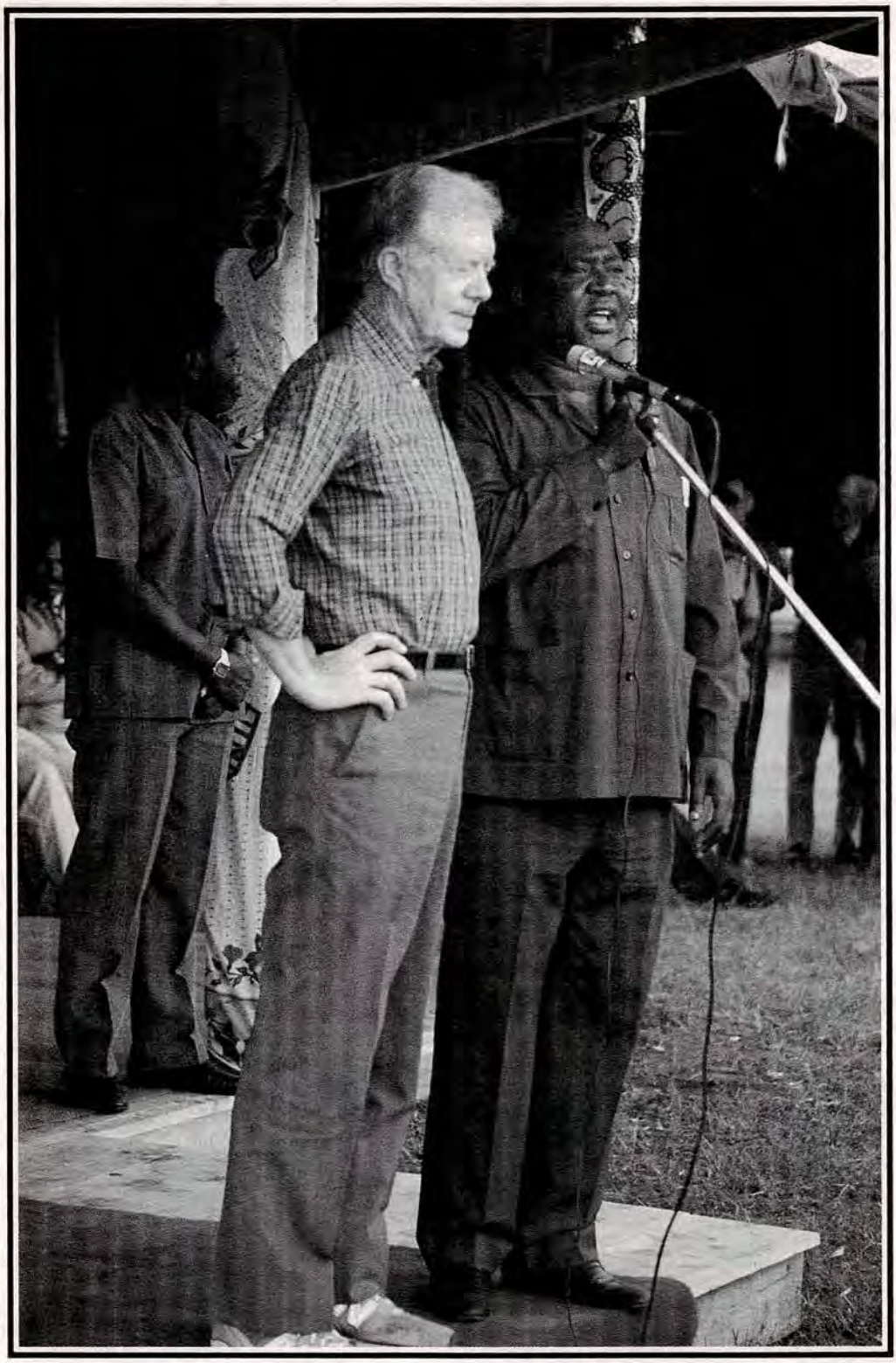
- Promotion of increased and more efficient use of organic fertilizer in integrated systems involving field and tree crops as well as livestock.

In conclusion I wish to point out that my country is convinced that there can be no democracy without development, just as there can be no development without democracy.

Togo
Koudjolou Dogo
Minister of Rural Development

The SG 2000 Project in Togo was initiated only a year or so ago, but my impression is that it has already had positive effects. The project is enabling us to address a number of important issues, the first of which is the feasibility of offering loans in support of food production. As many of you know, most of our programs for rural development are subsidized and are concerned generally with the production of cash crops for export rather than food crops. As a result, we have not previously provided loans to food producers, and their access to improved technologies has therefore been limited.

Farmers are very enthusiastic about the SG 2000 Project, and those participating in it have nearly doubled their crop yields. We feel that the challenge of extending credit to food producers is now being dealt with effectively through the ambitious yet realistic program of the SG 2000 Project. Other problems remain, however, particularly in food storage and marketing. They are not yet extremely serious, however, since in Togo we have still not seen a real revolution in food production.



International Governance and Agricultural Development in Africa

Jimmy Carter
Former President of the USA

I would like to point out several circumstances that give us cause for encouragement as we consider sub-Saharan Africa's future and that help put the African situation in perspective.

It is interesting to recall, for example, that major technical innovation in the agriculture of developed countries is a relatively recent phenomenon, as the experience of my own family illustrates. Ever since my father's family arrived in North America from England 361 years ago, they have been farmers. In fact, I was the first one who had the chance to finish high school. Conditions on the Georgia farm where I grew up were quite rudimentary. We had no running water, no electricity, and practically no farm machinery. We planted and harvested all of our crops by hand. We pulled every leaf off the cornstalks and shocked and dried them for use as cattle fodder. We pulled peanuts out of the ground by hand. If our peanut yield was a half ton per acre, it was worthy of a front page story in the local newspaper.

So, not that long ago agricultural technology in my own state was little different from what it is in much of sub-Saharan Africa today. Now, of course, Georgia peanut farmers regularly obtain yields of 2 tons per acre. The increase has resulted not so much from mechanization as from the application of basic science and technology to production, which led to better varieties, improved soil fertility, and new knowledge about crop development.

I am currently chairing a committee for the Carnegie Foundation that is analyzing the need to introduce science and technology in the developing nations. In preparing our first preliminary report, we have become increasingly aware of a breakdown in relations between donors and recipient countries or communities that greatly limits the transfer of technology. Often, there is little cooperation among donors; sometimes they even compete with one another. And as a result, very little feedback is generated about what works and what does not. Another problem is that developing nations seldom give clear signals about their needs to donors, who are anxious to be part of a success story. Often, the funds and suitable technology are available, but the relations among the groups involved are inadequate and sometimes even antagonistic.

Where development projects in the Third World have succeeded, I think the single most important factor has been competent governance within the countries involved. The recipients of donor funds and services must have the capacity to make efficient use of them. This is not always an easy condition to fulfill, particularly in view of Africa's colonial past. When the colonial powers withdrew from the continent, they left behind little infrastructure and few people with sufficient preparation to deal with the huge challenges that lay ahead. To make matters worse, many of the new governments came into power

through military means, and quite often they distributed government responsibilities less on the basis of experience in education, health care, transportation, finance, or agriculture and more on the basis of service to the revolution. An additional problem is that those now immersed in government administration have far too few opportunities to become personally acquainted with what is going on in the rest of the world or even with developments at the village and family levels in their own nations.

In spite of Africa's growing number of experienced and capable government leaders, progress in agricultural development and health is greatly hindered by civil war.

This particular difficulty is being addressed by the Global 2000 programs in agriculture and health care. Such is the case, for example, in our effort to eradicate guinea worm worldwide. I recall that the first time we visited Pakistan in connection with this project neither the president of the country nor the minister of health had ever heard of guinea worm, even though it was a major problem in many villages. Only after conducting a survey to document the prevalence of this disease, were we able to mount a successful program. The president became closely involved in it, partly because of my visit to Pakistan and also because he sent top officials to the Carter Center to learn more about the guinea worm problem. Now, it seems likely that by the end of this year the disease will be completely eradicated in Pakistan.

That experience and others in the Global 2000 programs demonstrate the importance of working at the micro level with individual farm families and villages and of simultaneously getting major government officials personally involved. They need to see for themselves what can be done and to get some of the credit for it. For example, it is very important for Flight Lieutenant Jerry Rawlings to visit Ghanaian villages and help demonstrate methods of avoiding guinea worm, for the prime minister of Tanzania to visit maize production test plots, and for Tanzania's President Mwinyi to be responsible for the success of an agricultural production campaign.

Unmitigated success stories, however, are hard to come by. Even a highly successful endeavor, like the Sasakawa-Global 2000 Project in Ghana, can be marred by mistakes. But the mistakes of a project can contribute to its success as long as they are viewed as opportunities for learning. The main thing is to be willing to experiment with new ideas in dealing with longstanding problems. In Ghana our mistake was to move too fast, increasing the number of participating farmers from about 16,000 to more than 80,000, far beyond the capacity of the current infrastructure. Out of that experience we have learned valuable lessons that will contribute to the future success of the project in Ghana and of similar efforts in Tanzania.

In spite of Africa's growing number of experienced and capable government leaders, progress in agricultural development and health is greatly hindered by civil war. It will be hard to

engender confidence among donors and deal with development issues effectively until African societies are stable enough to attractive heavy, long-term investment. This is a major challenge for African leaders. Even in the absence of peace, however, it is amazing what can be accomplished. In Sudan, for example, which is engaged in a bitter and costly civil war, the team working under Dr. Norman Borlaug's leadership has contributed to a quadrupling of wheat production in the last three years. Moreover, production has remained fairly stable in spite of severe drought and inadequate use of fertilizer.

One key reason for such success is that the Global 2000 programs emphasize simple technology. Rather than give tractors to farmers who still rely mainly on simple implements and manual labor, we concentrate on the kinds of technology that can be distributed at reasonable cost—such as improved seed and fertilizer. The Global 2000 programs also emphasize training of extension workers, who can carry on the work once the program has come to a close. Another important aspect of the Global 2000 programs is that they are not concerned only with increasing yield at the village level. They also address the need for better grain storage, improved transportation, more prompt delivery of fertilizer, and stronger ties between researchers, extension workers, and farmers—elements that have been missing from many previous programs for agricultural development.

It is extremely important, though, that progress on the technical front be accompanied by a move toward democracy. Ties between government leaders and villagers can be created artificially by someone like myself, through visits and special efforts to promote a particular program in the country. But a far better situation is for the people of every village to believe that the government is theirs and for leaders to learn through the democratic process what farmers and other groups in society really need.

In talking about democracy, I do not intend to imply that Africans must adopt the exact form of democracy practiced in the USA, Great Britain, or some other country. Democracy must be engendered locally and without interference from the superpowers, western European countries, or anyone else. When democracy is well established in Africa, the continent will be better able to achieve sustained improvement in the quality of life.

In almost every African country, I believe, such improvement must start with agriculture, and it must focus on the farm family, in which women quite often make key decisions about crop production and other enterprises. Having begun to deal effectively with problems in agriculture, governments will then be in a good position to provide better health care, improve transportation, preserve the environment, protect wild life, promote tourism, build up their export trade, and create a system of open markets that encourages foreign investment.

In considering the prospects for agricultural development in sub-Saharan Africa, it is helpful to bear in mind that this is not the only continent with serious difficulties. Consider the USA, for example, which is commonly viewed as having the world's most successful agriculture, with vast areas of highly productive land, well-developed infrastructure, and highly advanced science and technology. In spite of all these advantages, however, the US government appropriated $25 billion last

year to subsidize the American farmer in some way. The entire amount—roughly $100 for every man, woman, and child in the country—went to about 4% of the population. The government thus spent some $2,000 per farm family member to subsidize agricultural production. Imagine what could be done if that amount of money were given to farm families in Tanzania or other developing countries.

Much the same problem of enormous subsidies exists in Europe and Japan, creating dissension among countries. The reason the GATT negotiations have reached a stalemate is that the nations involved cannot agree on how much to reduce agricultural subsidies. My point then is that serious problems in agriculture are not unique to Africa and that large-scale mechanization and other technical advantages provide no guarantee of success.

I learned the lesson that big is not necessarily better as a young naval officer. My boss was Admiral Hyman Rickover, who in my opinion was one of the greatest engineers who has ever lived. About 25 years ago, he made a study in his inimitable way of the most efficient use of land for producing food and fiber. The admiral did not conclude that the Iowa or Nebraska farmer in the USA is the most efficient, as you might expect. Rather, he determined that land is used most efficiently by a farm family on about one hectare of good land. He viewed this as the best arrangement for controlling erosion, minimizing the use of energy and outside inputs, and for efficient crop production. My point is simply that much of the technology Africa needs is already available in the form of improved seed, fertilizer, better storage, and so forth. Widespread mechanization is not a prerequisite for more efficient agricultural production.

In concluding I would like to reemphasize the importance of close ties between donors and developing countries. I regret to say that I am the only president of the USA who has ever visited sub-Saharan Africa. I came here while still in office and on a particularly memorable occasion led a church service with General Obasanjo and afterwards visited nearby farms. Such contacts are not nearly frequent enough, and their value is poorly understood. I can honestly say, though, that I have learned a lot more from Africans than I have been able to teach them in the last few years. Yesterday I had one such experience in talking to farmers who had dramatically increased their yields of maize. To me that provides proof that there is no inherent reason why African leaders and citizens cannot achieve drastic improvement in the quality of life. I am very proud of my own relationship with African people and hope to be a part of this continent's great future.

National Governance and Agricultural Development in Africa

General Olusegun Obasanjo
Former Head of State of Nigeria

It is indeed a pleasure to be here today in Arusha examining with you issues that are of critical importance to Africa. Of the various manifestations of the African crisis, perhaps the most disturbing is an obvious decline in agricultural production. We are all aware of the consequences—food importation, famine, and so forth. The root causes of this problem are numerous. Certainly, some of them lie in the nexus of national government and agriculture.

Perhaps the greatest problem in this regard has been overcentralization of political power. There is also the epiphenomenon of overcentralization in the formulation and implementation of policy. Particularly irritating is the spectacle of arrogant central government officials who believe that local government structures are staffed by less capable individuals and therefore unable to make worthwhile contributions to policy making. As a consequence, the problems in rural areas and agriculture production have often been compounded by efforts made to resolve them.

From a generation of experience, it is plainly apparent that the centralization of project funds has been one of the major causes of failure and of the pervasive problems of official corruption and embezzlement. In my opinion it is imperative that governments be structured in such a way as to place real power at the lowest tiers. Government at the local level must not be made to seem a mere appendage of the central or state government. It must be given the required degree of autonomy and the means of acting forcefully to meet the challenges of sustainable development in all sectors of society. Authority without resources will lead to further abortive efforts.

In addition, rural people must achieve better access to government institutions if they are to contribute effectively to policy formulation and decision making. It is high time that we in Africa realize the efficacy of decentralized government that emphasizes accountability, the devolution of authority, the decentralization of funding, and the democratization of access to resources.

We must also take due cognizance of institutional proliferation, especially in agriculture, which has created confusion, unnecessary overlap and duplication, and destructive rivalries. An even more disturbing consequence is that limited budgets in the agricultural sector have been expended more often than not on

endless chains of government bureaucracy at the expense of inputs and equipment. The consensus of opinion among students and practitioners of African agriculture is that governments have sent confusing signals to African farmers. There are two main reasons for this: first, the inconsistency of government policies and, second, instability in the staffing of government institutions.

Where government policies are erratic, there is a strong disincentive to invest in agriculture. Investors like stability and predictability. In my view the errors of African leadership can be broadly categorized as mistakes of omission and mistakes of commission. While the former result from ignorance and limited experience, the latter are deliberate and calculated actions in the service of narrow interests. The regularity with which the same mistakes are repeated makes it very hard not to conclude that most of the mistakes made in African agriculture are errors of commission.

Compounding the problem of confusing signals given by government institutions is the high rate of turnover of political leaders in agriculture. In many cases new political leaders create new policies as if none had existed before. Though not exclusive to agriculture, this is nonetheless a worrisome trend that robs us of the vitality, experience, and practical understanding that we need for meeting the challenges of agriculture effectively.

In my own country, Nigeria, we have had 18 ministers of agriculture since the establishment of a Ministry of Agriculture in 1965, giving us an average of about one minister every 15 months. That, you will agree, is not an enviable record. But I suspect that similar, if not worse, situations prevail in other Africa countries. As a result, consolidation and follow-up of existing projects seldom feature on the agenda. Creating new projects provides much more gratification than the maintenance of old ones.

Another policy mistake that African governments have made over the years has been to pay inadequate attention to the development of human resources for increasing agricultural output. The development of agriculture in Africa depends on our ability to draw effectively upon the continent's vast human resources. It is vital that we create programs that are capable of mobilizing small-scale farmers for more efficient use of agricultural resources.

Arguably, poverty is at the root of our present mismanagement and inability to sustain agricultural production. Among other consequences, poverty prevents farmers from acquiring needed capital for the purchase of other inputs. Particularly baffling in these circumstances is that our governments do not encourage differential lending rates for agriculture. In my own country, the interest rate for agricultural credit was as high as 32% only six months ago. Such rates are bound to stifle investment and keep rates of loan repayment low, discouraging further lending to the agricultural sector.

One of our first priorities then must be to enhance farmers' income by stabilizing their earnings from the sale of agricultural output. Farmers ought not be subjected to the whims of the middle-man and market forces alone. Agriculture must be at the center of our policy formulation. Our modes of governance must take due cognizance of our essentially agrarian setting.

One of the problems with African agriculture is the fragility of its topsoil, which is highly subject to erosion, especially where extensive deforestation has taken place. Partly the result of natural forces, erosion is further aggravated by the activities of a growing human population. A related problem is the exhaustion of soil nutrients where land is left in fallow for an insufficient time. African soils will require skilled management if we are to achieve sustainable agricultural production. The continent's most fertile soils lie here in the eastern part of Africa, though even here sloping soils are at great risk of erosion and the alluvial soils are prone to waterlogging. African farmers have developed ways of coping with these difficulties over time, but these methods have in recent years become part of the problem. Nomadic livestock raising was perhaps the only practical system for those areas of Africa in which sparse and erratic rainfall made it necessary to move livestock continually in search of good pasture and water.

Farmers' attachment to the land is fundamental to their feelings of self-esteem and freedom from coercion.

Slash and burn agriculture was hitherto considered appropriate for the forest and savanna areas, with their abundant land and low population density, because it allowed long fallow periods for the land to regenerate. Now, however, this system has become problematic. Rapid population growth has made it impossible in many parts of Africa to maintain the traditional extensive cropping and livestock systems. Pressure on the land is forcing farmers to shorten the fallow periods, causing a decline in crop yields and overgrazing. As the vegetative cover of the soil is weakened, soil erosion and degradation accelerate. In view of these developments, it is crucial that more productive technologies be developed and adapted to the requirements of our farmers and environments.

Agricultural development must be based on a joint effort between farmers and the government. In order for such an undertaking to succeed, the government must make a concerted effort to provide farmers with secure land tenure. My rural and Baptist upbringing has taught me that farmers' attachment to the land is fundamental to their feelings of self-esteem and freedom from coercion. Quite apart from these humanitarian considerations, land reform often brings increased production in its wake.

In fact, land reform is often cited as a first condition for increased agricultural output. A more than cursory examination of the economic structure of rural areas in most, if not all, African countries reveals that a generally inequitable pattern of land ownership contributes strongly to the inequitable distribution of rural income. This situation has very much determined the character and overall pattern of agricultural development. Unequal distribution of land greatly limits the hopes and possibilities of small-scale farmers for economic advancement. If planned and implemented effectively, programs of land reform can help establish the basis for converting subsistence into mixed farming with

increased output levels and improved standards of living for small-scale farmers.

Of course, egalitarian land reform is not by itself a sufficient condition for agricultural development. It must be complemented by programs for strengthening rural institutions whose activities impinge on agricultural production—such as the rural banks and systems for distribution of seed, fertilizer, and other inputs. In addition, we must strengthen government services, including extension, credit agencies, storage and marketing facilities, and rural transportation.

Another important issue is that of government policy on the pricing of inputs and outputs. In some parts of Africa, where inequitable land distribution is not necessarily the root cause of low productivity and income, a broad network of external support services and appropriate pricing policies is vital to the achievement of sustained agricultural development. Increased productivity of land and labor would permit African populations to feed themselves and increase income without greatly expanding the cultivated area. These are essential conditions for transforming the vicious cycle of agricultural stagnation and environmental degradation into a virtuous one of growth and conservation.

Higher agricultural incomes, especially in conjunction with improved education and health care, should encourage smaller family sizes, thus helping to reduce pressure on the environment. Achieving these goals will require the collaborative efforts of millions of African farmers acting in their own interests to modernize and sustain the region's agricultural development. Whatever mode of governance we choose, it must be one that gives African farmers the promise of a brighter future and improved quality of life. In conclusion, let me emphasize that if we in Africa cannot reach the moon, and surely we cannot, we should at least be able to reach our neighbors and our environment and contribute importantly to our own survival and that of the rest of the world.

Governance and the Sustainability of Agricultural Growth

*Elliot Berg**

Recent discussion of sustainable agricultural development has concentrated on environmental and technological problems: how, for example, to prevent soil exhaustion as population growth or new cropping possibilities lead to more intensive methods of production. The focus is right, these are fundamental issues. By the end of this decade, according to the Food and Agriculture Organization, the amount of cultivable land per person in the developing world is likely to be down by almost a quarter of the amount available in the early 1980s; and soil erosion, salinity, overgrazing, and lack of water could take another quarter of the total then available out of production. Sub-Saharan Africa, with its fast-growing population and its slow rate of technological change, shares these worldwide problems in full measure.

Economic policy—the dimension of governance that concerns us here—has numerous and profound effects on environmental sustainability. Experience and analysis have made clear that ill-considered policies often have extremely negative environmental consequences:

- Investment incentives and other subsidies or overvalued exchange rates can induce rates and patterns of deforestation that are economically unjustified as well as environmentally damaging.
- Protectionist trade policies aimed at food self-sufficiency objectives can translate into increased erosion via intensified hillside cultivation of food crops.
- Subsidized irrigation water encourages wasteful use and ensuing salinity.
- Benefits from the use of subsidized agricultural chemicals have to be weighed against the costs of poisoned groundwater and contaminated rivers.

Everybody now recognizes how important environment-sensitive policies are to achieving sustained agricultural growth. There is, moreover, a wide area of consensus between most economists and environmentalists about what the right policies are; most involve removal of divergences between private and social costs and benefits.

There is less consensus in a second area of public policy, which is central to agricultural sustainability and which also receives a good deal of attention—the role of the public sector as price setter, regulator, and provider of services to farmers. The range of policies at issue here is vast: It includes price supports and stabilization policies; subsidies and fiscal policy; food security management; and the respective roles of parastatals, cooperatives, and private

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traders—what in French-speaking countries is called the *organization du monde rural*.

These policies were reshaped during the 1980s in much of sub-Saharan Africa as part of formal structural adjustment programs or more informally as part of the worldwide swing toward a smaller role for the state. Thus, government price support efforts and stabilization arrangements have become less pervasive; input subsidies have been reduced or eliminated; and parastatals have been closed down or partially privatized and the scope of their activities often reduced.

Many observers, including numerous African policy makers, are unhappy about these changes, which they believe to be misguided. They argue that profoundly important functions need to be performed in rural Africa in reducing farmers' production risks, addressing market failures (such as inadequate access to credit), and creating or maintaining infrastructure. The weak private sectors typically found in African countries, they say, simply are not up to the job. Moreover, the attacks of liberalizers against input subsidies are said to be based on overly simple analysis and to ignore the need for intensified production. It is said also that African playing fields are not level; free markets will favor those with privileged access to information and credit and will accentuate rural inequalities.

In this paper I will consider three contested issues: 1) whether governments should try to provide floor prices to producers along with greater price stability; 2) whether fertilizer subsidies should be retained or reintroduced; and 3) whether current policy trends entail too great a shrinkage of public institutional presence in agricultural markets. More than the usual caveats about African generalizations apply here. Country conditions are highly diverse; experience is varied and often poorly documented; and the issues are complicated. I set out the arguments rather starkly for want of time and to facilitate debate.

Floor Pricing and Price Stabilization

Risk and uncertainty are greater in agriculture than in other sectors. World commodity prices are volatile, as are domestic prices for food crops. This led African governments in the past (and most other governments, one should add) to set official minimum producer prices and maximum consumer prices and to try to stabilize prices paid to producers of export crops.

Floor pricing—Proponents argue that unless government acts as a buyer of last resort, assuring producers a minimum price for food crops, incentives to acquire new inputs and adopt new technology will not exist, ruling out sustained output growth. The reasoning is straightforward. Rainfall remains the main determinant of output almost everywhere in the region, and annual variations lead to wide production swings. Marketed production varies even more widely than total production, because so much output is for own consumption. Fluctuating output and marketings, combined with inelastic domestic demand, create big interannual fluctuations in prices. (In many places these tendencies are accentuated by the presence of heavy inflows of food aid, which are often poorly timed because of unforeseen delays in arrival or poor

planning.) Most important, increases in marketed food production will punch prices sharply lower in the absence of price supports.

These considerations led one recent World Bank-sponsored study to conclude that "without some minimum support for prices as *one* (author's emphasis) element of a larger modernization strategy it is unlikely that modernization of agriculture will occur" (Lele and Christiansen 1990). However, there are strong reasons to doubt the desirability and feasibility of price supports in the context of dryland farming.

- Given variable rainfall, highly variable marketings, and inelastic short-term demand, the financial cost of buyer-of-last-resort policies is sure to be high. Marketings are large in good years, leading in the absence of export possibilities to sharp falls in open-market prices.

- The financial costs of carrying food stocks are heavy, and their management is demanding. Physical spoilage can be substantial. Interannual storage is also risky; two good years in a row can spell financial ruin.

- Since frontiers are so permeable, the benefits of floor prices have to be shared with producers in neighboring countries.

- The macroeconomic effects of floor price policies are almost certainly negative. In the absence of compensating policies, the production of substitute crops suffers; export earnings are less, and real incomes are lower.

- There are better ways to spend public money for sustainable agricultural development—for example, on maintenance and expansion of infrastructure, agricultural research, or reduced taxes on farmers.

Recent policy trends have been against support price policies. But these trends are not at all pronounced. For example, the World Bank financed 21 agricultural sector loans between 1980 and 1988. In only four of these (two of which were African) was government abandonment of price-fixing a condition; most of the price policy elements called for raising of official prices (Knudsen and Nash 1989). General structural adjustment loans in sub-Saharan Africa do, however, appear to contain more provisions for price decontrol. And governments have been compelled by budget pressures to abandon price supports in practice; their cereals boards have been too short of cash, transport, and storage capacity to engage in more than minimal crop purchases.

Price stabilization—We have thus far focused on domestic food crops. These are in some cases export crops as well, at least in good years (for example, in Zimbabwe and Kenya). But the major African exports (beverages, cotton, tobacco, and oilseeds) usually operate under different marketing and price regimes. Here a somewhat clearer consensus view has emerged on the issue of price stabilization. Some medium-term stabilization is acceptable to smooth out year-to-year fluctuations in world prices. But prices should stay close to those in world markets. Three-year moving averages are often recommended by the international aid agencies.

This represents a more modest, or less interventionist, view of the role of price stabilization for export crops than was common previously. Several developments lie behind this change. The track record of marketing boards in stabilizing producer prices proved to be dismal; recent studies show that in many countries marketing board prices were less stable than world prices (Knudsen and Nash 1990). In many cases, also, the marketing board's "stabilization" policies were displaced by their fiscal role; they tended to become more concerned with taxing farmers than with price stabilization and support. Moreover, their control over resources often led to low priority and undisciplined public spending.

Reduction or outright removal of fertilizer subsidies is perhaps the strongest, most general policy trend of recent years.

Even when the state trading agencies have tried to support producer prices, they often have tended to wait too long to make adjustments. The resulting subsidies and required budget transfers have wrought macroeconomic havoc, as in Cote d'Ivoire during the late 1980s.

Finally, there was a shift in the intellectual climate, as a number of economists raised theoretical questions about the true benefits of price stabilization (Newberry and Stiglitz 1981). And many observers came to believe that farmers were better able to deal with risk than are governments. Farmers are likely to handle windfalls better and adjust to adversity more flexibly by reallocating household resources between food and cash crops, between cropping and animal raising, and between on-farm and off-farm activities.

Fertilizer Subsidies

Input subsidies have been a common feature of agricultural policy in all developing regions. They became especially prevalent in the 1970s, when governments everywhere sought to cushion the impact of skyrocketing fertilizer prices after the 1973 oil shock. In many African countries, subsidies covered the whole range of inputs—from plows to pesticides. We consider only fertilizers here, because of their importance and because the fertilizer subsidy issue has been at the center of policy debate during the past decade.

Reduction or outright removal of fertilizer subsidies is perhaps the strongest, most general policy trend of recent years. The content of World Bank agricultural sector loans is indicative; 15 of the 21 loans made between 1980 and 1988 were conditional upon reduction of input subsidies.

Government representatives and many outside observers are worried about this trend. They note that in the most common case fertilizer use drops off sharply as subsidies diminish or disappear. They point out that the move to higher productivity requires more intensive methods, which in turn require greater fertilizer use. Without it, sustained agricultural growth will be especially difficult.

In considering this issue, it is important to note that it is not a doctrinal or ideological matter. There are plenty of good reasons—good even from the perspective of ardent free marketeers—to justify fertilizer subsidies. I will list them with brief comments.

- *Learning and adoption of new technology*: African farmers may not know how fertilizer use affects output, especially when it is part of a new technological package. Without subsidies they will use "too little" of it.

- *Risk aversion*: Use of fertilizer involves risks, notably in rainfed agriculture, since rainfall may be inadequate to assure a profitable response.

- *Lack of access to credit*: Farmers may know that it pays to use fertilizers and be ready to run the risks involved in its use, but there are often no banks or other credit institutions that will lend them money to finance the purchase of this input.

- *Soil fertility*: Fertilizer use can help rebuild soil fertility in cases of intensive land use.

- *Income distribution*: Where marketed output is concentrated among a few big farmers, input subsidies can be a more equitable way to stimulate production.

- *Compensation for taxes*: When farmers pay taxes on their output that are imposed to generate revenue and if production responds well to fertilizer, a subsidy can be the most cost-effective way to increase output.

- *Food self-sufficiency*: When greater food self-sufficiency is a policy objective, it can conceivably be achieved most cost-effectively by subsidies.

The questions one must ask about these arguments are, first, whether they are generally applicable and carry significant weight and, second, whether the negative impacts of subsidies are outweighed by their positive potential. Most of the negative arguments are well-known.

- The lack of information rationale is at best a reason for temporary subsidization, and in fact there are probably no longer many places where it fully applies, since farmers have been exposed to fertilizer messages for a generation or more even in Africa's most sluggish economies.

- Risk aversion seems to justify only a little subsidization; recent studies have found that most farmers are only moderately risk-averse when returns to fertilizer use are more than trivial. And risk can be reduced—for example, by using sidedressings of urea only after crops are established.

- Capital market imperfections provide a limited rationale for subsidizing all inputs. But subsidized institutional credit has well-known limitations and deficiencies, and informal credit markets do exist and serve many farmers. A first-best policy is to directly address the credit constraints.

- The income distribution argument turns on the question of whether fertilizer subsidies are more equitably distributed than the gains from price increases. Although it is true in many African countries that marketed production is concentrated among bigger, richer farmers, the same is

true of fertilizer distribution—in other words, it tends to go to zones that have better soils and rainfall, irrigated areas, bigger landholders and village influentials, and males. Not enough is known about these relative inequalities (concentration of benefits of product-price increases and fertilizer subsidies) to make a general statement.

- The soil-enrichment/conservation argument is two edged. In Africa's most vulnerable areas—the semiarid tropics—what seems to be most needed is adoption of less-expensive and better adapted organic fertilizers and secondly use of moisture-retaining methods. Also, there is evidence that sustained use of chemical fertilizers, without large applications of animal manure, leads to soil depletion (Matlon 1983).

The most persuasive reasons against fertilizer subsidies are institutional in nature. First, in practice a subsidy-ridden input-supply system generates organizational inefficiencies and consequent resource misallocation, almost always on a scale that swamps the misallocation effects of "wrong prices." Second, subsidies discourage "learning." They slow up the development of a peasantry that is more aware of technological options, more market sensitive, and more flexible. They also hold up the emergence of private input-supply networks. All of these institutional effects have profound implications for sustainability.

Organizational inefficiencies—Organizational inefficiencies have typified subsidized input (fertilizer) supply systems in Africa. One of these inefficiencies is late delivery at the farmgate. This is of some consequence, since yield (the value-to-cost ratio) is usually highly sensitive to time of application, falling sharply even with slightly tardy use.

One common reason for late delivery is the financing system. Because of the timing of the budget process, the amount of financing available is often not known until relatively late in the fertilizer cycle, often too late to arrange imports. The government tendering process is also a frequent source of delay. Procurement procedures are slow, and priority is often not given to time-sensitive goods like fertilizers. In some countries it can take 8 to 12 months to bring fertilizers to users. The logistics of distribution are demanding, given weaknesses of public sector trucking systems and difficult road conditions.

The public sector delivery systems that usually administer subsidized input arrangements tend to run unspecialized or uniform operations. They often follow panterritorial pricing practices; the delivered price is the same for all users, regardless of location. They offer few alternatives in nutrient mixes. Despite the fact that soil needs vary by crop and location, "shotgun" approaches are common. One formulation will be used for, say, coffee and maize in the humid forest zones, or in semiarid regions one formulation may be used for cotton, millet, and sorghum.

Subsidized systems tend to generate endemic excess demand; farmers want to buy more fertilizers than can be financed at existing prices. Rationing becomes necessary and gives rise to allocation of rents or corruption. Bigger, better-located farmers get more than others. In the past women were often discriminated against, because they grow food crops that usually are not eligible for subsidies.

Obstacles to learning and institution building—When inputs are subsidized and marketed by state agencies, farmers have reduced opportunities for learning and for growth of managerial competence. For example, subsidy systems that are characterized by constant disequilibrium between fertilizer supply and demand do not encourage farmers to learn how to make marginal decisions on input use. Part of modern farm management is discovering how to adjust inputs and outputs as relative prices and other conditions change. Since the price of fertilizer is almost always held below market-clearing levels, farmers only know that they would like to have more than they can get and are rarely induced to learn how to judge the optimum level and pattern of use.

Input subsidies usually impede the development of private input marketing for one obvious reason: Private sellers cannot compete with lower priced (subsidized) inputs marketed through parastatals and other public sector channels. There is nothing inherently contradictory between subsidies and the growth of private marketing agents: Subsidies could be granted without discrimination to all buyers, public and private, ex-port or ex-factory. And parastatals could operate transparently by including all other subsidies in their cost structure. In fact, neither is ever done.

The first reason for this is that unless quantities supplied are big enough to eliminate the need for rationing, the first buyers enjoy rents (or unearned incomes). And even if supplies are adequate to eliminate rents at the subsidized prices, responsible officials rarely believe that markets are sufficiently competitive to assure that subsidies would be passed on to farmers. Secondly, parastatals (and related public sector agencies) rarely account for the many implicit and explicit subsidies they receive. In practice, therefore, subsidized input systems tend to involve public sector monopoly of all or most of the distribution network.

The result then, in institutional terms, is stunted growth of the private sector, the retarded emergence of decentralized commercial competence, and slower deepening of commercial capital. This is a matter of genuine consequence for the sustainability of African agriculture, since it is hard to envisage transformation of lagging agricultural systems without the presence of a class of dynamic intermediaries—traders, transporters, artisans, financiers, bigger farmers—who can sell and rent inputs to smallholders and help bring to the village level new knowledge and approaches. This theme is taken up in more detail below.

Parastatals, Cooperatives, and Private Sectors

Governments in Africa have always had a large presence in agricultural markets, as they have elsewhere. Price and marketing controls were common everywhere in the region, some of them exercised through parastatals (state-owned enterprises) created in the 1920s or 1930s, notably in ex-British Africa. In the 1970s parastatals became the vehicle of choice for implementing government agricultural policies and programs. Monopoly or single-channel marketing arrangements flowered; price controls spread; and the public sector agencies became the principal or exclusive supplier of inputs and purchaser of outputs.

According to an analysis made in 1980, in 26 out of 39 countries studied, fertilizer supply and seed distribution were entirely state controlled, and in 10 other countries it was jointly controlled. State control over other agricultural chemicals and agricultural equipment sales was only slightly less prevalent. In only four countries, was the private sector the sole supplier of fertilizer and seed, though it controlled the distribution of pesticides and agricultural machinery in some eight countries (World Bank 1981). On the output marketing side, government-controlled cooperatives or parastatals had legal monopolies of purchase not only of export crops but also of food crops.

Since 1980 the state has retreated from its dominant position in agricultural marketing and other service provision. Redefinition of parastatal roles, deregulation, encouragement of private sector participation—these have been typical of the policy orientation of the 1980s.

A substantial body of opinion is critical of this shift in policy direction. One line of argument is that the parastatals have performed vital functions and could continue to do so; the implication is that some of the criticisms of parastatal deficiencies are misplaced. A 1988 World Bank review of agricultural marketing experience contains the following observations:

> Current disenchantment with parastatals should not be allowed to obscure the important role they have played in developing countries in Africa and Asia. They have been the dominant market force in export products and large scale grain marketing. . . . Sometimes, parastatals have been used to wrest control of the marketing system from ethnic minorities, in which case political considerations may well have overridden concerns for efficiency. In other cases, governments seem to have felt that it was easier to replace an oligopolistic marketing structure than to regulate it. In yet other cases, governments have seen parastatals as a way of ensuring government "control" of domestic food supplies. They have been unwilling to leave this vital function, especially stockholding, in private hands.

Redefinition of parastatal roles, deregulation, and encouragement of private sector participation have been typical of the policy orientation of the 1980s.

The second main avenue of criticism concerns the assumption that private actors can take the place of the parastatals. Market conditions are extremely demanding. Physical distances are large in most countries, while transport and communications are poor. Prices are volatile, and credit is costly and difficult to obtain. Risks and uncertainties are high and pervasive. At the same time, private traders are inexperienced, risk averse, poorly capitalized, usually unspecialized, and almost all small in scale.

These criticisms are partly valid. Some parastatals did fulfill special historical

functions, such as allowing national control at a time when indigenous private sectors were almost nonexistent. They did (and still do) exploit economies of scale in processing activities. And they were not invariably inefficient in fulfilling these and other functions, as is suggested by the experience of cotton development agencies in West Africa and the Kenya Tea Development Authority (until recently). Much of what went wrong with them—their large financial deficits, for example, and their chronic overstaffing—was due more to political intrusion than to management failures.

Unrealistic expectations about privatization have also been common—a tendency in some quarters to believe that even partial liberalization in thin markets would lead private sectors to take over quickly as the parastatal presence was withdrawn. The transition proved much more intractable, especially in fertilizer distribution, where privatization was often combined with subsidy reduction, leading to shrinkage of already small demand and making these markets unattractive to private traders.

Nonetheless, some elements of the critique of recent policy changes are overdone. The notion that privatization has been taking place with unseemly haste, for example, is much exaggerated. The parastatals have typically been pruned rather than cut down. When efforts have been made to get rid of them, they have shown great resilience, in some cases reappearing under new names and with different donor financing.

The Senegalese experience may be typical. Numerous essays have criticized premature privatization in that country (Commander et al. 1989). Yet closer study indicates that public sector entities remain strongly present in the agricultural sector. The pace of withdrawal has been slow. The Senegalese government started its formal program of privatizing state enterprises in 1985. But employment in agricultural parastatals fell by less between 1985 and 1989 than in the previous five years, when there was no privatization program at all.

Although there will be need for a continuing public sector presence in many agricultural markets, the move toward privatization and liberalization in these markets is certainly in the right direction. Sustainable agricultural growth does require a much expanded private sector role. This is so because sustainability demands economically efficient institutions, and the private sector has strong inherent advantages in this regard. Private agents are much less vulnerable to political pressures. They can offer the salary packages needed to find and hold good managers and workers and provide the incentives that are essential for competent management performance. Even in uncongenial external policy environments, private agents have stronger incentives to cut costs and find new markets than do public sector managers.

Private traders in Africa also have inherent operating advantages. They are smaller in scale and better plugged in to transport, credit, and cross-border markets. They know their clients and their suppliers better and thus have lower transaction costs. They are usually better informed about product market conditions. They are more flexible and better equipped to operate in these economies, which are characterized by

large physical space, imperfect information flows, unstructured capital markets, and highly varied and rapidly changing conditions in product markets.

The private sector is also a potential source of rural dynamism and innovation to a far greater degree than the public sector. It is hard to think of any society that has modernized its agriculture in the absence of a class of intermediaries—traders, transporters, artisans, bigger farmers—who could play leading roles in the process.

And the private sector is "authentic" in a way that most other rural institutions are not. The government agencies and parastatals represent remote capitals, and cooperatives are often dominated by government. The intermediary class arises from the peasantry and has solid roots. It is durable. Unlike most other contemporary institutions in rural Africa, it is not dependent on subsidies from the state budget or, more commonly, from foreign aid agencies.

For all these reasons, public policy aimed at building sustainable institutions to serve a sustainable agriculture should welcome the expansion of the private sector role. But this does not usually happen. Despite the spread of structural adjustment programs and moves toward market-oriented policies, attitudes toward private trade remain reserved. Government officials and others worry that markets are not competitive and exploitation will result, that ethnic minorities will dominate, and that dissipation of state "control" is too risky. In many cases they are reluctant to fully implement privatization/liberalization programs and often try to find proxies for a direct public sector presence, notably by creating and subsidizing village organizations, such as cooperatives.

Part of the reason for lagging private sector response lies here—in the partial and hesitant nature of many liberalization or privatization programs and a continuing tilt of the playing field in favor of public sector or quasi-public sector organizations. This should change with time, and a more stable public-private balance will emerge. The private sector will take over more fully those functions for which it is clearly better suited, while a leaner set of public sector agencies will perform needed social functions and operate where scale economies or other factors make it appropriate.

How quickly and smoothly the new equilibrium will be reached depends substantially on the policies of Africa's external partners. Their aid programs have enormous impact on the evolution of agricultural institutions. When they decide that a marketing board or grain agency is worth supporting, those agencies survive and even thrive. If they find cereal banks a good idea, these village institutions multiply. When they withdraw support from farmer cooperatives, those organizations dissolve. And all of these interventions help determine the speed and nature of private sector development. Achievement of sustainable growth will be easier if aid donors and African governments become more sensitive to the long-term institutional implications of their programs.

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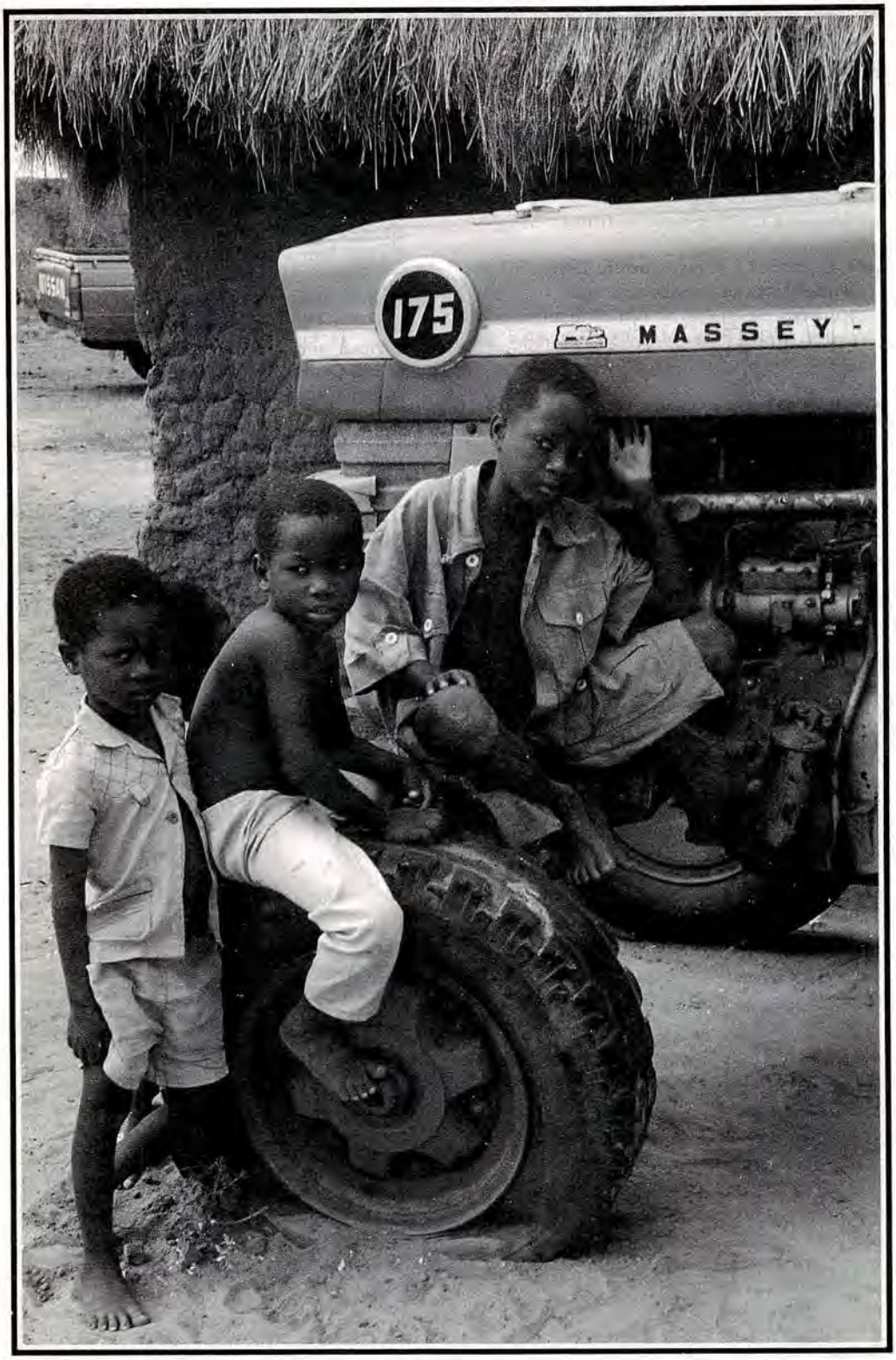
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MASSEY

The Influence of International Conditions on Sustainable Agricultural Development in Africa

*Louis Emmerij**

Before addressing the subject of international conditions and their influence on development in Africa, I would like to make four, short preliminary remarks. First, I am from the OECD, which, as you know, includes the 24 industrial countries of the world. Fewer of you, perhaps, know about the OECD Development Centre, of which I am president and which constitutes the bridge between OECD member countries and the rest of the world. While the secretary-general of the OECD has only 24 countries to look after, I have the whole world to care for.

Second, since the world is asking developing countries for good governance, the developing countries have a right to ask the international community for good international governance. And this, of course, depends mainly on the national policies of powerful countries and their international implications.

My third remark has to do with the African agricultural situation. I need not comment on it in detail, since other participants in this workshop have done so. The main points are that there has been a steady decline in per capita food production, food imports have grown, and the task ahead for Africa is to achieve a growth rate in production of 4 to 6% per annum, while reversing the degradation of natural resources. It is in this formidable framework that we must view the Sasakawa-Global 2000 (SG 2000) Agricultural Projects.

My fourth and final preliminary remark is on sustainability. Elliot Berg has offered one definition of this concept. I shall speak both about environmental and economic sustainability, though mostly about the latter.

Now, I will turn to the international dimension of the sustainability issue in general and to policies for sustainable agricultural in Africa particularly. In speaking to a largely African audience, I do not have to explain how much the international factors are interwined with national policies. Exogenous factors have shaped entire societies on this continent. They have determined the pattern of economic and social development and have influenced the choice of crops, land use, and even income. So, in talking about international factors, which are often so vague, we are dealing with a crucial and very concrete influence on national policies.

I would suggest that seven main factors must be changed if African economic development in general and agricultural development in particular are to be started up again and sustained. The

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challenge is not just sustainable development but starting the economic machinery all over again.

The Economic Marginalization of Africa

The first factor is the growing marginalization of Africa in the world economy. As President Carter has pointed out, there is a lack of partnership between the developed countries and Africa. In the North we have an economic bullet-train that contains the OECD countries as well as those of East and Southeast Asia. To all intents and purposes, these countries constitute the mainstream of the world economy. At the other extreme, we have the least developed countries, most of which are found on this continent. Far from being on the economic bullet-train, they have been adrift economically ever since the early 1980s.

Africa has seen its share in international trade go down, along with its per capita income and per capita food production. It is not part of a trading block, since I cannot consider the Lomé Convention as a true trading block. Given the development of synthetic products, Africa becomes less and less relevant to the North in terms of raw materials. The North can even neglect Africa's demand for its products, given the continent's relatively low population and low income.

One gets the impression that the mainstream of the world economy, basically the North, considers Africa to be a kind of social security case that can be dealt with only by handing out development assistance. This is a fundamental error. There are real interdependencies between these regions, not economic ones perhaps, but very real ones, such as international migration. Alfred Sauvy, the French demographer and economist, said that if capital does not move to where the people are, the people will move to where the capital is.

There is also an environmental interdependency. Growing desertification has implications for the climate in the rural sector of the South and to a certain extent for that in Europe. There are other factors as well. Many people agree on this point about interdependency, but very little is being done to address it. In fact, actions are being taken that make matters worse, further delinking Africa from the world economy. My next six points provide examples.

International Debt

My second point has to do with international debt. This problem, which is now almost 10 years old, has reinforced the dual economy in Africa's agricultural development. It has led to an expansion of traditional agricultural exports without much increase in export revenues, given low prices. Rural areas have suffered from fiscal austerity accompanying the structural adjustment policies adopted in response to the international debt situation. Investment in rural infrastructure and in agriculture has declined, as have expenditures on agricultural research and extension.

Various initiatives are underway to deal with the debt problem. I think it is close to being solved for the least developed countries, but it will have taken close to a decade or more. By the time the problem is solved, it will have done tremendous damage. For in the meantime, Africa is paying more money

to the International Monetary Fund than it receives.

The Implications of Europe 1992

My third point concerns the implications of Europe 1992 for the rest of the world generally and the developing world in particular. I am inclined to believe the evidence showing that Europe 1992 will have rather negative effects on the developing countries, especially the poorest ones. Europe has a longstanding tradition of protectionism. Why should that tradition miraculously and suddenly disappear on 1 January 1993? If anything the common tariff barrier around the 12 members of the European Community will be higher than at present, because the more protectionist countries will tend to put pressure on the others. We will see an increase in nontariff barriers, technical norms, and antidumping measures. The Lomé Convention countries, which previously were allowed relatively easy entrance in the European market, will essentially be thrown to the wolves, because they will be subject to the same rules as all other countries.

Protectionism in Agriculture

A further source of concern is the common agricultural policy, which leads me to my fourth point. When on 7 December 1990 no agreement was reached in the Uruguay round of the GATT negotiations in Brussels, an outcome many had predicted, Arthur Dunkel, the secretary-general of GATT, was asked to do something about the impasse. Agriculture is one of the biggest stumbling blocks to agreement within the Uruguay round. It is the one area where OECD countries do not practise what they preach. They preach deregulation, liberalization, and the end of subsidies, but their practice is quite the opposite when it comes to the agricultural sector.

In 1987 at the annual OECD Ministerial Meeting, the ministers solemnly declared that they had to do something about this problem, simply because it was becoming too expensive. Nonetheless, in 1990 the price paid by OECD countries to their farmers reached an all-time high of US$300 billion. This amount includes two components, subsidies and higher prices paid by consumers, compared to what they would have paid if full liberalization had taken place and other countries, particularly in the developing world, had been allowed to import freely to the OECD countries. Development assistance, on the other hand, amounts to about $50 billion annually.

Of course, the question of protectionism in the agricultural sector is a very delicate one. Farmers have very powerful lobbies in the OECD countries. There is much concern about preserving the countryside and the quality of life in rural areas. Moreover, farming is highly productive in these countries. Be that as it may, the current situation is very damaging for agricultural production and exports in the developing countries. And we can expect to see further obstacles to trade in the European Community, especially in the form of increased technical norms related to such issues as the environment and health.

The Diversion of Resources to Eastern Europe

My fifth point pertains to eastern Europe. Will there be or is there already a diversion of aid, trade, and

investments from the South to eastern Europe? I think the answer is yes at least with respect to development aid. Some countries, including Italy and the USA, have already shifted part of their development assistance from the South to the East. I think this is scandalous. It underestimates both the problems in the South—the involuntary delinking of Africa, for instance—and, even more so, the huge problems that we are facing in eastern Europe. If we believe that we can even make a dent in these problems by taking a few million dollars from the pot of the developing countries and placing it in that of the east, then we are kidding ourselves. The Germans are apparently the only ones who understand the scope of the problems in eastern Europe; they have set aside DM100 billion to be spent over the next few years for 17 million brothers and sisters in the five eastern states of their new country. That is the level of assistance we should be talking about.

The implications of events in eastern Europe are unclear, but they are surely not likely to be positive for the South.

We should also keep in mind the *perestroika* that is going on in South Africa. Even so, I would agree with President Nyere, who in Amsterdam last week at a conference of the Society for International Development said, "Look, don't shout victory yet. Mandela can now swim in the same swimming pool as de Klerk but he still has no vote."

On the other hand, if growth resumes in eastern Europe (and we now realize this is a much more difficult task than was anticipated), a market will be created, particularly for tropical fruits and beverages, one which is currently saturated in general. On balance, the implications of events in eastern Europe are unclear, but they are surely not likely to be positive for the South.

The New Conditionality

My sixth point is about the new conditionality. In the field of environmental affairs, there is some danger of a new, green conditionality, which applies as follows. When industrialized countries become sensitive about a particular issue, as they are now about environmental problems, they establish severe standards for themselves. The next step is to generalize these norms to the rest of the world, irrespective of the economic and social situations in other countries. In the case of China, for example, the industrialized countries might say, "Now, look, you're already the third largest producer of CO_2; you should industrialize a little more slowly." China or any other developing country will reply, "You're not going to stop or slow down our industrialization. If you want us to industrialize in a cleaner fashion, transfer to us the clean technologies available." So the debate should be, not about green conditionality, but about the difficult problem of transferring clean technology.

Then we have the possibility of a new political conditionality. Few countries in this world have achieved the rare and marvellous combination of political freedom and economic efficiency. Do we believe now that there is a unidirectional and simple relationship between

political democracy and economic efficiency? Plenty of examples suggest otherwise. Where is the political democracy in South Korea, for example, which is so notable for its economic miracles? We are told that it's coming, that economic efficiency is putting pressure on the political system. So, we have to be very careful about imposing political democracy upon countries. The result may be the introduction of a formal democracy that does not change a thing in governance and economic performance.

That is the crux of the matter. We should avoid encouraging the establishment of merely formal democracies. Any African leader—or any leader for that matter—can create as many political parties as are required to give evidence of democracy and even permit the people to vote. Meanwhile, though, the economic situation may continue just as it was. I do not mean to understate the importance of voting rights or of the existence of different parties. The important thing, though, is not political democracy but economic democracy. It is the participation of farmers and of people in the informal sector and elsewhere in the decisions that shape their economic destiny.

Building a Science Base in Africa

The final and seventh point is on technology, which is the main subject of this meeting. Were it not for the SG 2000 Projects, Africa would have been bypassed by the Green Revolution. Will it miss out on biotechnology? The message for Africa in this question, even more than for the international community, is that African countries must develop a science base. One lesson I have learned from Abdul Salam, the Pakistani Nobel Prize winner and director of the Trieste-based International Institute for Theoretical Physics, is that if countries ever want to be less dependent technologically they must create their own science base. For Africa this means regional integration. There are other reasons for such a move as well, but the need for a science base is a major one.

Conclusion

Present trends in the world economy mean further marginalization for Africa. I do not believe that this is sustainable for Africa, nor is it desirable and sustainable for Europe and the rest of the world. Not enough is being done at the level of the international community. Not enough is being done to achieve consistent policies with respect to aid, trade, investment, and credit. Very often what is given with one hand, the aid hand, is taken by the other.

There is no consistency between policies within the same donor country and even less, of course, among donor countries. And what about the innumerable United Nations agencies and nongovernmental organizations? We do not see any move toward what some of us have called "development contracts," that is long-term agreements between a northern region and a southern region, with an internal component—national governance—and an external component in the form of international governance.

The world has not been kind to Africa. I therefore believe that in the meantime it has been very wise for Africa to try at least to move in the direction of self-sufficiency in food, the basic need of countries and of people.

Bilateral Cooperation in Agricultural Development: A View from JICA

*Hidero Maki**

It is my great pleasure to have the opportunity to speak here before so many prominent people. First, I would like to express my heartfelt gratitude for the cooperative efforts of the Center for Applied Studies in International Negotiations. Second, I wish to pay my sincere respects to the Sasakawa Peace Foundation for its support of this workshop and its continuing substantial contribution to agricultural development in Africa. In listening to the reports on the progress of the various projects being assisted by the Foundation, I was deeply impressed with their impact.

Types of Development Assistance

The Official Development Assistance (ODA) program of the Japanese government supports economic development and the improvement of human welfare in developing countries by three means: 1) bilateral grants, including grants-in-aid and technical cooperation, 2) bilateral lending, known as yen-loans, and 3) contributions to relevant international organizations. In many cases assistance to the least developed countries takes the form of grants that need not be reimbursed, while lending is our usual means of assisting countries that are in better financial circumstances. Among the various ODA programs, JICA, the one for which I work, implements technical cooperation and handles operations relating to grants-in-aid, both of which activities come under bilateral grants. Our disbursements now account for some 10% of Japan's total ODA.

More specifically, JICA's main contributions to developing countries are to: 1) dispatch experts, 2) provide training, 3) provide equipment, 4) engage in cooperation (through technical projects undertaken for a specific purpose over a long period in combination with the first three measures), 5) conduct development studies, whose purpose is to formulate official development plans, 6) provide both technical and financial support to the private sector's direct overseas investment, 7) send overseas cooperation volunteers, and 8) conduct surveys and carry out operations relating to grants-in-aid. The measures we take within Japan include training and recruitment of personnel for technical cooperation, studies of methods for assisting specific sectors and countries, and compilation and dissemination of information accumulated in the course of international assistance.

As you are aware, in an effort to fulfill its international obligation to meet the needs of developing countries, Japan has expanded its ODA aggressively, raising its midterm target for expansion several times. The Japanese contribution reached US$9 billion in 1989, the latest year for which statistics are available. With its steadily increasing activities,

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JICA has taken on greater responsibilities and come to play a major role in Japan's ODA.

In rendering assistance Japan observes the principle of meeting requests from recipient countries through official diplomatic channels. We provide assistance only after the government of a developing country has first filed a request with our counterpart and this request has been carefully considered.

JICA's Involvement in Agricultural Development

JICA has a keen interest in the theme of this workshop—Africa's agricultural development—and is already working closely with several African countries toward this end. Our first efforts to support agricultural development naturally centered on various Asian countries, partly because of our strength in rice production and because of these countries' geographic and economic association with Japan. Though we later extended our assistance to other regions, the largest share still goes to Asia. Among other regions, however, Africa is the one in which our cooperative efforts have expanded most rapidly in recent years. Overseas cooperation volunteers now render one third of their total assistance to African countries, and the continent's present share of our other types of cooperation is about 10%. Our growing commitment to cooperation with African countries is based on our perception of the urgent need to assist these countries in facing their difficult problems, including successive food crises and advancing desertification.

Of the long-term comprehensive projects involving technical cooperation, we currently have underway a total of seven in Africa—three in Kenya, two in Tanzania, one in Nigeria, and one in Zambia—of which five are related to agriculture. Here in Tanzania we initiated the Kilimanjaro Agricultural Development Project quite some time ago and in January of this year began the Kilimanjaro Village Forestry Project. The former is related to the Lower Moshi Agricultural Development Project, which is supported through a yen-loan. I was pleased to learn that an evaluation conducted by JICA and Tanzanian authorities in November of last year showed excellent progress in the improvement of rice production. Yields of nearly 6 t/ha have been achieved in the Lower Moshi area, and improved technology is spreading rapidly in the surrounding rice area. Other measures taken to facilitate the development of agriculture, forestry, and fisheries in Tanzania include a series of development studies and the posting of several overseas cooperation volunteers.

Needless to say, the economies of most developing countries are based on agriculture, forestry, and fisheries, and these activities are central to any effort to secure an adequate food supply while preserving the environment. It cannot be overlooked that many countries, particularly in Africa, still suffer from food shortages and that a sizeable proportion of their populations is undernourished. To make matters worse, serious environmental problems have emerged, such as the destruction of tropical forests and advancing desertification, which have created growing international concern about environmental damage on a global scale. This concern has led developing countries to make an increasing number of requests for cooperation in agriculture, forestry, and fisheries. As a result, a large share of our activities (20 to 30%) are concentrated in these fields.

In recent years developing countries have tended to make requests for cooperation in quite diverse areas. Our general approach is to provide flexible forms of assistance that are suited to the social and economic conditions of the recipient countries and to their levels of development. We seek particularly to provide assistance that encourages the country to show initiative in its agricultural development. More specifically, in countries where staple foods are scarce, our assistance concentrates first on increasing food production, since we consider food security to be vital for developing countries. In countries that are well on the way to achieving this objective, we have recently expanded our cooperation considerably in enterprises other than the cultivation of staple foods, such as fruit growing and livestock production, as a means of increasing income, alleviating poverty, and improving living standards in rural areas. The next step is to gradually increase assistance in the processing of farm products (with the aim of converting them into higher value items), in the improvement of marketing, and in integrated approaches for developing rural communities.

We are also responding positively to requests for assistance in enhancing the environment and achieving sustainable development through more efficient utilization of renewable resources.

We are also responding positively to requests for assistance in enhancing the environment and achieving sustainable development through more efficient utilization of renewable resources. Reforestation is a critical measure for achieving these ends, since it not only creates a valuable resource but improves the environment of agriculture and enhances daily life in other ways as well. In the Kilimanjaro Village Forestry Project, we are placing special emphasis on expanding cooperation in forestry-related businesses. Currently, we are seeking means of achieving development in agriculture and forestry in a more integrated manner. We would also like to add to the program activities that will benefit village women, who play an important part in farming and daily life in rural areas.

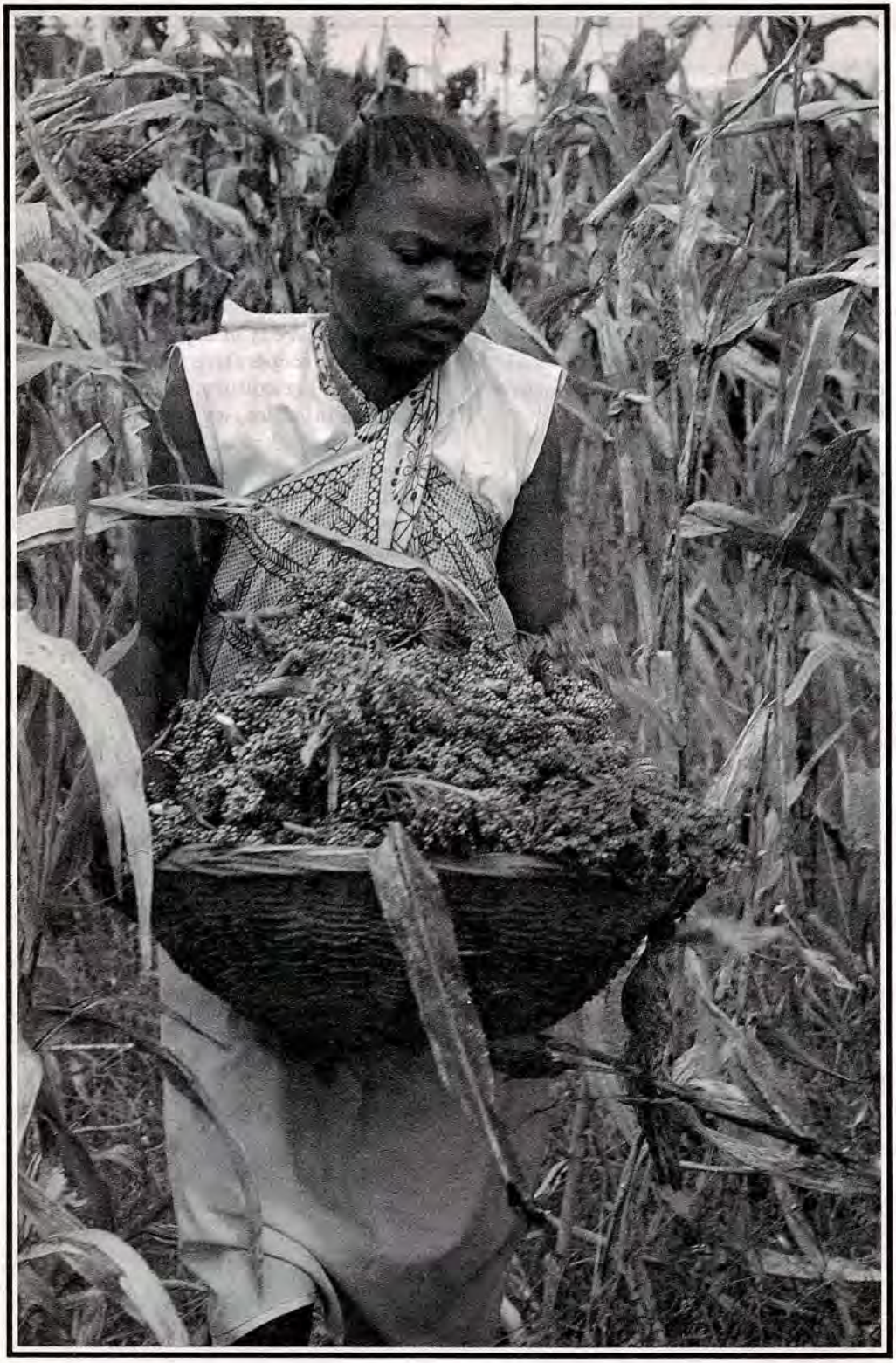
Proposals for Supporting Agriculture in Africa

In an effort to establish appropriate directions for Japan's bilateral ODA, JICA has been conducting development studies on each region and country. Just recently, we completed our final report on Africa. Here I would like to summarize the report's main points with respect to proposals for supporting the agricultural sector in Africa.

Expansion of agricultural production is essential for achieving social and political stability as well as economic progress on this continent. Hence any effort to address problems in this area must include means of both expanding and intensifying agricultural production. Effective and environmentally friendly measures are needed to solve the problem of water, which is the greatest limitation to the expansion of arable land. One possibility is the construction

of low-cost wells, reservoirs, and small-scale irrigation facilities by rural people themselves. At the same time, it is necessary to achieve more intensive, continuous agricultural production on the land now under cultivation through closer integration of crop production with animal husbandry. Other requirements are the introduction of new crops and exotic varieties and improvement in crop management practices so that they better fit local climatic conditions. Further measures that are essential for better environmental protection are the establishment of improved methods of livestock management and of farming systems that maintain and even improve soil fertility. In the future Japanese assistance will focus on solutions to these problems.

In coping with an expected increase in requests for such assistance, we at JICA intend to further improve both the quality and quantity of our cooperative activities in developing countries in keeping with the policies I have described. We fully appreciate that agricultural development in Africa will continue to be an important challenge requiring urgent action. Despite a supposed scarcity of experts capable of joining our cooperative programs for improving agriculture, forestry, and fisheries in Africa, we are willing to expand our technical assistance as much as possible and in ways that fit local conditions. This workshop has given me an even better understanding of the need for this course of action. I hope that the SG 2000 Projects will share their accumulated experience with us and that on this basis we can develop intergovernmental cooperation.



Modern Crop Production Technology in Africa: The Conditions for Sustainability

*Donald L. Plucknett**

Much has been written about Africa's food and agricultural problems (Binswanger and Pingali 1986; Eicher 1982, 1983; National Academy of Sciences 1974; US Congress OTA 1984, 1986, 1988; USDA et al. 1980; USDA 1985; World Bank 1989; Yudelman 1987) and agricultural research in Africa (Arnold 1976; Eicher 1989; World Bank 1987). I believe we would all agree that Africa's agricultural performance is not what it should be, and we must all ask why that is so. African agriculture must improve—in productivity, in profitability, and in a sustainable way. How can this be achieved?

It has been suggested that Africa's agricultural production environment is more difficult than that of other regions. Are lands in Africa inherently less productive than those on other continents? And are those lands inherently more fragile and difficult to manage? And what about African farmers? Are they less industrious or capable than farmers elsewhere? Certainly, the productive potential of both land and people are important questions affecting the sustainability of agriculture. The issue of the potential of Africa's production environment is a crucial one, for it raises the question of whether the continent's agriculture can evolve and modernize, become more vigorous and robust, and drive economic development in African countries.

My thesis is that Africa is not inherently less productive in agriculture than other continents and that much can be done to improve its agricultural performance. My perspective is that of an agronomist who has spent most of his professional life studying and working to improve tropical agriculture. In this paper I will concentrate mainly on biological potential and productivity, since agriculture begins with biological processes and their management for productive purposes. I will also emphasize productivity, since questions of sustainability necessarily relate to productive potential and effective use of resources.

Background

I would like to spend a little time reviewing the history of agricultural productivity in general, because I believe it helps to put the African situation in perspective. For most of human history, agricultural yields were low and unreliable. Most gains in agricultural production came from expansion of the area cultivated or managed. Gains in production per unit of land came very slowly—at most only a few kilograms per hectare per year. Agriculture was an uncertain business. Producers developed innovations on the basis of their own experience and intuition. Options for changing production techniques and improving production were few indeed.

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As a consequence, crop failure and famine were frequent—in Europe and North America as well as Asia and Latin America.

The big change came during this century, which has witnessed tremendous growth and improved stability in food production worldwide, especially since World War II. This has been the greatest transformation of agriculture in the history of humankind, and most of it has taken place during the lifetime of those of us here today. The change was brought about by the rise of science-based agriculture, which permitted higher and more stable food production, ensuring food stability and security for a constantly growing world population. Most people do not appreciate these developments sufficiently, because they do not realize just how insecure and unstable agriculture was in times past.

There are two basic strategies for improving agricultural production: One is to increase the amount of land cultivated and the other to increase yields per unit of land cultivated. For most of human history, production increases came largely as a result of expansion of the area cultivated. Few means were available for increasing production per unit of land. As a result, the productivity of individual farmers was low, and many people had to be employed in agriculture, earning a meager living, to provide small surpluses for feeding the landless and growing urban population.

Modern agriculture had its origins in the latter part of the 19th century but became firmly established during this century, with the advent of scientific agriculture (Plucknett 1991a). Discoveries in agricultural chemistry concerning plant nutrition led to the development of the fertilizer industry and to a dramatic increase in fertilizer use, especially since World War II. Also, the rediscovery of Gregor Mendel's laws of genetics in the early 1900s established the basis for plant breeding. By then agricultural research was on its way to improving farm life in Europe, North America, Australia, New Zealand, and Japan, and its efforts would be felt in other countries in years to come.

As an example, Figure 1 shows changes in the productivity of US agriculture from the 1860s to the present that resulted from scientific agriculture. One hundred years ago, the USA was still a developing country, challenged by a growing population and a shrinking land frontier. Science provided the basis for productivity growth in agriculture and for rapid industrialization.

Yields in Europe, North America, and Australia increased slowly during the first half of this century. Most of the varieties used were traditional landraces, and plant nutrition needs were met mostly by animal manures and crop rotations. Fertilizer use increased slowly during this period from about 2 million tons at the beginning of the century to 4 million at the start of World War I to 9 million in 1938-39. Fertilizer consumption was 7 million tons in 1945 and afterwards increased sharply to 21 million tons in 1955, 31 million in 1965, about 90 million in the mid-1970s, and 132 million in 1987 (Plucknett 1991b).

So fertilizer use was one of the keys to improvement of agriculture in developed countries. Advances in crop breeding were also beginning to contribute to crop productivity. One outstanding accomplishment was the development of hybrid maize in the USA just before

World War I. By the 1930s farmers had started to adopt hybrids. A specialized seed industry grew up to take advantage of the scientific gains made by plant breeders. From the time of the Civil War (1861-65) to the 1930s, US maize yields were about 1,400 kg/ha. Since the introduction of hybrid maize in the 1930s, yields have increased more than fourfold to 6,700 kg/ha. I might add that Zimbabwe was the second country in the world to introduce hybrid maize to its farmers. Hybrids were developed there about the same time they were being released to farmers in the USA. Zimbabwe's hybrid breeding program was begun in 1932, and from it came the well-known hybrid SR52, which has performed extremely well in Zimbabwe and neighboring countries. Zimbabwe released its first hybrids to farmers in 1949 (Gelaw 1986).

The big gains in scientific agriculture were made after World War II. Organic pesticides were developed to help control weeds, insects, and plant diseases. Increasingly, new pesticides were selective in their effects. Farmers began to take advantage of these new products and thereby improved their productivity. Agriculture became more specialized. Both government and the private sector began to see agricultural research as a good investment.

The establishment of the international agricultural research centers (IARCs) was a major step forward in improving world agriculture. For it gave rise to the development of a global agricultural research system, in which each country can participate and benefit. Today, there is no need for any country to go it alone in developing new agricultural technologies for its farmers; from the global research system any country can obtain training for its scientists, improved plant materials, new agricultural technologies, and advice and support (Plucknett 1991c).

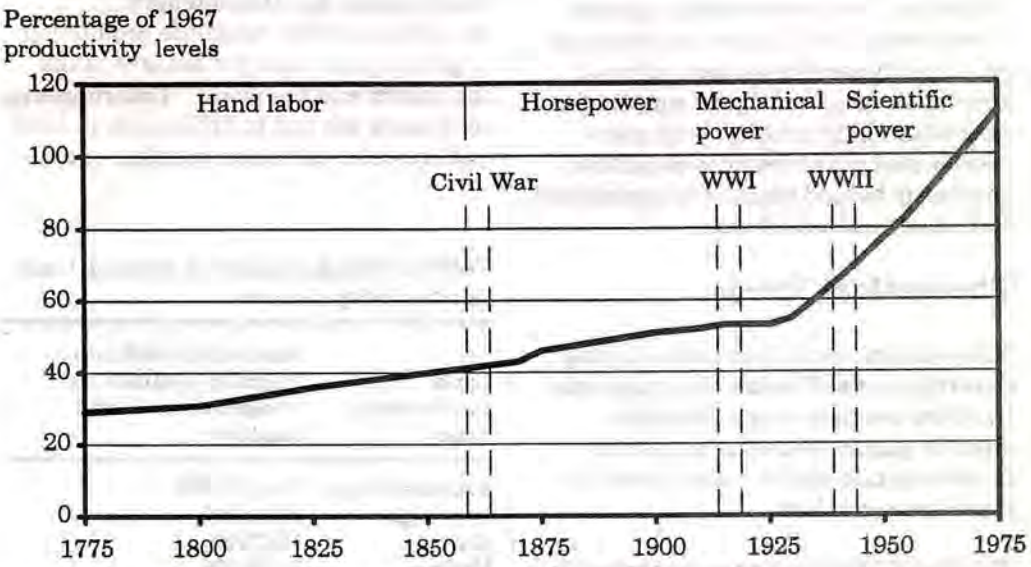

Figure 1. Farm productivity and the scientific revolution in the USA. Source: US Congress, Office of Technology Assessment.

The Green Revolution

I cannot go further without speaking briefly about the Green Revolution, from which we have learned a number of lessons that should be heeded in Africa. The Green Revolution has been both praised and criticized and often misunderstood. To some it is a symbol of all that is bad about modern agriculture. But the Green Revolution consisted simply in the spread of new semidwarf wheat and rice varieties in Asia mainly and to a lesser extent rice in Latin America. Because they were much higher yielding than the genotypes they replaced, the new varieties brought dramatic gains in the agricultural performance of countries, where previously crop yields had been stagnant.

The Green Revolution dramatically illustrated the potential of a more productive agriculture; it showed that national investments in agricultural research and development could pay big dividends. Countries in Asia began to move forward, with gains in agricultural productivity serving as the engine of growth. Governments gave support for agriculture high priority, with good results, and countries once considered hopelessly behind reached or neared self-sufficiency in basic staples.

Theoretical Yields

The yields of most crops in developing countries are well below their potential. In Africa and elsewhere, there is a sizeable gap between the yields that farmers obtain and those obtained on experiment stations.

The Dutch have long been interested in high agricultural productivity, perhaps because of their country's small size and its extreme requirement for land reclamation and development. In the 1970s a group of Dutch scientists undertook to determine, as they put it, "the absolute maximum food production of the world, the upper limit of what can be grown on all suitable agricultural land" (Linneman et al. 1979). They first had to estimate the maximum theoretical yields for crops under optimum conditions of sunlight, moisture, and nutrients and in the absence of attack from insects and diseases. They expressed maximum potential yields in terms of grain equivalents (GE).

Table 1 shows the maximum production in grain equivalents of six classes of agricultural land ranked according to potential productivity. Note that land with very high productive potential is estimated to have a theoretical yield of more than 25,000 kg GE/ha/yr (this amount would be equivalent to about 400 bushels per acre of maize or wheat).

Table 2 gives the Dutch team's calculations of the "absolute production of grain equivalents per hectare of the continents and the world." Differences in continents are due to differences in land quality, solar radiation, number of days

Table 1. The potential of various land productivity classes

Land productivity class	Maximum production in grain equivalents of agricultural land (kg/ha/yr)
Extremely high	Over 25,000
Very high	20-25,000
High	15-20,000
Medium	10-15,000
Low	5-10,000
Very low	Less than or equal to 5,000

that crops can be grown, and other factors relating to productivity potential. Note that the theoretical potential is highest not for Europe, Australia, and North America—where scientific agriculture predominates and high yields are common—but for Latin America, followed by Africa and Asia. That Africa ranks so high in terms of potential productivity will perhaps surprise some people, especially in view of the continent's present productivity levels. The key point is that, even though the margin between potential and actual productivity may be quite wide for a particular continent, significant productivity gains are possible provided that suitable technologies are made available to farmers.

Is There a Yield Take-off Point?

Given that yields in most countries are far below their theoretical potential, how do we go about narrowing this gap? What patterns can we observe in productivity growth over time?

Throughout history yearly gains in the productivity of annual crops have generally been small, ranging from 2 to 15 kg/ha/yr (1% or less). Gains of this order are too small to be of much general benefit, especially as populations and food needs rise. Professor de Wit and his colleagues in the Netherlands (1979) suggest that economic and social constraints on the growth of agricultural productivity cause average grain yields to remain low, with very low annual rates of increase. They also note, however, that a yield level of 1,700 kg/ha/yr seems to be a kind of transition point in the growth of agricultural productivity. Below that level annual rates of increase are only 17 kg/ha (1% per year), but above it the annual rates of increase jump to 50 to 85 kg/ha/yr, an increase of 4 or 5% per year. The authors speculate that this yield level marks the transition from "traditional agriculture with little outside input to modern agriculture with considerable input of outside resources." Figure 2 shows the transition point of wheat yields in the UK and USA just after World War II. In

Table 2. Absolute maximum production of grain equivalents (MPGE), by continent

	Average MPGE (kg/ha/yr)
South America	18,014
Africa	14,259
Asia	13,182
North and Central America	11,250
Europe	10,454
Australia	10,447
Total	13,368

Source: Linneman et al. 1979.

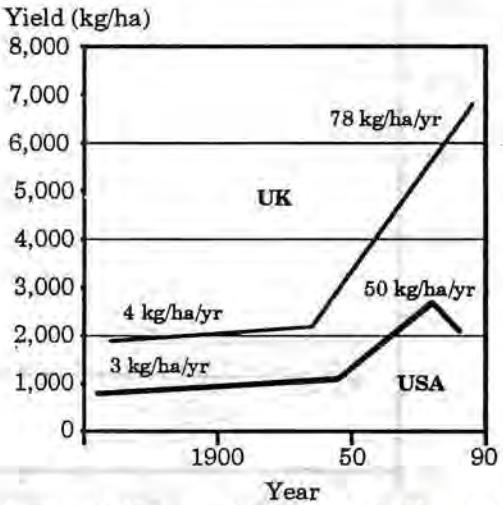

Figure 2. Wheat yield trends in the UK and USA. Source: de Wit et al. 1979.

both these countries, wheat yields began to climb in the 1950s with the advent of new varieties and improved practices. Figure 3 shows the transition point for rice in the late 1960s in Indonesia. After centuries of almost stagnant rice yields,

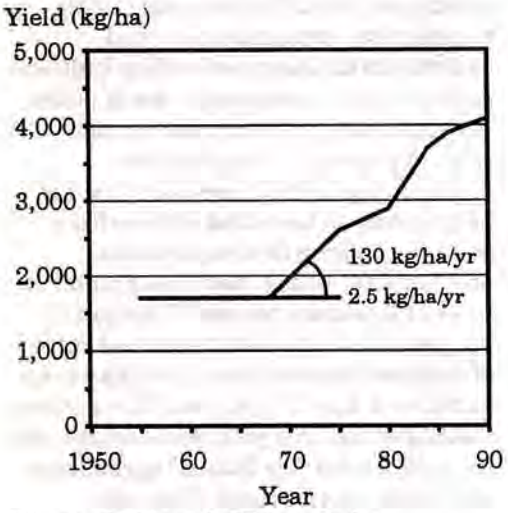

Figure 3. Rice yield trends in Indonesia. Source: de Wit et al. 1979.

Indonesia has achieved very high growth rates in the productivity of this crop. Professor de Wit and his colleagues go on to say that just below the transition point farmers tend to move more and more onto marginal lands in attempting to meet food and production needs, destroying natural ecosystems in the process. Thus, identifying the transition point and moving beyond it could be a significant requirement for protecting the environment.

Figure 4 shows advances in maize yields in the USA from the 1860s to the present. Note that productivity was virtually level until the 1930s, when hybrids were released, permitting a dramatic rise in yields. The yield takeoff thesis is also borne out by data for wheat in Mexico's Yaqui Valley in the state of Sonora and for wheat in the entire country (Figure 5). In this case a developing country managed in just a few years to match world productivity levels in wheat.

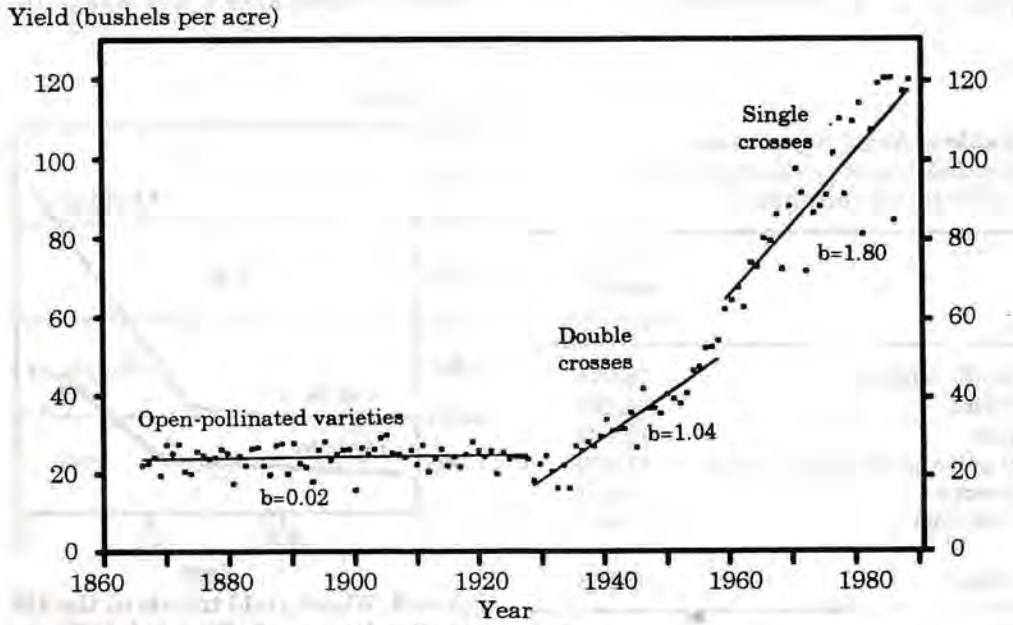

Figure 4. Maize yields in the USA, 1860-1990.

What about Africa then? Do we have any evidence that a yield takeoff is in progress or about to start? Figure 6 shows maize yields in Tanzania over the past 40 years. Until 1960 annual yield gains averaged about 11 kg/ha but from then on were higher, reaching 71 kg/ha/yr during 1970-75. Then, after levelling off for about 10 years, maize yields began to increase again in 1985 and have continued to rise at a rate of 75 kg/ha/yr. These yields are still low by world standards but the rate of growth in productivity is impressive and could signal a yield takeoff. Figure 7 shows the steady increase in cassava yields in Nigeria from 1950 to about 1970, when yields averaged 12 t/ha, followed by a decline lasting almost 10 years (a period corresponding to the nation's oil boom), and then another era of increasing yields to 1990, when they averaged about 13 t/ha. This is an impressive figure—almost 3 t higher than the current world average. Though I have not looked thoroughly at national yield trends for other crops and countries, I am confident that the same phenomenon does or will take place where high priority is given to agriculture.

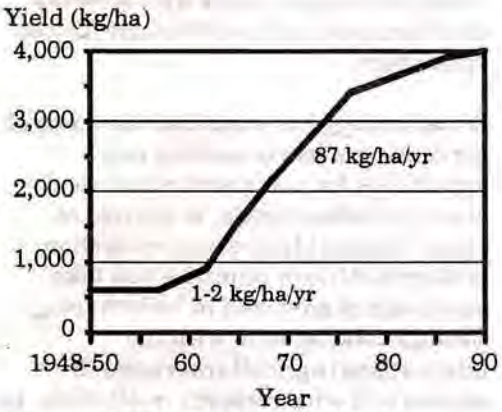

Figure 5. Wheat yields in Mexico.

The idea of a yield takeoff point is fascinating. Whether it is 1,700 kg/ha/yr, as de Wit and his colleagues suggest, or lower or higher is immaterial. The important points are that: 1) There is a clear transition point at which annual rates of gain in productivity move beyond 1% to 2% or even higher, 2) the latter rate seems to signal a shift toward modern agriculture, and 3) in most cases those rates of gain can be sustained for a number of years.

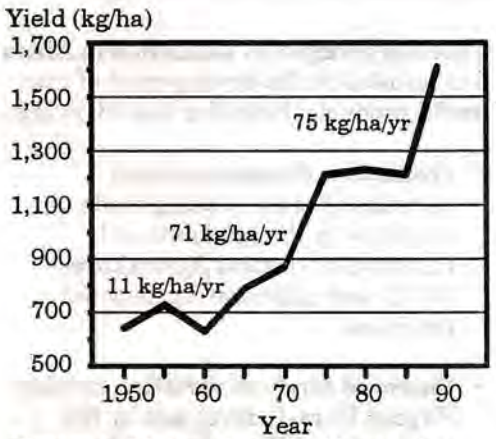

Figure 6. Maize yields in Tanzania.

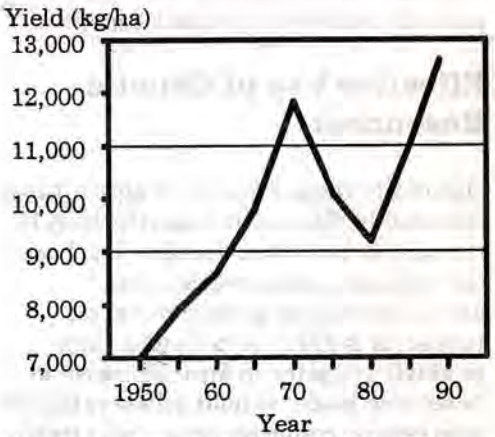

Figure 7. Cassava yields in Nigeria.

Lessons From the Past

History tells us several things concerning productivity and agricultural technology: 1) Higher yields are still attainable in most crops, provided that improved technology is available and widely adopted; 2) once higher yields are attained, it takes more and better research just to maintain or keep them advancing slowly—the concept of maintenance research (Plucknett and Smith 1986); 3) future gains in productivity can be achieved through a combination of plant breeding and improved crop and natural resource management; 4) crop improvement efforts have paid off handsomely, in most cases giving productivity gains in cereals of 1 to 2% per year; 5) in cereals particularly, these gains have come largely through improvements in harvest index (the ratio of grain to stover), not through increased production of plant biomass; 6) crops can be tailored more closely to the conditions—even harsh conditions—under which they will be grown; and 7) gains in productivity can be achieved only through research that is well supported and has continuity. Our experience also indicates that national and international research must be closely linked to ensure that all partners derive the greatest benefit.

Effective Use of Genetic Resources

One of the success stories of agricultural research in this century, particularly in the past two or three decades, has been the collection, conservation, and utilization of crop genetic resources. Indeed, it is difficult to imagine how productivity gains in agriculture could have been made without collaboration in crop genetic resources on a global level.

Global priorities have been established in the collection and conservation of crop genetic resources. The system created to carry out these activities includes gene banks linked to plant breeding centers that draw on the conserved germplasm to address existing and emerging problems. For most crops, breeders can obtain the germplasm they need in a readily useful form. African countries should make every effort to establish effective links with the global germplasm system, so that they can obtain training for their scientists, receive useful germplasm of important crops, and keep in touch with scientific developments that could benefit African agriculture.

Biotechnology has expanded the scope of germplasm work, promising new approaches for using wild relatives of crops, including weeds, as sources of genes that could solve key production problems. African countries can take advantage of advances in biotechnology through collaboration with the international agricultural research centers and with research institutions in developed countries. Many African countries are already routinely exchanging and using germplasm that is transferred in tissue culture form.

Effective germplasm utilization in Africa has resulted in the development of many useful products, including the following:

- Productive, disease-resistant varieties of cassava being made available by the International Institute of Tropical Agriculture (IITA) and collaborating national programs

- Improved sorghum varieties, notably Hageen Dura-1, developed by the International Crops Research Institute for the Semi-arid Tropics

(ICRISAT), the sorghum/millet collaborative research support program (CRSP) funded by the US Agency for International Development, the Semi-arid Food Grains Research and Development (SAFGRAD) Project, and several national programs

- Groundnut parental lines, with genes from numerous wild relatives, developed by ICRISAT, the Peanut CRSP, and several national programs

- Short-duration, disease-resistant cowpea varieties developed by IITA and by Nigerian and other West African research institutions

- Maize varieties and hybrids developed by IITA, the International Maize and Wheat Improvement Center (CIMMYT), SAFGRAD, and numerous national programs

- Rice varieties for diverse production environments developed by the West Africa Rice Development Association (WARDA), International Rice Research Institute (IRRI), Institute for Tropical Agricultural Research (IRAT), International Center for Tropical Agriculture (CIAT), and national programs

There are other examples as well. Their central message is that national programs, working with the international centers and with institutions in developed countries (such as IRAT and European and North American universities) and groups supported by bilateral donors (such as the CRSPs and various regional entities) can help bring to Africa the fruits of effective use of plant genetic resources in crop improvement.

Sustaining Agricultural Yields

Once yield gains have been made, they must be sustained, a goal that can be realized only through an effective research system (Plucknett and Smith 1986). Particularly for crops or commodities in which yield gains have been significant, an ever-increasing research effort is required just to maintain the gains. For example, the Hawaiian sugar industry estimates that probably more than 80% of its research on sugarcane is devoted to maintenance of past gains (Plucknett 1991b). Every national agricultural research system should be prepared to conduct high-quality maintenance research to protect production gains in each of its major crops.

Improving African Agriculture

I want to discuss now some specific ways in which African agriculture can begin to reach its potential. Where are the productivity gains to come from?

Fertilizer use—Most developing countries, but particularly those in Africa, need to increase fertilizer use, especially on their major crops. It has been estimated that in large parts of the world the soil, whether under natural conditions or in agricultural use, releases a meager 30 kg of plant nutrients per hectare per year, sufficient for a grain yield of only 1,000 to 1,500 kg, which is probably below the yield takeoff point for most crops (de Wit 1968). To drive yields up will in most cases require that nutrients be applied as chemical or organic fertilizers from sources external to the farm.

Soil fertility and fertilizer research should receive high priority in developing countries. Crop starvation places severe limitations on a country's agriculture. In 1983 sub-Saharan Africa used about 5 kg of fertilizer per hectare of arable land, up from 2.3 kg/ha/yr in 1970 (World Bank 1986). By contrast, in that same year China and India used over 90 kg of fertilizer per hectare of arable land. In 1983 fertilizer use in various other countries was as follows:

	Avg. amount of fertilizer applied on arable land (kg/ha)
Philippines	32
Canada	48
USA	104
Malaysia	111
Italy	169
Israel	183
France	311
South Korea	331
UK	374
Japan	437
Ireland	697
Netherlands	788
New Zealand	1,147

About 10 years ago Professor Pedro Sánchez, who will soon become the new director general of the International Council for Research on Agroforestry in Nairobi, surveyed a number of worldwide assessments of fertilizer needs in developing countries (Sánchez et al. 1983). About one-third of the total increase in food production in developing countries was estimated to be directly attributable to use of chemical fertilizers. They were also estimated to provide about 40% of the nutrients for the world's crops, with other sources being releases from soil reserves (46%), organic fertilizers (6%), biological nitrogen fixation (10% of the nitrogen supply), and atmospheric deposition.

Fertilizer is a primary means of realizing a high proportion of the attainable yield (de Wit et al. 1979). If plants are to reach their maximum or near-maximum yield potential, there must be an adequate supply of nutrients at all stages of growth. Fertilizers can be a major management tool for ensuring a proper balance of nutrients at the appropriate time.

In advocating higher fertilizer use in Africa, I am opening myself up to criticism, since fertilizer costs are high on this continent and rising. Though I fully recognize the problems in Africa of limited access to fertilizers and high prices, I believe we must do all we can to find ways of applying strategies that include the use of fertilizers as well as plant nutrient inputs that are internal to the farm (e.g., organic materials and biological nitrogen fixation). African agriculture cannot advance as long as crop starvation is widespread. We simply must find ways to improve plant nutrition for African crops by developing technologies that make the best use of internal and external inputs. Otherwise, farming will be more of a soil mining operation than a productive, profitable system, and sustainable production will be jeapordized by continued soil-nutrient depletion.

Water management—Water is probably the most limiting factor in agriculture. Where irrigation is possible, more efficient use of this expensive resource is required. In most of the world's agriculture, though, including Africa's, rainfed farming predominates. For this type of production, improved practices are needed to capture and use water where it falls. One option for enhancing water management is the use of tillage for land preparation and shaping the soil surface. Another is the creation of small catchments to store

runoff for future use. Where water is limited, drought-tolerant cultivars can also be useful. Many breeding programs aimed at improving African agriculture have drought tolerance as a major breeding objective (IDRC 1985).

In drought-prone areas, farmers tend to think in terms of good and bad years. Crop varieties and production techniques must be resilient and robust enough to take full advantage of good years while helping protect against crop failure in bad years.

Protecting against yield losses—Yield-increasing technology must be complemented by yield-protecting technology, whose purpose is to allow fuller expression of yield potential. Many gains have been made in crop protection since World War II. Cultural practices for controlling pests, used with differing degrees of success for centuries, continue to be important. New chemicals—especially selective ones—have made it possible to produce satisfactory yields under constant pressure from diseases, insect pests, and weeds. Also, very impressive gains have been made through breeding for resistance to crop pests.

Biological control has made a contribution in specific cases. The world's most spectacular example of success with this approach has been control of the cassava mealybug here in Africa over the past few years. Through a massive research program and control campaign—the largest ever—IITA in Nigeria, working in collaboration with CIAT in Colombia, the International Institute for Biological Control in the UK, and many African countries, have saved billions of dollars in production that otherwise would have been lost (Glass 1988).

Africa has its share of difficult animal and plant diseases, including trypanosomiasis, East Coast fever, and the black sigatoka disease of bananas and plantains. In most cases the damage they cause can be reduced through technologies and control strategies based on good research.

Resistance breeding has produced impressive results in reducing yield losses. Many new varieties have multiple resistance to pests and diseases, and new sources of resistance are being found. Resistance breeding based on the primary genepool (comprising the genetic resources within a given species) has been successful in many crops, and continued searching of the primary genepool of some crops will probably reveal new sources of resistance. For many crops the main object of this search will be new variation for disease resistance. For other crops sources of resistance must be derived through wide crosses with the secondary (different species within the same genus) or tertiary (other genera) genepools. There are many genetic barriers to wide crosses, but new techniques developed through biotechnology research show considerable promise as aids to genetic manipulation (Plucknett et al. 1987).

Improving Productivity Through Agricultural Technology

Over the past two or three decades, it has become fashionable to talk about packages of agricultural technology. Though I have no quarrel with this concept, I am concerned about its occasional misinterpretation as a kind of cookbook approach to agricultural development. A package of technology is basically a series of options that farmers

should have available for improving their production systems. In some cases substituting improved for traditional varieties may be enough to increase production potential. In other cases an improved variety and some fertilizer use are required, while in still others an improved variety plus fertilizer and line planting may be needed. Thus, technology packages should be viewed as a means of overcoming problems in a stepwise fashion, dealing with the most limiting constraints first. This approach is somewhat analogous to apple picking. The wise grower picks the low apples first and then concentrates on getting the ones at the top that are harder to reach. That is my concept of agricultural development—picking the low apples first. Most developing countries can make significant gains in agricultural production if they set their sights on first overcoming the most obvious constraints with the easiest solutions (Cooper 1970).

Conclusion

Since World War II many countries have used technological change—particularly in agriculture—as a source of economic growth and development. Countries like South Korea that were poverty-stricken 40 years ago have developed industry and become economically strong through technological change. But these countries were not able to industrialize successfully until they had improved their agriculture. In almost every case, technological change in agriculture, made possible by effective research, was a necessary precondition for modernization and a broadening of the economic base.

Before World War II any country wishing to improve its agriculture had to do so pretty much alone. Little international collaboration took place in agricultural research. Today, any country wishing to get its agriculture moving need not go it alone. A global agricultural research system is now in place that can help any country, developed or developing, improve its agriculture and resolve its most important production constraints through cooperative research.

In almost every case, technological change in agriculture, made possible by effective research, was a necessary precondition for modernization and a broadening of the economic base.

Farmers need an array of technology options for improving their production systems. This in turn requires that each country plan and develop a strong national agricultural research system, closely linked with the global research system, that is capable of solving local problems either alone or in concert with other countries having the same problems. I am convinced that for agriculture to be sustainable it must be productive and profitable for farmers. Sustainable agriculture is also knowledge- and management-intensive. By developing the capacity to conduct

effective research and introduce technological innovations in agriculture, every country can better achieve the goals of: 1) providing enough food, 2) preserving the soil, 3) making the best use of land, 4) developing crop and animal industries for production of export commodities, 5) broadening the base of agricultural production, and 6) ensuring a fair return to the producer and good quality products for consumers (Arnold 1976).

I do not believe that Africa is inherently less suited to productive agriculture than other continents. In fact, theoretical estimates of potential productivity place Africa second among the continents, behind Latin America but ahead of Asia, Europe, North America, and Australia in that order. Nor do I believe that the development of science-based agriculture is beyond the reach of most African countries. In many cases research results and farmers' achievements indicate quite the opposite.

Most African countries have not given agriculture the high priority that it deserves. If African countries invest in effective agriculture research and development, then the continent's agriculture will improve, probably much more quickly than most of us would predict. But I must also sound a note of warning: Africa must not continue to neglect agriculture if it is to come anywhere near meeting the food and income needs of its rapidly growing population or if it is to develop a sustainable agriculture. Increased investment in agriculture—with the aim of creating a knowledge base and support structure for achieving improved, sustained productivity—is not an option but an imperative.

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The Role of Soybean in Sustainable Agriculture in Africa

*Kiyoaki Katoh**

At present the world protein supply, including that required for animal feed, is greatly dependent on the 130 million tons of soybean (*Glycine max*) production in the USA, Brazil, Argentina, and China. Soybean is a traditional crop throughout East Asia. Recent years have seen marked growth in soybean production in several European countries as well, particularly Italy. In Africa soybean has developed rapidly as a new crop over the past five years. It has tremendous potential for helping to meet the nutritional requirements of the continent's growing population in the coming century. The magnitude of soybean's role in sustaining African agriculture will depend greatly on the extent to which Africans find it to be a palatable and interesting food.

The Origin of Soybean and Its Utilization

Soybean is considered to have originated in China long before recorded history. Because of the large number of semicultivated species in Manchuria (such as *G. usuriensis*), northern China was once considered to be the birthplace of the crop. Now, however, soybean is believed to have evolved in southern China from a common wild viny legume *(G. hispida)*, which still grows ubiquitously in Asia. In China's Yunnan Province, well known as the area where rice cultivation originated, rice and soybean are believed to have been cultivated in combination since the birth of agriculture in East Asia. In rural regions of East Asia, mixed or intercropping of rice and soybean in rice paddies is commonly practiced. And this system contributes significantly to low-input sustainable agriculture in these regions.

In Asia the soybean has been consumed since ancient times as fermented whole soybeans cooked and wrapped in rice straw or hybiscus leaves. This preparation is still important in some Asian countries in the form of nonsalted and naturally fermented whole-soybean products, such as *tempe* in Indonesia, *natto* in Japan, *kinema* in Nepal, *tuanao* in northern Thailand, and *Dou-shi* in Yunnan Province, China. The African equivalent of these products are various preparations made from fermented legume seeds.

By the time of the Han Dynasty, the Chinese already knew how to extract soy milk from cooked soybeans. Around 200 B.C., someone living in the Huai Nan region of central China discovered how to coagulate soy milk into a curd by mixing it with a mineral powder containing calcium-magnesium sulfate (though the ingredients had not been identified at that time). This clotting (coagulating) technology provided the

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basis for processing soybean into interesting and esthetically pleasing foods for human consumption. A wide variety of products were later derived from soy milk and curd (*tofu*), such as deep-fried curd (*age*), frozen and dried tofu (*sponge*), and a film-like soy protein (*yuba*). All of these traditional soy foods, indigenous to East Asia, remain quite exotic to Africans. Nevertheless, as has happened with curry from India and Pakistan and spaghetti from Italy, food habits can move quite rapidly from one region to another. There is thus a good chance that Africans will acquire a taste for soy foods originating in the Orient, where the soybean has been an essential food for many centuries. The idea that the soybean is suitable only for animal feed is an unfortunate prejudice in western countries, such as the USA, where the crop was originally introduced primarily for feed production after extraction of the edible oil.

In all civilizations the human diet consists of a combination of cereals, as a source of calories, and legumes, as the protein source. In East Asia the combination is rice and soybean; in the African savanna, it is sorghum/millet with cowpea. Though the most important food legume in Africa has traditionally been cowpea, this crop could gradually be displaced by soybean. Such a change, however, would require timely and appropriate policy measures as well as acceptable technology.

Soybean in West Africa

Soybean was first introduced in Nigeria in 1906, but the first cultivar tested was unable to nodulate in Nigerian soil. In 1938 the variety Malayan from Southeast Asia was introduced and proved capable of taking up the same nitrogen-fixing rhizobium that the African cowpea does. The International Institute of Tropical Agriculture (IITA), established at Ibadan, Nigeria, in 1967, undertook a vigorous soybean breeding program based on this variety. Many new varieties were developed during the 1970s, and during the 1980s soybean cultivation slowly began to spread in many African countries.

Table 1. World soybean production

	1984-85	1986-87	1987-88	1988-89	1989-90	1990-91
			000 t			
USA	50,644	52,869	52,736	42,153	52,354	52,303
Brazil	18,279	14,250	16,979	18,021	23,319	20,100
Argentina	6,500	7,100	6,614	9,830	6,650	10,729
China	9,705	10,521	11,614	12,430	11,645	11,230
Europe	916	1,700	2,775	2,402	2,838	2,715
Africa	368	378	400	452	478	476
Total	108,450	122,750	125,660	117,870	127,990	126,560

Source: *Oil World* (1991) and *FAO Yearbook: Production.*

Throughout West Africa, from Senegal to Cameroon, one finds a unique condiment (called *iru* in Yoruba and *dawadawa* in Hausa) made with fermented locust bean (*Parchia filicoidea*), a leguminous tree (called *darew* in Hausa) that is common in the tropics. Though important in local diets, this product has never attracted much scientific interest in the industrialized countries. In most of West Africa, the dried cakes of cooked and completely fermented locust bean are an indispensable ingredient in daily cooking, serving as a soup or stew base, just as Maggi cubes do in Western countries. Fermentation gives rise to a certain quantity of glutamic acid, a taste substance produced through protein digestion, and of butyric acid, which gives a very strong flavor somewhat similar to that of Swiss cheese. In Nigeria alone some 200,000 t of iru are produced, based on 250,000 t of substrate locust bean (Odunfa 1987).

Dr. S.R. Singh, director of the Grain Legume Improvement Program at IITA, estimated in 1987 that Nigeria produces about 120,000 t of soybeans annually. Much of this production is used as a substitute (a superior one apparently) for locust bean in the preparation of iru. By 1987 half of the total soybean output was already being transported from the major production area in Benue State to Kafanchan in Kaduna State, where iru is produced. Pressure to use soybean instead of locust bean has two sources, a growing scarcity of locust bean trees resulting from their use as fuel, and the changing work conditions of women, which give them less time to collect the beans.

The government of Nigeria has established a strategy of developing soybean production (Table 2). The Association of Nigerian Soybean Scientists has held a national meeting every year for the past 10 years and has published the proceedings of each one. These meetings bring together specialists from all the relevant disciplines (agronomy, plant breeding, entomology, plant pathology, economcs, food technology, and others) and manifest the strong interest and continued efforts of Nigerian scientists in soybean development.

At the Institute of Agricultural Research and Training (IART) in Ibadan, the chief of home economics (Mme. Ogundipe), made a vigorous effort during 1987 to develop and promote soybean recipes for common food preparations in rural areas. Her approach was to try to gradually replace cowpea with soybean in various recipes, including *ogi* (a weaning food), *moin-moin*, *akara*, *epa*, *egusi* stew, and others. Soybean is richer in protein than cowpea, and Mme. Ogundipe's recipes were all flavorful and generally acceptable.

During 1986-88 the American Soybean Association posted a food technologist at IITA to experiment in the manufacture of food products with texturized protein from soybean, using a single-screw extruder, which is normally employed

Table 2. Annual production targets for soybean in Nigeria

Year	Area (ha)	Projected yield (t/ha)	Total yield (t)
1990	141,000	1.5	211,500
1991	157,000	2.0	314,000
1992	173,000	2.5	432,500

Source: Astje (1990).

only in making dog food. To make texturized protein for human consumption, it was necessary to use a double-screw extruder. My impression is that this is the wrong approach to making soy foods more acceptable to Africans. I do not subscribe to the Western notion that meat is the most valuable human food and that meat analogues must always be sought in the development of new foods.

In 1989, IITA asked the Japanese government to send an expert on soybean food manufacture. Dr. Nakayama, an old colleague of mine at the National Food Research Institute and Japan's leading expert in bean curd technology, was sent to Nigeria. His mission at IITA is to explore local techniques for soybean processing, especially for producing soybean curd, which was originally developed in Asia. In studying indigenous food processing in Nigeria, he has learned of a process for clotting cow milk using the latex component of the wild plant *Calotropis procera*, whose common name in English is madar. This plant has long been used locally as an alternative to rennet. Dr. Nakayama was very successful in using the plant to coagulate soy milk into curd. Now he has developed a process for soy curd manufacture that is suited to rural conditions in West Africa, since it employs a widely available wild plant instead of the conventional calcium sulfate, which is not easily obtainable in rural Africa. Dr. Nakayam believes (and I share his view) that Africans will eventually consume soybean in the form of a protein-rich, deep-fried soybean curd.

FAO Mission on Soybean Development

In January 1987, FAO appointed me as the first biotechnology officer, Food and Agricultural Industries Service, Agriculture Department. My mission was to identify pressing needs for biotechnology applications in the Third World, particularly in the areas of 1) food industries, 2) nonfood agroindustries, 3) rural energy, and 4) agricultural residue utilization. Priority issues were identified as: 1) the protein and calorie content of human diets in Africa, 2) rain forest conservation, 3) the development of a biotechnology network in the Asia-Pacific region, and 4) bioenergy for the Sahel.

Earlier in 1986 the Biotechnology Program of the United Nations University (UNU), Tokyo, initiated a training program on soybean technology at the National Nutrition Center in Bogor, Indonesia. Five UNU fellows were appointed from among senior academic staff specializing in food technology (two from Ghana and one each from Benin, Nigeria, and Madagascar). We considered these scientists to be an important human resource for future soybean development in Africa and asked them to join the FAO mission to Nigeria. With the generous and effective cooperation of IITA's Grain Legume Improvement Program and the National Coordinator of Nigeria's National Soybean Research Program (Dr. Oyekan), a meeting was organized by the FAO mission at IITA in September 1987 to discuss strategies and project formulation for legume utilization, development, and extension. The 35 participants—representing

international agricultural research, government, universities and industry—reached the following conclusions:

1. Soybean production in West Africa will grow rapidly if appropriate measures are taken to promote its direct utilization for human consumption.

2. At present the major outlet for soybean in Nigeria is the production of iru, a traditional protein-rich condiment, through a fermentation process. This process has vital local significance but needs to be rationalized and modernized within the rural context.

3. The soybean development and extension project to be formulated may include Nigeria, Cameroon, Ghana, and Benin. The participating countries will conduct technical surveys in Asia (China, Indonesia, Japan, Taiwan, Hong Kong, Singapore, and Thailand) to identify products that seem suitable for transfer to Africa. Some possibilities are soy milk, curd, deep-fried curd, tempe products, fermented whole soybeans (natto), and texturized plant protein.

4. The development of recipes that are well adapted to traditional diets in rural Africa is an absolute necessity if soybean is to serve as a supplement and substitute for cowpea.

5. In view of the expected rapid development and extension of soybean in West Africa during the coming decade, it will be of the utmost importance to strengthen infrastructure, budgets, and human resource development for soybean research as well as extension in rural areas.

Based on these conclusions, a proposal was prepared at FAO headquarters for a project entitled Legume Improvement and Utilization Through Biotechnology in West Africa (including both cowpea and soybean). The proposal was submitted to the government of Japan in February 1988 at the regular meeting of FAO and the Japanese government. Unfortunately, the government has not given the proposal high priority.

Further action was taken by the National Crop Research Institute (NCRI) of Nigeria's Federal Ministry of Science and Technology. Based on the NCRI proposal, the Nigerian government submitted a request to the government of Japan for a grant-in-aid project for establishing a Legume Utilization and Development Center under NCRI at Badeggi, Niger State, which would eventually serve as the central institution for soybean and cowpea technology development and extension in West Africa. In view of the large number of extension personnel required for soybean development in the region, NCRI believes that a training center must be established as part of the program for technology development and transfer. The proposal for this project, whose funding requirement may reach US$10 million, will soon be evaluated by donor countries. One issue that must receive careful consideration is the most appropriate location for this institution in West Africa. I am hopeful that the

plan for a center will eventually be realized and am convinced that soybean research and promotion may be the only solution to alleviating serious protein deficiency and malnutrition in rural Africa after the turn of the century.

did not accept tempe because of the moldy growth that covers it. Indonesian tempe is a kind of soy Camembert, in which cooked whole soybean is fermented by the fungus *Rhizopus oligosporus*, which covers the soy with a

Soybean research and promotion may be the only solution to alleviating serious protein deficiency and malnutrition in rural Africa after the turn of the century.

Observations on Experience in Nigeria

Tempe in Osegere Village, Ibadan— In 1980-82 Professor Djurtoft of the Technical University of Denmark, under the sponsorship of the Danish government, attempted to establish the production of Indonesian tempe in Nigeria in cooperation with Professor Omololu of the Department of Nutrition, University of Ibadan. Experiments conducted in Osegere Village at the outskirts of Ibadan were reported to be successful at the International Nutrition Congress and at a symposium held in Tsukuba, Japan, during 1985. An FAO team, of which I was head, visited Osegere in September 1987 to observe the results. We were shocked to find that tempe production had ceased altogether.

The village had been chosen for the experiment because it had a health center run by a professional nurse, who could measure and record the growth and health of infants. The nurse explained to us that people in the village

whitish mycelium mat, making a sort of cake, and turns it into a nutritious and delicious food through protein digestion. As with soybean curd, tempe itself has no particular flavor or taste.

Dr. Djurtoft pioneered the use of cowpea as a substrate in place of soybean. Nonetheless, the product of this work, with its fungal or moldy growth, proved unacceptable because it was so contrary to traditional food preferences. This case illustrates the extreme difficulty of introducing foods from exotic cultures. Dr. Djurtoft's idea of transferring tempe technology to humid Africa appeared to be a promising one, since the region's tropical climate is much the same as that in Java. I myself was badly disappointed, since I had intended to follow up on the Danish experiments and had given tempe priority in biotechnology applications. I was somewhat more encouraged when I visited Lisabi Mills Ltd., a leading food manufacturer in Lagos. There I was given the impression that processed tempe products, such as deep-fried slices, a popular snack food in Southeast Asia (referred to as *tempe goreng*), may have large market potential in Africa.

The Food Center, Ijaye-Orile Village—In urban areas of Nigeria and other African countries, women are increasingly likely to take employment outside the home and thus have less time for food preparation. New collaborative arrangements are needed for preparing food and handling other domestic tasks.

Dr. Natalie Hahn, formerly with IITA and currently at the International Fund for International Development (IFAD) in Rome, has established, with funding from UNICEF, a simple facility for *gari* production, which is operated by a group of housewives in Ijaye-Orile Village near Ibadan. Named the Food Center, this facility required only a small investment in electric machines, including motor-driven raspers and an oven. Gari, an essential source of calories in West African diets, is produced from cassava through a process of fermentation and oven drying that eliminates the cyanide present in cassava roots. The Food Center produces some surplus gari for sale in the town market, which generates extra income for the women and helps defray maintenance costs.

Grassroots agroindustries in rural Africa should not rely on sophisticated technology and outside investment. They should be simple and sustainable at the village level and ought to yield some cash income. The FAO team that visited the Food Center was highly impressed with Dr. Hahn's approach.

Indigenous fermentation—Because of my views on the potential of tempe in West Africa, I was interested in comparing the traditional fermention of locust bean, a process described above, with its Asian counterparts based on soybean. In the heart of Nigeria's iru producing area at Zonkwa Village, Kafanchan, Kaduna State, the FAO team conducted an organoleptic evaluation of two stews prepared according to the same recipe, except that one used Nigerian iru and the other Japanese natto. The two preparations were found to have the same flavor, and a test panel of villagers liked the version in which natto had been used. The cook told us that the soybean-based stew had a slightly better flavor than that using locust bean. The difference was possibly due to the former's higher content of free glutamic acid, which is derived through soy fermentation. Glutamic acid accounts for 20% of the amino acid composition of soybean protein, the highest proportion among beans.

The bacteria resposible for locust-bean fermentation were isolated from a sample of iru in Japan, with the collaboration of Professor Hara of Kyushu University. It was confirmed that all bacteria involved in bean fermentation in Nigeria, Nepal, Thailand, China, and Japan are of exactly the same variety of *Bacillus subtilis*. A particular homologous plasmid common in this variety was identified, and its DNA base sequences were found to have remarkably similar genetic traits in fermenting bacteria from different parts of the world, as is the case with the yeasts that ferment alcohol. This finding suggests that it should be possible to improve the manufacture of iru by refining natural fermentation through control of microbiological processes.

Conclusion

According to UN estimates, world population will reach 8.5 billion in the year 2030, with India ranking first, China second, and Nigeria third, with more than 400 million people. Nigeria's population alone will require 10 million tons of protein annually, based on the daily protein requirement for adults. Obviously, animal sources of proteins will be inadequate for meeting this huge requirement. To avoid widespread protein malnutrition, Africa must be prepared to draw upon other protein sources, among which soybean seems to me the most likely solution for meeting protein requirements. It is urgent therefore that the continent acquire the infrastructure, institutions, financing, and particularly the human resources required for soybean and cowpea development and extension.

Protein biochemist and enzymologist M.L. Anson, one of the Rockfeller Institute's early pioneers in enzymology, was associated with Northrop and Summer (both Nobel laureates) and was renowned for his studies of Carboxy-peptidase A in the 1940s. In the USA he emerged after World War II as a leading figure in international efforts led by the UN to deal with protein deficiency; he created the UN system's Protein-Calorie Advisory Group (PAG) and strongly promoted the spirit of international collaboration. I once had the opportunity to meet him and consider myself to be his last disciple. He was the first person to bring Asia's traditional soybean technologies to the attention of the international scientific community; toward this end he organized a series of PAG conferences. In his prophetic chapter in *Processed Plant Foodstuffs* (1958), he wrote:

> The ancient Chinese discovery of the technology of producing soybean curd, which is rich in digestible protein of high quality, is bland in flavor, and has the quality of being suitable for repeated daily consumption, was a great historic step in direct utilization of oilseed protein by man and has made possible a great protein nutritional experiment on many millions of subjects. The traditional manufacture of soybean curd points the way to modern technology of using soy protein for man. . . . The wonder is that the Oriental experience has been so long neglected.

The Sasakawa-Global 2000 Project in Ghana has already achieved great success in soybean development at the grassroots level. I believe that this crop will figure very importantly in a green revolution in Africa during the coming decade.

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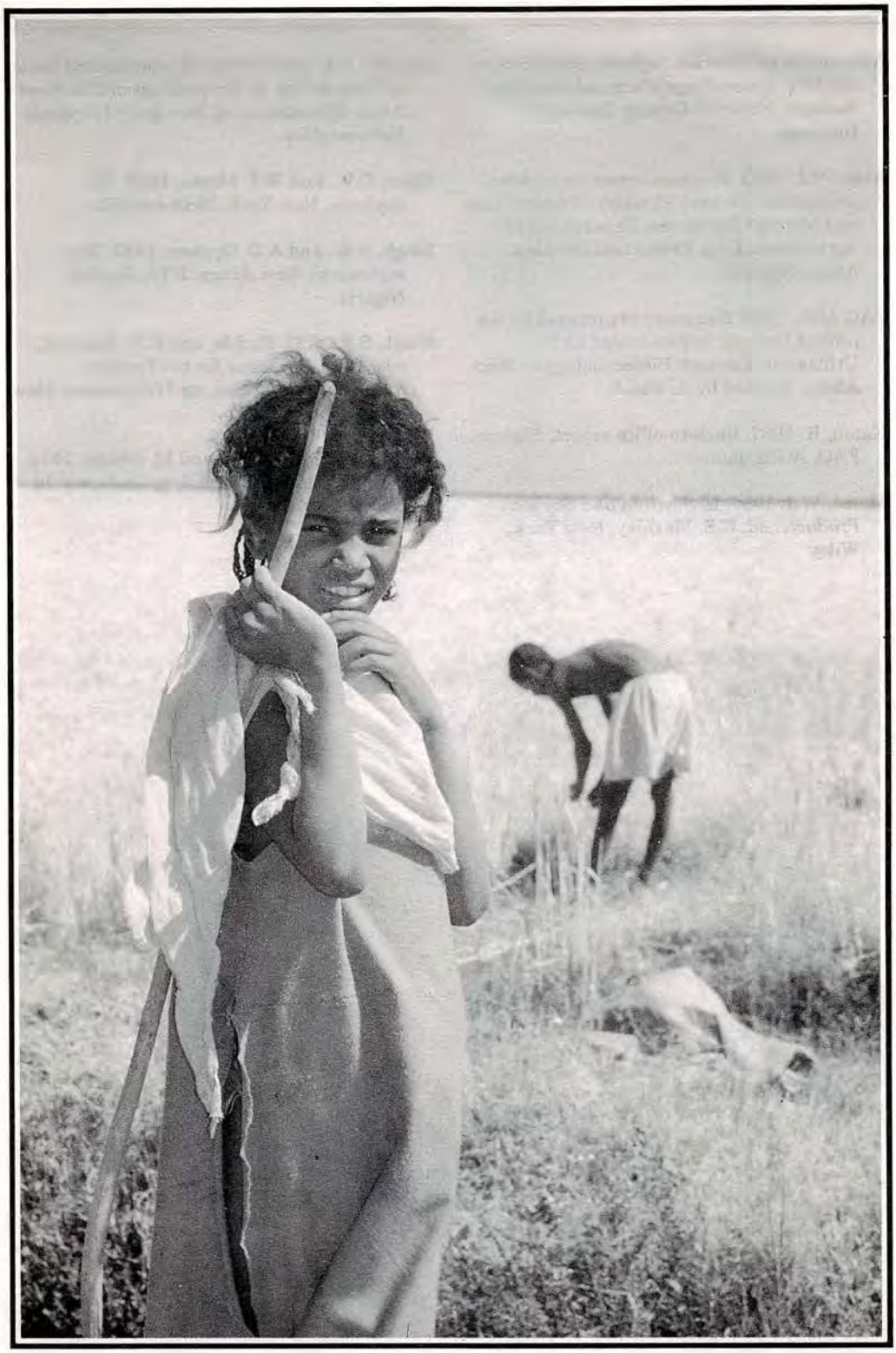

Environment, People, and Agricultural Production in Africa

*Lloyd Timberlake**

Many elements of the African environment make agriculture difficult. Much of the continent is too dry for rainfed farming, other areas too wet for most crops. Soils lack important nutritional elements. Pests attack plants and animals.

The typical response of African farmers has been to develop elaborate systems for farming in harsh environments, such as the nomadic pastoralism systems of the Sahel, or to seek out and develop techniques for production on small, less hostile bits of larger ecosystems or in small, prepared areas. Examples include river banks and riverine strips, natural terraces and levees, valley bottoms (*fadama*, *wadi*, *vlei*, etc.), alluvial pans, artificial terraces, pockets of fertile soil (as in former livestock pens), naturally sheltered areas: The list is endless (Chambers 1990).

These plots are usually small and dispersed, may be low lying, may be under the management of women, and may grow crops other than staple grains or roots. For all of these reasons, they tend to be overlooked by agricultural researchers and planners, who opt for crops and systems with which they are more familiar.

An interesting example exists close by. Some 40,000 ha of grazing land controlled by the Barabaig pastoralists on the Basotu Plains of Arusha Region were planted in wheat 20 years ago in a joint Canadian/Tanzanian venture. Yields are high, but the effort has cost the equivalent of US$75 million and is not sustainable; Canadian involvement must continue. The most recent official economic assessment of the scheme found that "the costs have exceeded the benefits and this is likely to continue through the year 2000." But for our purposes, it is interesting to note that this land, crucial to Barabaig pastoralist strategies, was described in a 1983 Canadian aid report as "previously idle land" (Lane and Pretty 1990).

Perhaps in no other continent is agriculture so site specific—and specific to relatively small sites. In no other continent is it harder to generalize about successful techniques or appropriate plant or animal species.

Along with complex farming strategies have evolved complex systems of rural survival, which go beyond farming to include using wild plants and animals, trading, and doing part-time jobs either in the local community or, seasonally, in cities. Farmers' decision-making processes are intricate but usually rational responses to conditions and opportunities.

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Undervaluing People and Resources

It is strange that agricultural development in Africa has tended to undervalue both the importance of local environmental variables and the body of knowledge that farmers have devised to cope with those variables.

The reasons for the apparent lack of concern on the part of African governments for environmental resources may be partly historical. Newly independent African states stressed industrialization over agricultural development, despite the fact that no region of the industrialized world—neither Europe nor North America nor Imperial Russia—managed to industrialize without first developing agriculture and the rural majorities engaged in it.

Also, the modern environmental movement originated in the industrialized countries and seemed to have little to offer the agricultural nations of Africa. Slogans such as "Save the Environment" and "Protect the Environment"—apparently aimed at keeping human beings and the natural environment separate—had little meaning in a continent where environmental resources such as topsoil, wood, and water provide the means of daily survival.

Even today, when that rather naive environmental rhetoric is rapidly being replaced by the goal of "sustainable development," many Africans remain suspicious of any emphasis on environmental management, still seeing such efforts as incompatible with economic development. This is a peculiar attitude in a continent full of nations, such as Tanzania, where the environmental resources that underpin agriculture determine the welfare of 85% of the population and the development of a nation that relies on agricultural exports for most of its foreign earnings. In 1987 Tanzania exported $296 million worth of agricultural exports, as opposed to $408 million in 1980, according to World Bank tables. In 1987 the average Tanzanian was producing only nine-tenths of the food he or she produced in 1980. The fact that this drop in per capita production is due largely to population growth is all the more reason to manage environmental resources carefully. The next generation of Africans, within 24 years, will be twice as large as this one.

Economist Dennis Anderson studied reforestation projects the world over to prove how profitable they can be in terms of increased agricultural production. But he concluded that "the recommended policies have not been applied in Africa because public recognition of the problems and a commitment to addressing them have been lacking. Part of the emerging tragedy is that the resources required would be small in relation to the prospective economic gains . . ." (Anderson 1987).

Governments' tendency to undervalue African farmers' skills and knowledge also has roots in history. Andrew Coulson, writing of Tanzania, summed up a major aspect of the tendency thus:

> The Tanzanian ruling class . . . had no experience of large-scale agriculture, and little faith in small-scale agriculture. . . . Most of its leaders and their parents had sacrificed to get their children into schools precisely in order to remove them from the necessity of hard work for little reward on the land. (1982)

Thus, there is not only a tendency to rashly dismiss small-scale, traditional farming systems but to rashly accept industrial systems that have worked well in other ecosystems and other economies. Julius Nyerere said in 1983 that Tanzanian schools had stopped teaching farmers to compost, as composting was old-fashioned, and were teaching them to use fertilizer. The result, he said, was that "in many places nothing is done to refertilize our soil after it has been used, much less improve its fertility. Our peasants . . . legitimately complain that having told them to use fertilizer, we do not make it available at a price they can afford or when they need it."

The undervaluation of African farmers and African environmental resources has led to misguided language in discussions of the African environment. Africa's true "environmental problems" are such givens as poor soils, erratic rainfall, and aridity. Such syndromes as deforestation, desertification, and soil erosion are not so much *environmental* problems as political and economic problems with environmental consequences. This distinction is not merely a play on words but a helpful guide in deciding whether solutions are technical, political, economic or—most usually—all three.

For example, the lack of trees in many of the farming areas of dryland Africa—trees that would diminish wind and water erosion as well as providing firewood—is often described as an environmental problem. The environmental, or technical, solution, is to plant trees. Indeed, public and private aid agencies have planted many millions of trees in Africa, especially in the Sahel region. Most of these quickly died.

Lack of trees actually reflects a political and economic predicament. Farmers tend to have far less political power than their numbers warrant and far less economic power than their contributions to gross national product demand. Terms of trade are set against them. Thus, they often lack both the means and motivation to conserve their soils, which in many places would involve the planting of trees. Where farmers have political clout and where farming is profitable, trees are planted without outside action, motivation, or money. In parts of Kenya, seedlings are available for sale along the roadsides.

Even the so-called "environmental problem" that gets most attention outside the continent—the loss of its majestic animals—can more helpfully be viewed as a political and economic problem. The view is helpful because it guides us towards solutions.

Few African national parks or reserves manage to protect elephant, rhino, and other species from poachers and casual local hunters, because local people rarely receive economic benefits from the parks.

Where systems have been put in place that give local people some control over the running of the parks and some reward from the tourist and other revenue, poaching has declined dramatically. Examples of such successes are few, because central governments tend to claim all control and all revenues for themselves.

When local Masai were given the chance to profit from tourist visits to Amboseli Reserve in the late 1970s, were compensated when carnivores attacked their cattle, and were allowed to water their herds at sources within the park

and have water piped from the park to cattle watering points outside, then poaching fell off markedly. Numbers of rhino doubled between 1977 and 1983; numbers of elephant, buffalo, and other migratory species increased. I gather, though, that this success has had its ups and downs in recent years.

When elephants had to be culled during the dry years of 1981-82 in Chizarira National Park and Chirisa Safari Area west of Harare, Zimbabwe, the government returned money from the sales of tusks and dried meat to two local councils. Over the two years, the councils received the equivalent of $960,000, which they spent on local transport, schools, and clinics. Poaching, which had been rampant in these areas, declined so spectacularly that wardens were dispensed with in both reserves. It makes little sense—and it is very a very inefficient way to protect animals—for African governments to arm African rangers to shoot African poachers so that fees paid largely by outside visitors can go into central government coffers.

The realization that many flawed environmental management systems stem from flawed political systems encouraged the World Commission on Environment and Development to conclude in its final report in 1987 that the first prerequisite of sustainable development was "a political system that secures effective citizen participation in decision making" (1987). Such a system, allowing farmer participation in decision making at both the local and national levels, is certainly a prerequisite for sustainable agricultural development. Outside agencies are wasting time trying to force technical solutions into societies not moving toward participatory systems.

Farmers and New Technology

Outsiders, governments, and, of course, African farmers themselves have all made mistakes that have degraded African environmental resource bases. But many environmentalists, both inside and outside Africa, often suggest approaches that would degrade African agricultural development. Noting how pesticides and fertilizers have been overused and misused in the North, they tend to protest against the adoption of such useful tools in Africa. Noting how singular are many African agricultural environments and how well-adapted is farmers' knowledge to that environment, they tend to defend peasant systems against any change. Taken to its extreme, this line of thought leads to what A.G. Hopkins called "the Myth of Merrie Africa," in which all change is regarded as evil (1973).

The truth is, of course, "that both science and traditional agriculture can help future farmers."

The truth is, of course, "that both science and traditional agriculture can help future farmers." This truth is so obvious that this line appeared in a recent article on Third World agricultural development in the British news weekly *The Economist*—an article that also took environmental extremists to task (1991).

The truth may be obvious, but applying it in agricultural development projects requires many not so obvious lines of approach. The complex ecosystems of African farming are well understood by the farmers and are at last getting more attention from researchers. High-technology agricultural inputs—new crop varieties, new tools, fertilizers, pesticides, etc.—are well understood by researchers and are being pressed upon some African farmers.

But the farmer remains the crucial link between the environment and the new technologies and techniques. And the complex livelihoods and coping strategies of farmers still get too little attention from researchers and consideration by project planners. Both livelihoods and coping strategies must be understood before farmers and researchers can move toward helpful changes.

The notion of the importance of farmer realities and farmer participation is hardly new. My own 1985 book on the African crisis of the mid-1980s devoted much space to showing how projects fail because they do not meet farmer's needs and are not based on the truths of farmers' livelihoods. It also documented many instances in which new varieties and new technologies spread from farmer to farmer with no outside intervention when they were appropriate. Farmers in parts of Kenya turned to hybrid maize faster than did US farmers (Timberlake 1985).

Getting Farmers Involved

What is new since the mid-1980s is the development of a body of systematic, rigorous, tested procedures by which farmers lead the developing practitioners, as both work together to initiate improvements that make rural livelihoods more productive, secure, and sustainable.

These participatory approaches have emerged in varying forms and contexts and have been called Participatory Rural Appraisal (PRA), Rapid Rural Appraisal (RRA), Participatory Learning Methods, Community Based Development, and Local Level Adaptive Planning.

A recent initiative to bring these efforts together has been given the title of Primary Environmental Care (PEC), a concept developed within the Development Assistance Committee (DAC) of the Organization for Economic Cooperation and Development (OECD), aided by the International Institute for Environment and Development (IIED) and others. It is basically the concept of sustainable development translated to the local rural level. It echoes the philosophy of primary health care, in that local environmental resources are managed by local people themselves in ways that truly meet their own felt needs. Participatory methods provide outside experts with ways of quickly and efficiently gathering data on rural realities. PEC is an approach whereby experts and local people can put local knowledge and those data to use for development.

These two approaches came together recently in a paper written for the OECD's Development Assistance Committee by Jules Pretty (director of IIED's Sustainable Agriculture Program and a pioneer in the development of PRA) and Richard Sandbrook (IIED executive director and an originator of the PEC approach). Much of what follows in this paper is based upon their work (Pretty and Sandbrook, in preparation).

PEC approaches have proved their ability to produce both improvements in farm yields and better management of environmental/agricultural resources. They are often described by Gordon Conway (1991), representative of the Ford Foundation in India, Nepal, and Sri Lanka, as the basis of the next green revolution. Larry Stifel, former director of the International Institute of Tropical Agriculture (IITA), has described them as "the quiet revolution."

The approaches are all aimed at involving poor groups and communities fully in planning changes. When so involved, these groups tend to be willing to contribute their own labor and finance to development efforts. A study of 68 multilateral projects found the economic rate of returns to be twice as high in projects that followed general PEC precepts, compared to ones that were less socially sensitive (Kottak 1985).

Another study looked at 25 multilateral projects 5 to 10 years after they were completed. It found that, where the projects had been based firmly on the strengths of local institutions, the flow of benefits had either increased or remained constant after the end of the project. Where local institutions were ignored, economic rates of return either declined markedly or became negative (Cernea 1987).

PEC focuses not only on local institutions but also on available resources and technologies. Resource poor regions with risky climates and poor soils typically produce five times less food per unit of land than do irrigated lowlands near cities. Yet many recent studies have revealed that development of pest, nutrient, and water management practices appropriate to local resources and technologies can lead to a doubling or tripling of yields of crops, livestock, and trees (Conway and Pretty 1990).

Experts meeting under the auspices of the Italian government (1990) last year concluded that the success of projects depends on the degree to which:

1. Local groups and communities are permitted to organize, participate in, and influence development priorities

2. Such groups and communities are allowed access to natural and financial resources

3. They participate in the generation and extension of productive and environmentally sensitive technologies and practices

4. Outside institutions give political support and provide for open access to information

5. Planning and implementing agencies are able to take an adaptive and flexible approach, building upon local knowledge and skills over long time frames

Maximizing each of the above variables makes obvious sense, but it does affect time scales and the approaches of project planners.

First, planners may want to spend much money quickly. Yet PEC requires that projects start small, perhaps in one village or small area. It also requires that projects start slowly—at least in terms of producing concrete, quantifiable, photogenic results. A small start is required because conditions vary widely in most of Africa, and thus

effective projects cannot be generalized over large areas. More importantly, there are only a maximum number of people who can practically be "permitted to organize, participate in and influence development priorities." And such organization goes more quickly if they are of the same village or area and have worked together before.

Often the time spent early involving local groups and communities pays off later in accelerated spread of project benefits.

PRA techniques, now being developed by groups in Africa, Asia, and Latin America, are essentially a group of multidisciplinary approaches to get local people to make the graphs, draw the maps, spot the trends, and do the research needed for project planning. These techniques offer structured approaches to getting local knowledge out of the heads and experiences of local people and into the open forum (Pretty 1990).

As Pretty and Sandbrook (in preparation) wrote, "Outsiders establish rapport, converse, catalyze, facilitate, and enquire; they choose, adapt, and improve methods; they hand over the stick, pen, or chalk, so that people can choose what to talk about; they watch, listen, and learn; they embrace error; and most of all, they do not lecture. Villagers map, model, diagram, quantify, rank, inform, explain, show, discuss, analyze, plan, and present."

Almost all projects focusing on conservation of environmental resources in Africa have taken about a decade to show real success. Thus, anyone interested in getting involved in improving the use of environmental resources in Africa—or anywhere else in the developing world—should not plan on a two- or three-year "project cycle."

The requirement of flexibility and adaptability (item five above) can also create difficulties for implementing agencies. It is difficult to plan, outside of Africa, several years of activities, only to have these plans radically change once one is inside Africa. Yet success appears to be impossible without such flexibility.

One of Africa's more famous yield-improving projects was an example of plans hijacked and rewritten by local people. OXFAM workers arrived in northern Burkina Faso with water-harvesting technology, mostly of the microcatchment sort, from Israel to help people grow trees. The local people were suspicious. They said that if these techniques could grow things, then they should be used to grow millet and sorghum. The OXFAM workers changed their approach to contour damming on the almost flat soils. Yields increased dramatically. Since the only "technology" involved was hoses full of water to find contour lines, farmers quickly spread the approach to other farmers. Long, low lines of stones now cover a large region of Burkina Faso and have spread into Mali. This success leaves one with the suspicion that if a government aid agency had gone in to grow trees, then their goal would have been trees or nothing.

PEC approaches in themselves may not lengthen the time needed to produce benefits from a given project. Often the time spent early involving local groups and communities pays off later in accelerated spread of project benefits. This raises the issue of participation by local people in the generation and extension of productive and environmentally sensitive technologies (number three above). If farmers understand the technology or techniques, can handle them, and—most important—if they work, then the farmers who have benefited will be the best people to spread the word to others. This is not only most efficient but can save outside agencies time and money.

Item four above, outside institutions' ability to "give political support and provide for open access to information," is crucial but dangerous. In some countries giving political support and certain types of information to village groups is viewed with strong suspicion by government. In some Sahelian countries, efforts to make nomadic groups more secure and self-reliant by helping them establish purchasing cooperatives were stopped by governments who did not want to see the self-reliance of large tribal minorities who moved easily across borders increased. Political support is important, but so is tact in providing it.

Summing up then, the PEC approach has the following implications for projects: It requires planners to start small; permit flexibility in changing objectives and in reporting procedures; design "front loading" for training, experimentation and dialogue; commit funds for long durations; and involve local communities fully in the implementation, management of resources, and monitoring.

PEC requires different uses of money but not necessarily more money. Greater efficiency and effectiveness, better cost recovery, greater desire to delegate responsibility so as to reduce dependency on expatriate staff, and fewer inappropriate interventions requiring costly repair mean that reallocation of current budgets can yield considerable results.

Finally, the lessons of this paper—like the lessons of most papers—can be neatly summed up in a single comment by an African farmer. British anthropologist Paul Richards, arguing that agricultural development must come from within African societies, must be "organic" rather than being plastered on from outside, quotes a remark by a villager in Sierra Leone: "You cannot turn a calf into a cow by plastering it with mud" (Richards 1985).

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Agricultural Land Use and Wildlife Policy in Kenya: Some Problems and Ideas

*R.E. Leakey**

One of the principal goals of the Kenya Wildlife Service (KWS), which was created as a new parastatal organization early in 1990, is to conserve the natural environments of Kenya and their fauna and flora for the benefit of present and future generations and as a world heritage.

This objective is closely linked to two other principal goals: 1) to use the wildlife resources of Kenya sustainably for the economic development of the nation and for the benefit of people living in wildlife areas and to protect people and property from injury or damage from wildlife.

Conflict Between Wildlife and Human Populations

Inevitably, there is conflict between wildlife and the human population, which in Kenya has almost doubled in the past 20 years, placing intense pressure on our wildlife preservation areas. Though 8% of the country's total land area has already been set aside as national parks and reserves, forming a solid base for Kenya's overall program of environmental protection, many of these are not self-sufficient ecosystems. Much of the wildlife from these core protected areas moves onto surrounding areas for part of the year. Maintaining the present size and diversity of these wildlife populations depends on their having continued access to traditional seasonal dispersal areas.

With increases in the human population, settlement in the dispersal areas has expanded rapidly. The area cultivated is increasing, although many of these lands are not well suited to agriculture, and traditional pastoralists and their livestock are being squeezed into ever smaller grazing ranges. These land-use changes are excluding wildlife from more and more land in key dispersal areas and producing greater pressure for grazing within parks and reserves.

Benefits From Wildlife

Overall, conflict between wildlife, agriculture, and livestock husbandry is increasing and undoubtedly will continue to do so. People living in areas with wildlife bear many costs, such as crop and property damage, predation on livestock, and in particular competition for grazing. Yet hitherto they have received very few of the large benefits from wildlife, derived through tourism and other means. There is scope for dramatic improvement, both in the quantity of money going directly to rural people and in the way it is targeted.

As pressure mounts on the protected areas, the importance of wildlife to Kenya's economy grows. Since 1987 tourism has been the largest single source of foreign exchange. It is one of

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the main sources of formal employment and also has substantial indirect effects on employment in construction, transportation, manufacturing, finance, and other areas. Indeed, tourism is the most successful area of economic diversification in Kenya, significantly reducing the country's vulnerability to fluctuations in export earnings from coffee and tea.

Wildlife has played a central role in this achievement. One recent study found that slightly over half of tourism's earnings were attributable directly or indirectly to wildlife. On this basis, and using official estimates of tourism receipts, wildlife generates over US$200 million a year for the Kenyan economy.

Wildlife Conservation and Rural Development

Thus, the relationship between people living and farming in the dispersal areas and wildlife moving or migrating out of the parks and reserves is becoming even more crucial. Indeed, this relationship—between wildlife conservation and rural development—is giving rise to radical new policies. Bold steps must be taken to ensure that rural people, who bear some of the costs of the country's revenue-generating wildlife areas, will also share in the benefits. Without these people's support, the underlying conflict will never be resolved, and there will be no future for Kenya's wildlife.

KWS has therefore taken a direct step to deliver benefits to people living in areas adjacent to parks and reserves by sharing its own revenues with these communities. Revenue sharing can make a very worthwhile contribution to rural development in some areas, even though KWS revenues represent only a small percentage of the total tourism economy. KWS will seek ways to increase local benefits derived directly from the industry. Involvement of local communities in tourism and other wildlife-related business will be one of the key tasks of the Community Wildlife Service, to be set up by KWS to work with people living next to parks and reserves. KWS wishes to allow landowners the opportunity to develop wildlife as a benefit rather than be obliged to tolerate it as a cost. Through extension work, KWS will assist and encourage landowners with wildlife on their land to benefit from it through tourism or other means.

KWS wishes to allow landowners the opportunity to develop wildlife as a benefit rather than be obliged to tolerate it as a cost.

With few exceptions consumptive utilization of wildlife has not been practised legally in Kenya for 13 years. Though it poses many problems of management, it is another potential mechanism for getting benefits to people who conserve wildlife. KWS will therefore consider the authorization and subsequently the supervision and evaluation of pilot projects for consumptive utilization of surplus wildlife in selected places.

Another important element in developing a positive role for wildlife is to reduce its negative aspects, i.e., to

minimize conflicts between wildlife conservation and legitimate human settlement. Where wildlife cause damage to crops or property, KWS will undertake control shooting or trapping or where the problems are serious and persistent erect wildlife-proof barriers.

Coordination between sectors in land-use planning and management is a crucial means of reducing conflicts and establishing an appropriate, stable role for wildlife conservation in the local pattern of development. KWS considers this coordination to be of paramount importance in the long term and will make every effort to develop strong local cooperation, especially with district authorities in major wildlife areas.

The last essential element in the strategy to win the support of Kenya's people for wildlife conservation is education. While its short-term benefits may be few, education is vital for conservation in the long term, especially as Kenya's population grows. In addition to providing natural history interpretation for visitors to the parks and reserves, KWS will participate in a conservation education program for a wider range of people in Kenya. The program will aim to reach both rural and urban people and will seek to inspire as well as inform. In developing and executing this program, KWS will work closely with other specialist organizations, both inside and outside the government.

Expanding Tourism on Private Land

Clearly, the conservation of natural environments requires much more than just parks and reserves. The use of wildlife resources for economic development is similarly not limited to protected areas, and the prevention of damage caused by wildlife specifically concerns lands outside parks and reserves.

One obvious area for tourism expansion is private land, where KWS is especially keen to promote wildlife conservation. Many group ranches would like to earn more tourism revenue, but they may face a dilemma. To attract tour operators, they will have to become better organized and manage the land to accommodate both tourism and livestock. There is certainly high potential: Some of the finest wildlife areas in Kenya are group ranches and trust land.

KWS intends to delegate to competent landowners some responsibilities and rights to use wildlife, limiting its own role to an advisory and supervisory one. Landowners already have, in effect, rights to use wildlife for tourism and recreation. KWS intends to confirm these rights and thus encourage a sense of economic opportunity and responsibility. It is KWS policy that landowners retain all the revenue that they derive from wildlife on their land, as they do for competing land uses. They may also choose the best way to use the wildlife for their own benefit subject to KWS approval. But any consumptive utilization schemes, as already stated, will be done initially on a pilot project basis.

There are various forms of consumptive utilization—including bird shooting and game cropping where wildlife is common and is harming other economic interests. In Kenya a commercial game cropping business has had special permission to operate on ranches on the plains south of

Nairobi and has found a profitable game meat market in the city's restaurants.

But sport hunting, a major activity in Kenya until the mid-1970s, will not be reintroduced until KWS has gained experience with other forms of consumptive utilization and studied further the concerns and opinions of the Kenyan people. Even with game cropping and hunting for home consumption, there will be no trade within Kenya in trophies and skins (unless the hair is removed), and it will be permissible to hunt only plains game species.

Forest Reserves

KWS is also involved in forest reserve management, which is more akin to park management than its role on private land. The Forest Department's management of natural forests has been weak, though there are plans to strengthen it through a World Bank program. The forests have been cleared or degraded at an alarming rate in recent years, to such an extent that the president banned all tree felling in natural forests. The mangroves, which are of tremendous ecological importance, have been heavily overexploited and cleared for salt production. KWS is concerned primarily with forests of value for biological diversity, tourism, or both.

Forests are underrepresented in the park and reserve system, and some are recommended for gazettement as parks. KWS and the Ministry of Environment and Natural Resource have agreed in principle that natural forests should be fenced where wildlife causes problems for adjacent communities. There would be manned entry points at intervals along the fense to allow traditional uses of the forests (e.g., gathering of firewood, poles, and honey and dry season grazing) to continue in a controlled manner.

In order to help meet the costs involved (for fencing, forest wildlife management, tourism development and management, and any continuing problems with animal control), KWS will receive revenue from tourist entries, camps, lodges, and services, just as it would for a national park.

Conclusion

In its relatively short history, KWS has scored significant successes in combatting the poaching menace. Indeed, elephant poaching this year has been negligible, and there are real signs that the elephant herds are beginning to expand again.

On this firmer foundation, KWS can plan for the future. A major document, entitled A Policy Framework and Development Program (1991-96), has been produced that calls for substantial investment in Kenya and in KWS to help make it a self-financing parastatal with no need for support from the treasury. If the plans outlined in this document can be carried out, they will make a major difference to more than Kenya's wildlife. The complex relationships between tourism, land use, community service, rural development, water and soil conservation, and wildlife are such that a project of this magnitude cannot fail to make an impact. Never before in Kenya has there been such an important chance to make a difference in the field of wildlife, which is increasingly recognized as a natural and valuable economic resource.

Comments on Sustainable Development in Africa

In addition to distributing the paper presented above, Dr. Leakey discussed a number of additional ideas, pertaining to wildlife and other aspects of sustainable development in Africa, with the intention of stimulating discussion.

I would like to begin by drawing attention to the fact that paleontologic and geologic records demonstrate that since life first appeared on this planet some 31.5 billion years ago there have been five major episodes of extinction—when more than 90% of the species that had lived subsequent to the preceding incident became extinct very rapidly. The pace at which we are losing species today suggests that we are within or on the edge of the sixth extinction. Loss of diversity, habitat destruction, and the erosion of life-sustaining environments across the length and breadth of this planet have never reached more alarming proportions. My view of the work of scientists developing new plants with which to feed more people is that unless we have a healthy planet the species will not survive.

I am also concerned about the apparent willingness of people to overlook the lessons of history and prehistory. Lake Turkana in northern Kenya provides such lessons, and they are quite relevant to the sustainability of Africa's agriculture. The lake is over 200 km long, an average of 30 to 40 km wide, and about 80 m deep at its deepest point, though much of the lake is shallower. For the last 20 years, people have studied this lake and its environs; one of their findings is that it receives 98 to 99% of its water from the Omo River, which drains the highlands of Ethiopia. The present Lake Turkana has been in existence as an uninterrupted reservoir for drainage of the Ethiopian highlands for at least a million years. Before that there were periodic lakes, which disappeared and later returned. For the last million years, there is a very complete geological record of the lake's history and of the history of the Ethiopian highlands in terms of rainfall.

I realize that it is difficult to think in terms of hundreds of thousands, if not millions, of years, so let me put this into the perspective of oral history—the last 150 years. Over the last 22 years, the period during which I have worked at Lake Turkana, its level has dropped by 15 m partly as a result of the evaporative rate, which presumably has not changed. Since the lake is in an area with little cloud cover and virtually no rainfall, the drop must reflect a lessening of rainfall on the Ethiopian highlands. Over this same period, we have seen a similar loss of rainfall and agricultural productivity in the Sahelian zone. The drought, famine, and tremendous suffering of the people across that zone of Africa is mirrored in the falling lake level.

Just before the beginning of this century, Lake Turkana was 30 m lower than it is today. The lake could fall a further 30 m, regardless of whether humans are interfering with the environment or not. The lower level at the end of the 1800s has to reflect catastrophic environmental change in certain parts of Africa at a time when population densities were not as high as they are today. The lake was 30 m lower long enough to permit the growth of *Acacia tortelis*, slow-growing hardwood trees that today still stand out in the water, preserved from that period. We have to understand that in many parts of Africa, where the

population is growing rapidly, the availability of rainfall and water for sustaining agriculture is not a given.

My current job is concerned with wildlife and to a large extent with the management of what we term protected areas—national parks and game reserves. In Kenya about 55% of our land is considered semiarid or inappropriate for normal agricultural practices, although much of it has traditionally been used for running poor quality cattle, sheep, goats, and camels. That stock has coexisted quite satisfactorily with certain species of wildlife over long periods of time. The protected areas lie not so much within the semiarid lands but in areas with higher potential for agriculture and pastoralism.

To be a good environmentalist or conservationist, you have to have at least one square meal a day.

In Kenya we have set aside something like 8% of the land for protected areas, including the large national parks of Mount Kenya, the Aberdare Mountains, and Mount Elgon. Much of the natural forest in Kenya is protected, since it serves as a catchment for water that is so critical downstream. We are also attempting to protect wetlands and some of the semiarid wildlife-rich areas. We have turned the protection of wildlife into an economic industry and are pressing ahead with further development of ecotourism. Today tourism accounts for more than 35% of Kenya's capacity for earning hard currency. We believe that with better management tourism could account for an even larger share, and the government is committed to further enhancing our country's tourist attractions and facilities.

Tourism in Kenya is directly related to a combination of sunshine, beaches, and, more importantly, wildlife. The protected areas provide a means of conserving wildlife and have a role in ensuring the sustainability of human life within the country. For too long the people living around the protected areas have to a large extent perceived them as land that was stolen or appropriated without due discussion and that now serves no useful purpose. It is extremely difficult to expect people living on the borderline of starvation to grasp the ecological importance of the protected areas.

To be a good environmentalist or conservationist, you have to have at least one square meal a day in my judgment. We have made the decision in Kenya to adopt a completely new approach in the development of tourism, one involving a deliberate attempt to increase revenues in the protected areas and a program of setting aside a substantial part of this income for rural development. We expect that by this means it will be possible within the next three years to channel approximately US$10 million a year into rural development in the areas peripheral to our protected areas.

This approach will give the people whose land was in a sense appropriated by a higher authority both a better understanding and an actual share of its current economic value. We expect that the outcome will be not only a reduction

in poaching but, more importantly, less pressure to encroach on the protected areas, which are preserved partly because of their economic worth but even more for their environmental value.

It is very difficult to speak of wildlife in the broader African context. Many African countries do not have the potential for ecotourism based on wildlife. Even so, we must remember that wildlife includes a variety of species, all of which constitute a source of protein. The development of this protein source in Africa's semiarid lands certainly merits further consideration. I do not believe farming of wildlife could be more profitable or more directly beneficial than the running of cattle, sheep, and goats, but a combination of the two might indeed increase the productivity of the land in some of the continent's dryer regions.

There are also other ways to develop protein from wild species. When talking about the development of policies for sustainable livestock production, we must remember that this continent was the birthplace of humanity and that Africans did remarkably well for a very long time. With colonial expansion into Africa, many traditional patterns of land use were set aside. Many of the constraints to rapid population growth were also removed. Little attempt has been made to determine whether we can learn lessons from those traditions that could be beneficial tomorrow.

I would like to comment briefly about the need for research institutions in Africa and to raise the question of whether African scientists are able to do all the research that is needed. Certainly, in many cases they could if they had access to the same resources that are available to their colleagues in other places. One of my appeals to the Sasakawa Foundation is that it employ its contacts and resources to help research institutions become more self-sustaining by setting aside funds in the form of an endowment that would guarantee the continuation of high-quality research programs, regardless of the changing political climate in one part of Africa or another.

In the area of wildlife, we have heard a great deal about debt-for-nature swaps. I have recently suggested that a better approach would be to swap debt for an endowment for nature. On this basis we could begin a program for developing the human resources required to tackle problems on this continent as well as in other parts of the developing world.

In conclusion, I would like to add a few remarks pertaining to other speakers' comments on democracy. Certainly, Kenya has often been written about in the international press with respect to this issue. In my view the key requirement is not that citizens be involved in all decisions but that they be able to hold their leaders to account. There needs to be a public audit of leadership at all levels. Whether in secondary schools, research institutions, or government ministries, systems must be established that give people the opportunity to question the performance of their leaders. That, I believe, is what most Africans seek, and I believe it is the direction in which many of us are now going. Unless we are accountable for some of the things that are happening today, the sixth extinction will be a reality, and it will be our fault.

Agriculture, Natural Resources, and Environmental Policy

*Björn Lundgren**

I have chosen to discuss two aspects of the complex set of issues that relate to the interface between agriculture, natural resources, and environmental policy. One has to do with our concept of these issues and the other with the way in which we deal with them from the institutional point of view. This paper is not a learned discourse, with references to the authorities on my subject, but is rather an informal presentation, whose purpose is to share with you my ideas and views. Inevitably, these are based to a considerable extent on my experience over the last 10 years as director general of ICRAF.

Our Concept of Agriculture and Natural Resources

In communicating and conceptualizing, human beings tend to organize ideas along gradients with clearly defined extremes—the thesis/anthesis concept. One such pair of opposites is nature and culture. The way we view these concepts, or used to view them, has a far-reaching effect on the way we deal with issues in agriculture and natural resources and on the way in which the two interact with one another. The predominant view is that natural resources—wildlife, rain forests, biodiversity, mountains, the seas, minerals, etc.—are out there waiting to be conquered and tamed and thus transformed into their opposite through various forms of culture, such as agriculture, horticulture, or silviculture. Another way of putting it is that all forms of culture are part of human civilization, whereas nature and natural resources are not.

Of course, most of us realize that there are strong interactions between agriculture and natural resources. But particularly in the last decade or so, we have become acutely aware of the obvious causal mechanisms between destructive uses of natural resources (leading to, among other things, deforestation and desertification) and our difficulty in sustaining increased levels of food production in many regions of Africa. Even so, there is often considerable confusion about the true nature of the causes and effects. It is often said, for example, that deforestation is a global problem and the cause of hydrological disturbances, loss of productivity of agricultural land, and desertification. This idea has achieved almost gospel status, and to contradict it is considered heretical. And yet, the idea is wrong, and to use it as a basis for major environmental and land-use policies will lead to very doubtful decisions about priorities and resource allocations.

With the probable, but virtually unquantifiable, exception of the loss of biodiversity and as yet undiscovered

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genetic resources, deforestation is not in itself a problem, let alone a global one. Rather it is the effect of a large number of local problems having a variety of causes, including landlessness, poverty, inadequate food production, insecure land tenure, government policies (or the lack of them), corruption, inappropriate technologies, and many combinations of these. The notion that deforestation is a problem arises from the understandable sadness and desperation that we environmentalists feel about the rapid loss of the magnificent and biologically unique tropical forest ecosystems. But with some exceptions their destruction is not perceived as a genuine problem by land users and leaders in most countries in the tropics, nor is it in fact a problem.

The real problem is what happens to the land after it has been stripped of its forest cover. Deforestation in itself does not lead to erosion, flooding, desertification, and so forth. Rather these are the consequences of the use of inappropriate and often destructive technologies for agriculture, livestock rearing, road construction, etc. There are several safe technologies—terracing, mulching, agroforestry, and proper management of shrub crops (tea and coffee, for example)—that in theory and practice can avoid the destructive use of land after forest has been cleared. Nine times out of ten, however, such technologies are not used and for a variety of reasons. Among these are a lack of technical knowledge and inadequate means of extending such knowledge to farmers, though socioeconomic and political factors are often more important. Thus, one can probably establish a strong statistical relationship between deforestation and the subsequent destruction of resources. But we have reason to be concerned if agricultural and environmental policies ignore the all-important steps in land use that occur between deforestation and soil degradation. In this regard I must admit that I feel somewhat uneasy about the preparatory work for the United Nations conference on the environment and development to be held next year in Brazil.

In spite of the misconceptions I have described above, I still feel that we are gaining a better understanding of the interactions between natural resources and agriculture at the macro and meso levels (via hydrology, climate, genetic resources, topography, etc.). Nonetheless, because of the old concept of nature and culture as opposites, many people have yet to realize that the important issue in sustaining and increasing food production is the way we manage natural resources within agricultural and mixed land-use systems. Nowhere is this conceptual difficulty more obvious than in agroforestry.

The basic idea of agroforestry is to integrate woody perennials (trees, shrubs, bamboo, etc.) into farming systems and, drawing upon their special characteristics, to manage these plants in such a way as to increase the total productivity, sustainability, and diversity of the output of farmland. Trees and shrubs can provide both direct benefits and products, such as fuel, poles, timber, fruit, and fodder, and indirect benefits or services, such as preventing erosion, maintaining soil

fertility, or enhancing the microclimate. Through their indirect benefits, trees and shrubs—themselves a natural resource—offer a means of managing the most important natural resources within farming systems, that is, the topsoil and water upon which crop growth depends. Both traditional land-use practices and ones developed more recently provide examples in which trees and shrubs have been used very successfully to maintain soil productivity on the farm. For example, the old practice of retaining the tree species *Faidherbia (Acacia) albida* in sorghum and millet fields in the Sudan savanna and Sahel region of West Africa has an obviously positive effect on crop yields. Similarly, the various forms of hedgerow intercropping (alley farming) that have been developed in the last 10 years or so have shown much potential for halting erosion (when the hedgerow is planted on the contour) and for producing mulch (green manure), which can contribute significantly to maintaining high nitrogen and organic matter content and thus the level of fertility in the crucial topsoil. It has also been shown that the effectiveness of mineral fertilizers can be increased substantially when they are combined with leguminous shrubs grown in hedges in fields sown to crops.

Agroforestry deals with systems in which one kind of natural resource, in the form of undomesticated trees , is used to manage other natural resources (soil and water).

Though agroforestry management is an extremely exciting subject, a discussion of its details—which tree species to use, how to plant and trim them, how to optimize the productive and service functions, etc.—is beyond the scope of this paper. The point that needs to be stressed here is that when small-scale farmers in Africa or elsewhere use trees or shrubs on their farms (as the vast majority do)—whether to produce goods, provide a service to the crop or animal component of the farming system, or both—they regard the woody plant as an integral part of their system, just as they do the cereal or root crop, goat, plow, or fertilizer. The experts and politicians, brought up under western systems of education and ways of thinking, are the ones who have conceptual difficulties with agroforestry—not the farmers. Agroforestry deals with systems and practices in which one kind of natural resource, in the form of undomesticated trees (most, though not all, multipurpose trees used in agroforestry technologies are not conventional silvicultural or horticultural species), is used to manage other natural resources (soil and water)

within crop and/or livestock farming systems. This approach is diametrically opposed to the traditional notion of culture versus nature or, in this case, of crop and animal production versus trees in natural forests.

As a result, agroforestry is viewed in many different and often confusing ways. To the Food and Agriculture Organization (FAO), at one extreme, it is a kind of forest system. Within the Consultative Group on International Agricultural Research (CGIAR), agroforestry is a vaguely defined natural resources management system, as opposed to a crop and animal production system, and at ICRAF it is regarded as a mixed farming system in which trees and shrubs play an integral role. The Indian Council of Agricultural Research (ICAR), at the other extreme, considers the trees and shrubs to be totally subordinate to the goals of crop and animal production within conventional agricultural systems.

Had these conceptual problems resulted only in an animated academic dispute about definitions, no harm would have been done. But our difficulty in analyzing clearly the interface between agriculture and natural resources and in dealing with integrated land use (through agroforestry, for example) has resulted in strongly discipline-oriented research institutions that are not well suited to addressing the agricultural and environmental problems (and potential) of Africa today.

Our Agricultural and Natural Resource Institutions

The institutions established to deal with the use of land originated from a particular period in the history and economic development of Europe. During the late 19th and early 20th centuries, European agriculture and forestry rapidly became commercialized as a result of industrialization and urbanization. Institutions for education, research, and extension were established to help ensure that adequate supplies of raw materials were provided for industry and food for the urban populations. By the turn of the century these people made up the majority of the total population in most West European countries and in the USA. Subsistence farming rapidly disappeared as markets expanded. The growing amount of wealth generated in industry provided a means of compensating farmers in the event of crop failures.

Over the centuries the geographical characteristics of the land led to a natural division in land use. While flat, fertile, easy-to-plow land was used for crop production, sloping and stony land was set aside for forest or left unused. Because of decreasing rural populations, conflicts between different land uses were rare. In addition to being practiced on different types of land, forestry and crop production were often managed by different categories of owners. Their management required different skills, and the products from agriculture and forestry had different markets.

Given these circumstances, it was entirely rational that agricultural, forestry, and range management institutions should develop independently from one another—in education, research, extension, and legal matters. Furthermore, it was (and still is) rational that the mandates of these insitutions should be to maximize production of individual crops and commodities from a given piece of land. Thus, commercially oriented monocropping and other single uses of land became, and remain, the predominant forms of land use around which the work of agricultural institutions revolves.

This institutional arrangement, with its accompanying mandates, laws, academic disciplines, government ministries, departments, and extension services, was imposed on Africa and other regions by colonial administrations early in the 20th century. The system is still intact today and has even been strengthened by the many new universities and technical institutions that have been established since independence—all based on the conventional disciplines and all aiming to develop professionals who are capable of helping maximize the production of single crops, trees, or animals.

Of course, such efforts have resulted in some remarkable achievements. Examples are the Green Revolution in wheat and rice, the development of systems for the production of export crops (such as coffee and tea), the creation of viable meat and dairy production in some environments, and the establishment of high-yielding forest plantations. The benefits of these achievements, however, have largely bypassed the hundreds of millions of small-scale, mainly noncommercial land users that make up the majority of rural populations in tropical and subtropical upland areas.

The serious inadequacy of present institutions and of the people that staff them lies in their inability to analyze and contribute effectively to the solution of problems faced by small-scale, subsistence or semisubsistence farmers and pastoral land users. The management strategies of these land users are aimed at minimizing risk and optimizing the production of crops, wood, and animals to satisfy all of their basic needs for food, fuel, shelter, and cash.

What we have today are institutions and experts that focus on individual components of farming systems and who can conduct research and offer advice on maximizing the production of these components but who lack the expertise to help farmers optimize all of the components in their systems.

An analogy with the construction industry serves to highlight the problem. In land management we have the equivalent of masons, carpenters, electricians, and plumbers in the form of agronomists, foresters, livestock experts, and agricultural engineers. But we lack institutions that can perform the all-important roles of the architect and civil engineer, that is, analyze needs objectively, design an integrated program for satisfying them, and coordinate the execution of this program.

Much the same constraint in dealing effectively with environmental problems and potential was highlighted by the

World Commission on Environment and Development (the so-called Bruntland Commission):

> Sectoral organizations tend to pursue sectoral objectives and to treat their impacts on other sectors as side effects, taken into account only if compelled to do so. Many of the environment and development problems that confront us have their roots in this sectoral fragmentation of responsibility. Sustainable development requires that such fragmentation be overcome.

Recommendations

I have argued that our ability to deal rationally with issues relating to the interface between agriculture, natural resources, and the environment is constrained by the way we conceive these issues and by the narrow disciplinary mandates of our institutions for dealing with them. Nonetheless, there are encouraging signs of change in the development, education, and research sectors. Various institutions, programs, and groups are showing a greater awareness that interdisciplinary and cross-institutional approaches are required to address complex issues related to the environment and sustainable agricultural production.

My main recommendation then is that we decision makers, scientists, educators, and planners do everything in our power to support initiatives leading to more integrated approaches in land development. This general recommendation can be broken down into three more concrete suggestions:

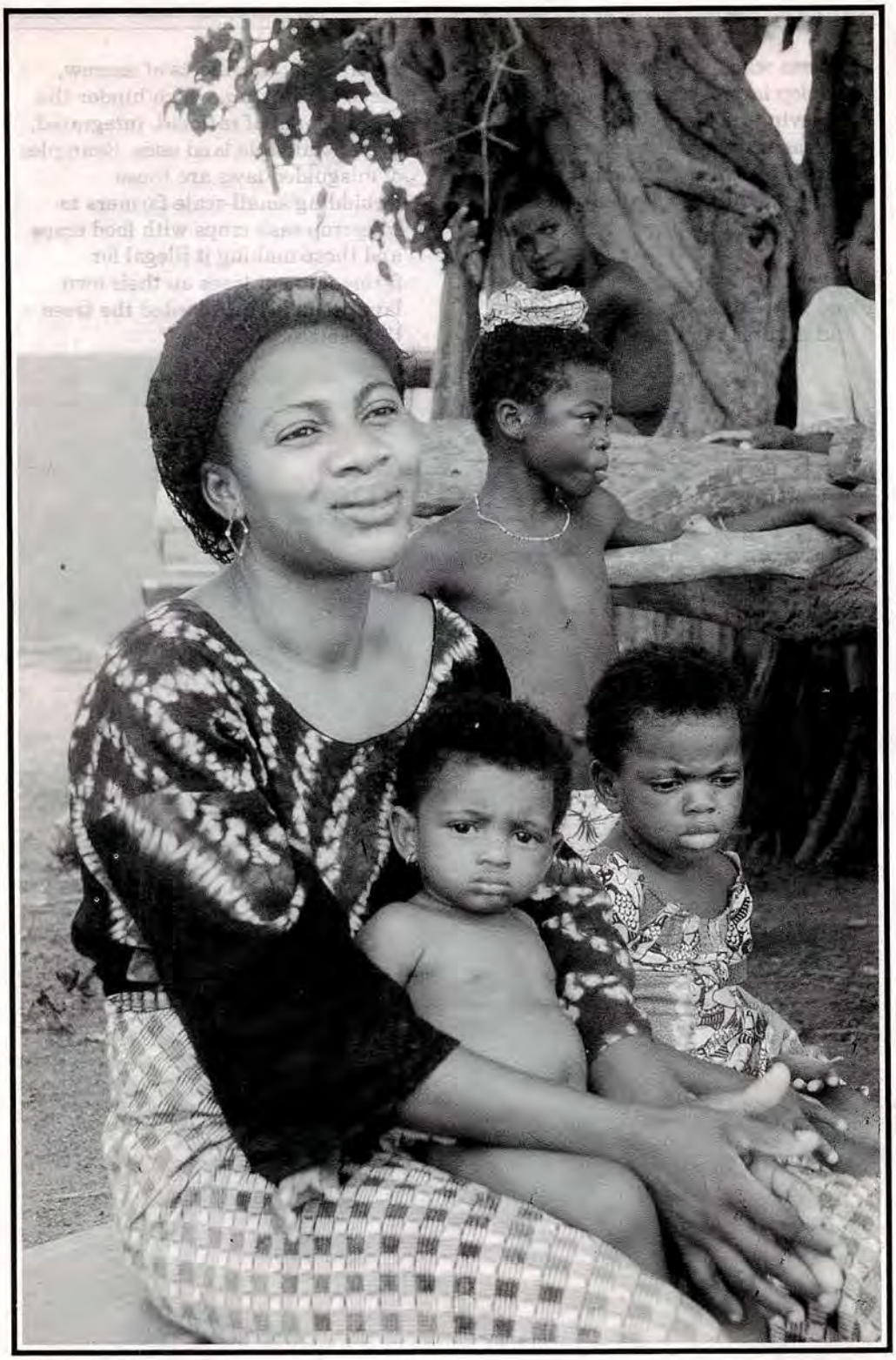
In educating our foresters, agronomists, economists, and other specialists, we must aim to develop their ability to analyze land-use systems in a broader and more integrated way than is done currently.

1. Policies must be put in place that allow development and research institutions to have broad enough mandates to deal with the improvement of complex land-use systems. These institutions ought not have to neglect an integral component of a system, be it a tree, crop, animal, or the soil, just because that component does not fall within their mandate. Obviously, institutions must also be given the means to broaden their array of disciplines and engage in interinstitutional collaboration.

2. Our approach to dealing with the environment and sustainable agriculture will undergo fundamental change only after politicians and technical experts have altered their attitudes about these issues. Therefore, in educating our foresters, agronomists, economists, and other specialists, we must aim to develop their ability to analyze land-use systems in a broader and more integrated way than is done currently. Our educational system must produce

experts who have the ability to develop improved technology for achieving sustainable production increases in land-use systems. Naturally, this ability must not come at the expense of detailed knowledge in specific disciplines.

3. Governments should review the laws and policies that guide the use of land and natural resources, with the aim of eliminating the effects of narrow, sectoral thinking, which hinder the development of rational, integrated, and sustainable land uses. Examples of misguided laws are those forbidding small-scale farmers to intercrop cash crops with food crops and those making it illegal for farmers to cut trees on their own land, even if they planted the trees themselves.



African Health Policies and Their Linkages to Agricultural Development

*William Foege**

An American comedian suggested recently that the Hubble telescope may not be defective after all, that it is really the universe that is out of focus. Perhaps, in some ways we are all miniature Hubble telescopes, unable to keep the universe in focus because we see only a small facet of it. My purpose in this paper is to show the linkages between certain facets of development. According to Polybius, who developed the first law of ecology some 2,000 years ago, everything is connected to everything else. Though I am not going to talk about everything in this presentation, I will discuss the related subjects of health and agricultural development.

Effects of Health on Agriculture and Nutrition

The role of nutrition in health is well known. A less common subject of discussion is the impact of health on both agriculture and nutrition. In view of this relationship, we need to ask what is happening to health, especially in Africa, what lessons can be learned from the current situation, and finally what we can expect to happen in health in the very near future. Perhaps the question underlying all of these is how we can become better ancestors.

Food production can be seriously compromised by malnutrition. As has been mentioned several times during this workshop, food intake in Africa has been eroding at the rate of about 3.5 calories a day each year for the last 20 years. No one has mentioned, however, the additional and well-documented problem of seasonal famine, which occurs just before harvest, causing people in some cultures to lose 5 to 10% of their body weight and greatly reducing their productivity.

Specific diseases are also widely recognized as having a direct effect on productivity. One of these is malaria, a chronic problem that is now becoming worse because of drug resistance. There are people attending this workshop whose productivity is affected by malaria, and the disease is a constant factor in Africa's agriculture. Another problem is onchocerciasis or river blindness, which reduces agricultural production not only through the direct effect of blindness but by preventing people from using some of the most fertile land.

A third problem is guinea worm, which we now know is a significant hindrance to agriculture in West Africa. Surveys conducted in parts of Nigeria have shown that this disease is the single most important cause of school absenteeism and a much bigger problem than was realized before. A fourth problem is tuberculosis, which is now the number one cause of death in the world, resulting in 3 million or more deaths a year. The alarming increase in

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the relative importance of this disease has occurred for three reasons. One is that surveillance is better. We now know more about the death rate from tuberculosis than before. Second, it is increasing as a result of AIDS. And third, the disease that used to be first on the list, measles, has been sharply reduced in just the last five years. Tuberculosis has always been a problem for the young. The death of 3 million people a year from this disease gives only a slight indication of its morbidity and its effects in reducing productivity.

Another problem much discussed in Africa is AIDS. Its growing impact on young adults is well known, and we are also becoming increasingly aware of the problem of orphans and social disruption. I could go on to mention a number of other diseases but instead would like to comment on tobacco, because it is a frequently overlooked health problem. Tobacco kills more people than AIDS. In the USA it is responsible for 10 times as many deaths as this disease, and much the same is true elsewhere. Tobacco will soon be the single most important cause of death in the world. The death rate from tobacco increased markedly in the 1940s and 1950s, but even before then it had significant effects on human health.

Malnutrition then is not just the result of limited caloric availability. Another cause is that the calories people ingest are frequently wasted because of disease. Their ability to use the calories available is further reduced by poverty, illiteracy, and other problems. In the past we talked about the effects of malnutrition in making infectious diseases worse. During the last 10 years, it has become clear that infectious diseases aggravate malnutrition. Diarrhea, for example, is a major contributor to the loss of calories. The death rate among children who have had measles continues to be high for months afterwards because of malnutrition caused by this disease. Intestinal parasites—helminths, roundworms, hookworms—all prevent people from making good use of the calories they have consumed. And further loss of calories results from the fever associated with diseases, such as malaria and measles. Thus, we now know that in some areas illness is a bigger factor in precipitating malnutrition than low intake of calories and protein.

A further problem that we have heard about repeatedly at this workshop is that population growth essentially neutralizes increased food production. We have then an inefficient cycle of high birth rates, high disease rates, and high death rates. Health has a multifactor influence on both agriculture and nutritional status. How well are we doing in improving health?

General Trends in Health

Infant mortality has been used for a long time as an index of health. As is evident from Figure 1, infant mortality varies widely around the world. While in some countries it is still over 150 per 1,000 live births, in others it is below 20 and even down to 5. Often, we make the mistake of focusing so much on the highest rates that we fail to get a picture of what is happening generally in infant mortality. An important general pattern, as shown in Figure 2, is that over the last 30 years or so the number of countries with infant mortality rates over 150 has fallen dramatically. As recently as 1960, almost 50 countries fit this category, and now just a handful do. Very few countries then had infant mortality rates below 20, but now they number 34.

How fast infant mortality rates changes is closely related to past rates, as indicated in Figure 3. The point is that, as infant mortality rates fall, the rate at which they fall increases. Thus, in the future we can expect to see even more rapid change than we observe now. If the infant and childhood mortality rates of 1960 still pertained today, 30 million children under the age of 5 would die this year. Instead, 15 million will die. That is still too many, but it represents a 50% reduction in just 30 years.

What is happening to life expectancy? Figure 4 shows that life expectancy, as you would expect, is highly correlated with a nation's economic performance. An even more important point in this figure, however, is that a number of countries have broken with that trend, achieving good health at low cost. In Chile, China, and Sri Lanka, for example, health has improved, even

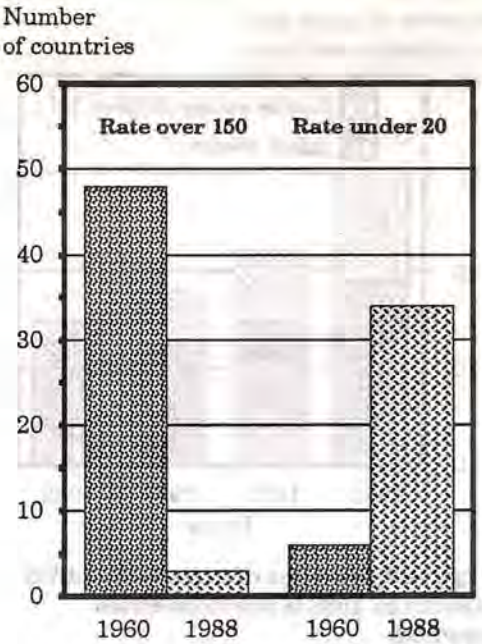

Figure 2. Trends in infant mortality rates (deaths per 1,000 live births).

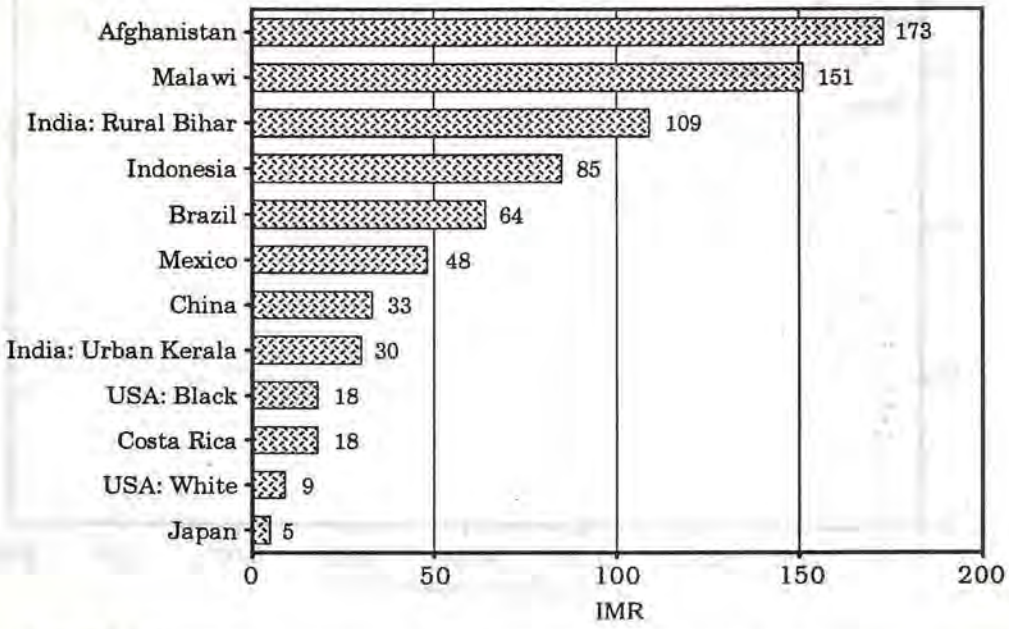

Figure 1. Infant mortality rate (IMR) in selected populations.

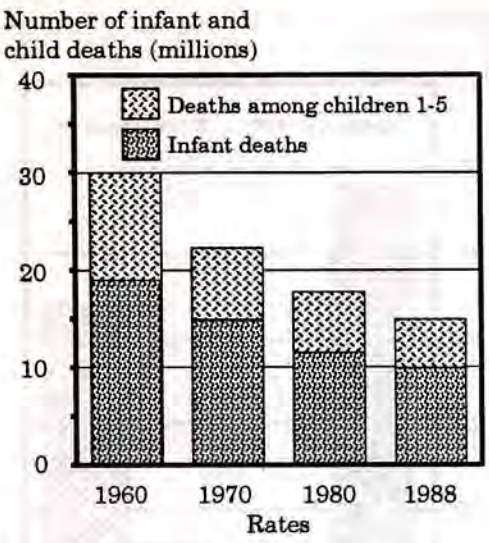

Figure 3. Number of infant and child deaths in 1988 if previous rates applied.

though gross national product is still low. In fact, in Costa Rica life expectancy is 75, essentially the same as in the USA—a very encouraging achievement.

Figure 5 indicates overall trends in life expectancy. In 1960 life expectancy at birth was less than 40 in many countries. Today no nation falls in that category. The number of countries in which life expectancy is over 70 has also changed rapidly. Particularly heartening is the fact that life expectancy is now increasing faster in Africa than it is in the USA. Some will say that this is because African countries are starting from a lower base. But in fact life expectancy is increasing faster in Africa right now than it has at any time in the history of the USA—in spite of extreme poverty and AIDS.

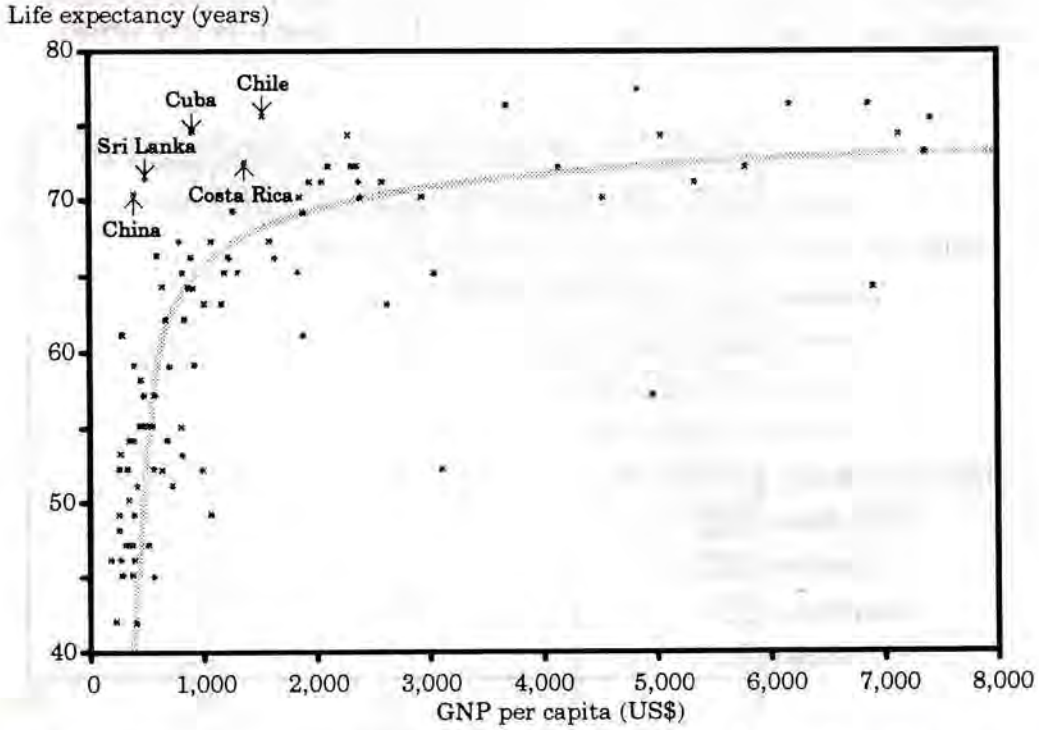

Figure 4. Life expectancy in relation to GNP. Note: line of central tendency is a freehand curve. Source: UNICEF 1989.

What is happening to the birth rate? As shown in Figure 6, there is a relationship between birth rates and infant mortality rates: The lower the infant mortality rate, the faster the decrease in birth rate. Often, we hear that allowing children to survive contributes to the population explosion. As is evident from Figure 7, however, the countries with the lowest net population

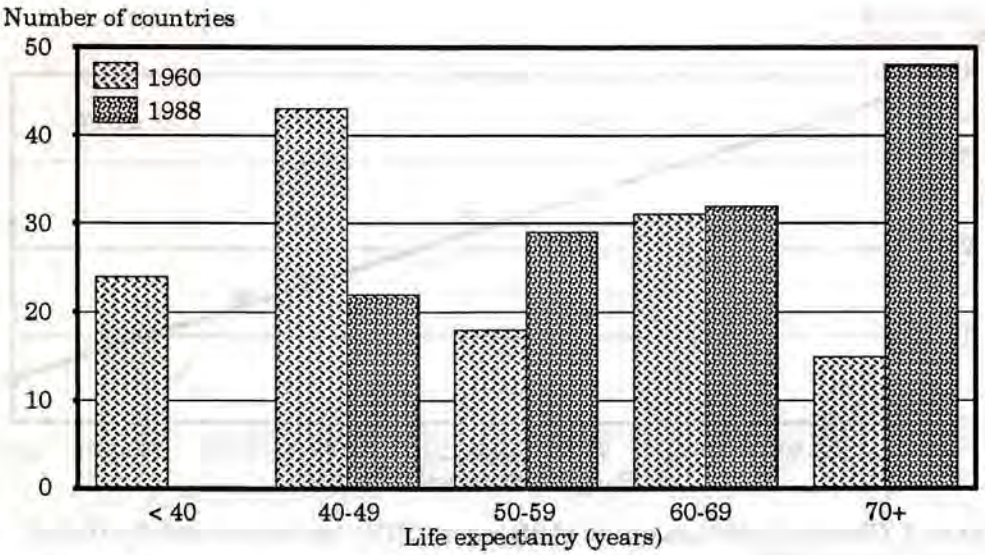

Figure 5. Life expectancy at birth (131 countries).

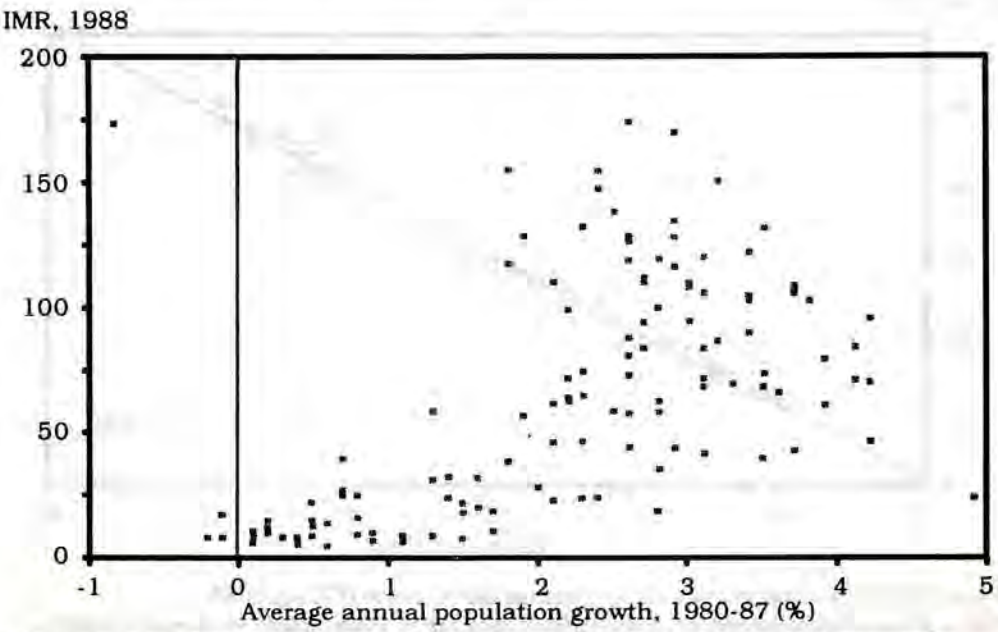

Figure 6. Population growth and infant mortality rate (IMR), 130 countries.

increase are the ones with infant mortality rates below 50. And the countries with the highest net population increase are the ones still plagued with high infant and childhood mortality. Even more surprising is that infant mortality turns out to be one of the best indicators of what will happen to birth rates. Thus, as shown in Figure 8, we were able to predict in 1980 what birth rates would be in 1988 based only

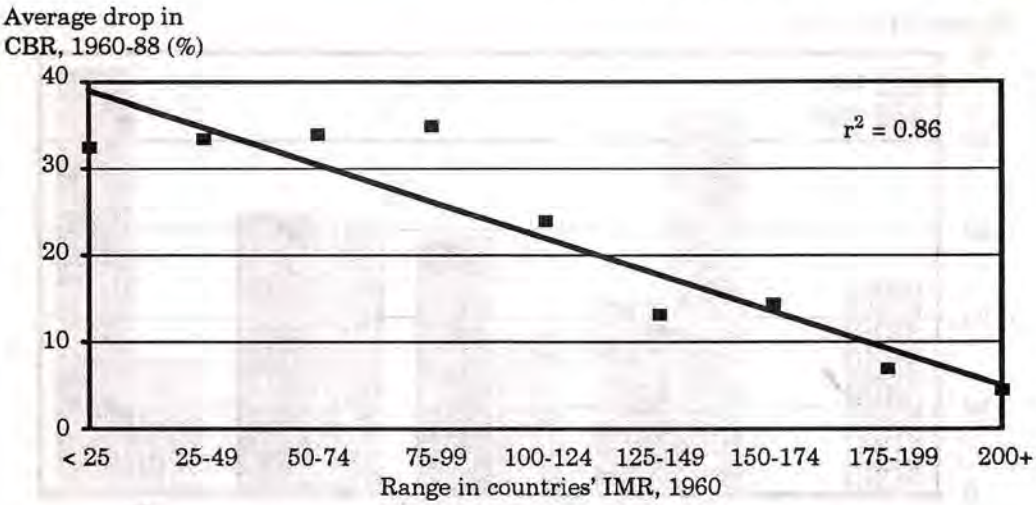

Figure 7. Global changes in crude birth rates (CBR), by initial range in infant mortality rate (IMR).

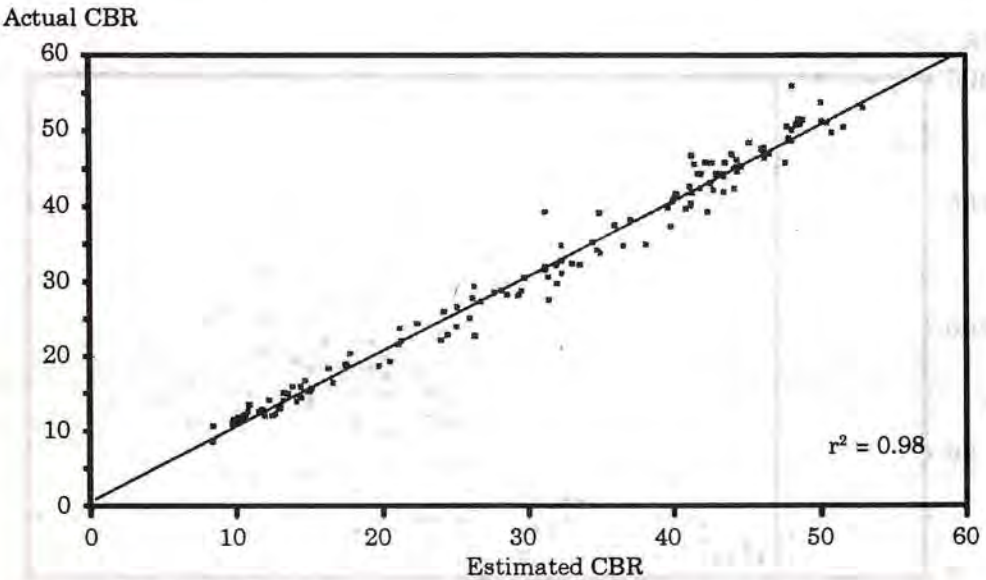

Figure 8. Projected versus actual crude birth rates (CBR), 1988.
Note: Projections based on 1980 infant mortality rate (IMR) and relationship between 1970 IMR and changes in CBR from 1970 to 1980.

on our knowledge of infant mortality. And we did so with an r^2 of 0.98, which indicates an almost perfect correlation.

The point is not that reducing infant mortality rates will reduce birth rates but that there is a relationship between them. The measures that help reduce infant mortality rates also reduce birth rates. We do not have to let children die to control population growth.

Money spent on reducing infant mortality rates, on child survival, also contributes to a decrease in birth rates. The converse is also true. Money spent on family planning not only reduces birth rates but infant mortality rates as well. It does so by decreasing the number of pregnancies that occur within two years after the previous one. Pregnancies occurring at shorter intervals, as shown in Figure 9, have high infant mortality rates. If you can reduce the number of such pregnancies, you can bring down infant mortality rates. Two major challenges are to lower the proportion of women having high numbers of births (Figure 10) and to reduce births to teenagers (Figure 11). Child survival and population reduction are thus two related problems that urgently require maximum effort.

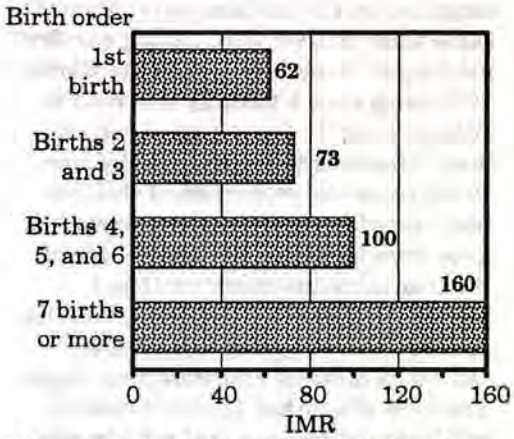

Figure 10. Relationship of birth order and infant mortality rate (IMR). Source: See Figure 9.

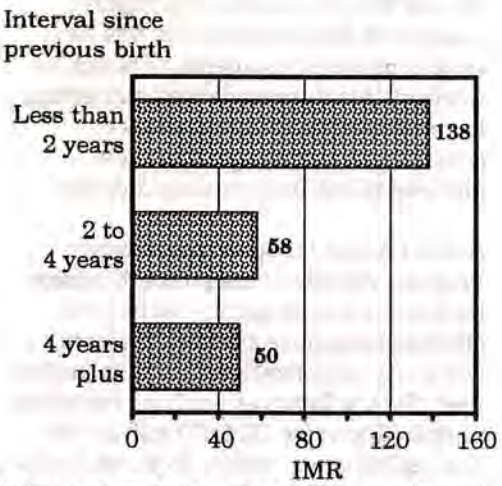

Figure 9. Relationship of interval since last birth and infant mortality rate (IMR). Source: Institute for Resource Development, Demographic, and Health Surveys, Columbia, Maryland.

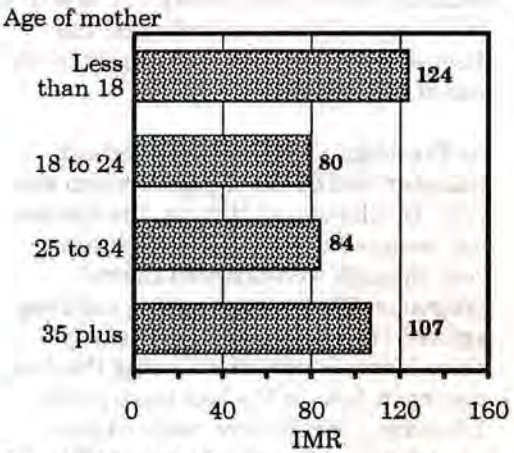

Figure 11. Relationship of mother's age and infant mortality rate (IMR). Source: See Figure 9.

Progress Against Specific Health Problems

Now I would like to review some specific improvements in health. I was very interested in the concept of yield take-off discussed by Dr. Plucknett, because immunization has reached a similar stage in just the last six years. About the same time that we were having our first meeting in Geneva to launch the Global 2000 programs, a meeting was held in Belagio to try to find a way of getting immunizations to the world's children. In six years the proportion of children immunized in the developing world has gone from less than 20 to 80%—one of the true miracles in international health. As a result, this year 2.5 million children will be spared from death caused by measles and whooping cough. The lives of another 1 million children will be saved because oral rehydration fluids are being used. And on the strength of these achievements, people now have the courage to suggest that we can eliminate polio worldwide. The last case in the Americas occurred in January of this year; it may be the last case forever. It seems likely that the disease will be eradicated entirely by the end of this decade.

As President Carter has pointed out, Pakistan will be rid of guinea worm this year. In Ghana and Nigeria, the disease has been reduced by 30% over the last year through well-targeted control programs. We are also making headway against river blindness, particularly since Merck is now distributing the drug mectosan free. In the last three years, 1.8 million people have received this treatment, and our goal is six million people a year. Mectosan is truly a miracle drug. With only one treatment a year, it totally prevents blindness from onchocerciasis.

As a result of these accomplishments, we need no longer be fatalistic about public health. In 1762 Jean-Jacque Rousseau published a manual on child rearing in which he says, "Half of all children born will die by their eighth birthday. This is nature's law. Do not contradict it." Now, we contradict it every day through the successful transfer of technology. Such achievements are especially remarkable in Africa, because they are made in spite of economic problems, AIDS, and decreased calories.

Reasons for Success

What factors account for these developments? One is that science has improved, and we have become more effective as health workers. A second factor is strong political commitment to health improvement in recent years. On 30 September 1990, 71 heads of state met at the United Nations (UN), and 69 countries sent high-level delegations for a meeting on child health. There has never been a meeting of so many heads of state for any reason. It is highly significant that child health was the topic considered compelling enough to warrant this unprecedented gathering. In country after country, you see government leaders getting their pictures taken immunizing children.

A third factor is social mobilization. Parents, churches, the police, business leaders—all have gotten behind the effort to immunize children. Private voluntary organizations are involved as well. Rotary International, for example, promised to raise US$120 million for polio eradication within 20 years. In fact, they raised $230 million in less than 5 years. A fourth and particularly key factor is management. The people who actually implement immunization

programs do not need extensive training and a knowledge of complex technology, but their efforts do have to be well managed. Perhaps there is a lesson in this for agricultural development.

A fifth factor is subsidies. Certainly, immunization is one area in which subsidies need not be a source of controversy. Currently, the industrialized countries are spending $350 million a year on immunization programs in the developing world. Six years ago Robert MacNamara said that if we could only raise $100 million a year for immunization, we could dramatically improve health in developing countries. Everyone told him it was impossible. And yet now rather than settle for $100 million a year, we are raising $350 million. This amount is about 20% of the total spent on immunization programs. The rest is provided by the countries that benefit from the programs, showing a considerable commitment on their part to improved public health.

My hope is that we will see the outside funds increase to $1 billion a year, as new vaccines become available. I also hope that it will not take 20 years for the contribution of rich countries to reach this level and consequently that the budgets of national ministries of health in the developing world will not be taxed beyond their capacity.

Future Developments

In concluding I would like to offer a few predictions and mention some new developments that have or soon will come to pass. Like agriculturalists, we in public health are faced with a sustainability question. We are convinced that the current system for immunization, which reaches 80% of the world's children, is a sustainable one. In some countries the immunization program does better than the postal service in reaching people. Even so, we must plan for additional growth of the present immunization infrastructure, so that we can reach new goals, such as polio eradication, and effectively handle new vaccines.

A vaccine for hepatitas B—the world's first anticancer vaccine—is now ready to go. It prevents liver cancer, which is the most common form of the disease in many countries. All we lack are the funds for distribution. In the next several years, we expect to have a vaccine against the rotavirus, which is responsible for about half of the diarrhea in the developing world. We also anticipate having a leprosy vaccine, and in the last several months a breakthrough has been made that leads me to think we will have a malaria vaccine in this decade.

In addition to new vaccines, we can expect to see what I call "smart" vaccines, in which the booster dose is built into the primary dose. The first, second, and third boosters will be released automatically at the correct time, thus reducing the number of injections that children require. Another measure that will contribute to this same end is the development of combined vaccines. A further refinement will be the development of heat stable vaccines that do not need refrigeration in the field.

We also expect an increase in the use of micronutrients, such as vitamin A, iron, and iodine. The use of iodine could increase the world average IQ within just a few years—a goal certainly worth striving for.

Of the 23 human worms or helminths, 20 can now be treated with three safe drugs. I expect that antihelmith programs will be established throughout Africa, that UN agencies will place increased emphasis on women's health, and that, as ministries of health begin to address this issue more vigorously as well, we will see another increase in the attention given to family planning.

Conclusion

In summary disease is a major cause of malnutrition, not just the reverse. Public health is improving in spite of conflict, poverty, and malnutrition and in some cases even where economic growth remains stagnant. Recent experience in health contains significant lessons for agricultural development, especially concerning the role of political commitment and effective management in the delivery of technology. And, finally, as good as the last decade has been, the next one will be even better in the improvement of public health. Perhaps the greatest victory of all will be the eradication of fatalism in public health circles.

Educational Policies and Agricultural Development: The Case of Zimbabwe

F. Chung
Minister of Education and Culture, Zimbabwe

One of the tragic ironies of Africa's ambitious education programs over the past two decades has been the alienation of young people from the land and the seemingly inevitable drift of educated youngsters to urban areas, where they face either unemployment or low levels of employment at poor remuneration. With rapid urbanization, rural areas have become less productive and less able to sustain the total population. Meanwhile, the laudable health measures taken by African governments have led to a dramatic lowering of infant mortality and therefore an equally dramatic increase in the population that must be fed. In Zimbabwe, for example, population increased by 2.1 million between 1982 and 1990 from 7.5 to 9.6 million. During the same period, the economy has just managed to keep pace with population growth. The number employed in the advanced industrialized sector, however, has not increased, remaining at 1 million. Whereas 1 industrial worker supported an average of 7 persons in 1982, today he or she supports an average of 10. Thus, the burden on the worker has increased quite markedly in a very short time.

In examining this common pattern of development in Africa, we find that brilliant achievements in education and health have not generally been accompanied by equally brilliant achievements in industrialization or agriculture. There are noteworthy exceptions to this generalization, but the overall trend has not been encouraging.

This workshop focuses on Africa's agricultural development in the 1990s, with a view to developing realistic recommendations for policies and strategies that will lead to sustainable growth over the decade. I believe it is necessary to look at growth holistically, examining national as well as international policies, different styles of government, health, education, and community development as a whole.

A Brief Look at the Colonial Past

During the century in which Africa was colonized, it was viewed by its colonizers as a treasure house whose purpose was to enrich Europe, particularly in terms of minerals and raw materials. A minimum of infrastructure was established to permit the movement of these resources to the metropolitan countries. Little attempt was made to process raw materials in the colonies. Generally, the manufacturing sector received little attention. Meanwhile, the indigenous people were directly or indirectly kept at medieval levels of human development.

Perhaps the worst example of this practice is Bantustan education in South Africa, which deliberately aims to deprive black scholars of modern know-how by fostering medieval social systems based on division by language, culture, and tribe. The colonialists' aim was to prevent Africans from posing a threat by depriving them of modern education for several generations and thus limiting their experience with modern political systems, their knowledge of industrial strategies, and their skills in marketing, management, and even agriculture. In Zimbabwe, for example, before Independence in 1980, communal farmers were not allowed to market their produce legally, a move intended, on the one hand, to protect the white commercial farmers from competition and, on the other, to ensure that these farmers could not develop into a strong economic force.

Since Independence

Naturally, all African governments have sought to redress the inequities of the past by removing racial discrimination, providing health and education for as many as possible, and improving infrastructure. These measures are, of course, absolutely basic and essential, providing the foundation for further development. It was not tenable to delay the development of human resources, for example, until further industrialization and economic development had taken place, because such resources are a prerequisite for any other form of development.

Even so, it can be argued that all too often postindependence education has merely imitated and expanded colonial education and that too little has been done to develop educational systems and curricula that are tailored to African conditions. The continent cannot afford to be behind the rest of the world in knowledge and skills, but these are of little use to us unless they are closely linked to the realities and problems that Africans face today and in the long term. Our challenge is to determine accurately Africa's possibilities in terms of human resources, social and political systems, technical skills, infrastructure, natural resources, and so forth and then to chart a progressive but attainable road to realizing these possibilities.

One of Africa's problems is that policies and plans have often been based not on objective and detailed analyses of the current realities but on the formulas prescribed by one brand of external "experts" or another. I am skeptical not only about the preordained Marxist-Leninist solutions that have been imposed on some African countries but also about the solutions offered by the International Monetary Fund and World Bank, which appear to prescribe one medicine for a multitude of diseases. What works well for one African country may not, for a variety of reasons, work for its neighbor. Just as a suit made in Siberia may not be appropriate in Africa, the preordained formulas for economic progress might not work on this continent unless they are tailored to the conditions of each nation and its particular stage of development. To continue with the clothing analogy, the type of clothes we wore as teenagers may no longer be suitable now that we are middle aged.

Zimbabwe's Situation

Health—Zimbabwe's policy has been to marry an aggressive primary health care program to maintenance of inherited, curative (and rather expensive) health facilities. The key personnel in this effort have been community health and family planning workers. They have focused mainly on education in

preventive medicine and nutrition, nutrition projects, immunization, the development of clean-water supplies, the construction of Blair ventilated pit latrines, and family planning. We have also concentrated on controlling malaria by spraying. As a result of such efforts, infant mortality has dropped drastically from 140 per 1,000 in 1979 to 73 currently, and the immunization rate has risen tremendously from about 20 to over 40% in rural areas and over 70% in some urban areas. Family planning has also been a success; about 90% of women in Zimbabwe are now familiar with at least one contraceptive method, though the percentage who use them is still too low at 38.4%. The rate of population growth has declined from 3.4 to 2.9%. Nonetheless, serious health problems remain. For example, 30% of Zimbabwe's children under 10 suffer from stunted development due to chronic malnutrition, even though the country has a huge surplus of food.

Most participants in literacy programs have cited the need for greater agricultural productivity as their motive for learning to read and write.

Education—Both primary and secondary education are widely accessible. Ambitious efforts have been made to ensure that the curriculum is relevant, of high quality, and suited to the teaching force and pupils. Subjects such as environmental and agricultural science and social studies at the primary school level and science, geography, and agriculture at the secondary level are taught using hands-on methodologies and in such a way as to emphasize their relevance to real life problems and to local and national conditions. The secondary science curriculum, for example, is based on a low-cost science kit (which costs about US$2,000 per school, compared to $40,000 per school for a laboratory) and on an analysis of the scientific knowledge and skills needed in Zimbabwe today. The major topics are science in the community, in agriculture, and in Zimbabwe's industries as well as mechanics and energy. In the course on agriculture in secondary schools, student evaluation is based 50% on practical projects, and standard equipment provided to schools includes ox-drawn ploughs. Zimbabwe also has a technical kits program, which incidentally was copied from Zambia, for equipping every secondary school with the basic technical equipment required for at least two industrial subjects.

Literacy is highly correlated with the utilization of modern agricultural technologies, including inputs such as fertilizer, and of bank loans. Most participants in literacy programs have cited the need for greater agricultural productivity as their motive for learning to read and write. These programs are linked to income-generating activities, and we have launched a new initiative for relating literacy training to agricultural improvement, primary health care, family planning, etc. Zimbabwe's literacy rate is now 70%.

Zimbabwe is fortunate to have inherited a strong system of agricultural research, including a number of government research stations scattered around the country. As a result, we have suitable varieties and agricultural practices for the various parts of Zimbabwe, and this

improved technology is made widely available to both commercial and small-scale farmers by the extension services, though the number of extension workers is far from sufficient. Also valuable is our system of forming knowledge cooperatives in which farmers join together to share new ideas and practices.

In addition, a number of short courses have been developed specifically for small-scale farmers. These normally have a duration of three weeks and focus on particular enterprises, such as cotton or pig production. Many of these courses are run by farmers' unions, most of which incidentally are inherited from the past. The Commercial Farmers Union and its affiliates in the cotton, pig, coffee, tobacco, and other industries are well funded, politically powerful, and still dominated by white farmers. The two black farmers' unions, representing small-scale black farmers, are neither as wealthy nor as influential. The power of the farmers' unions is reflected in various ways. They employ researchers, undertake research outside the government system, and run practical training courses for all farmers free of charge. They also have tremendous influence on government policy and by this means have secured the supply of inputs, attractive loan conditions and commodity prices, an effective transport and marketing system, and a system for exporting produce.

Some Useful National Programs

Zimbabwe has an extremely popular Food and Nutrition Program, which is based on community participation combined with some government input. In view of its success so far, the program is about to be expanded.

The Tree Growing and Tree Care Program is a successful effort in environmental improvement. Now entering its 10th year, the program combines government, NGO, and community inputs. Though it includes a number of subprograms, focusing on indigenous trees, fruit trees, and landscaping, its main thrust so far has been planting of eucalyptus woodlots at every school. One million trees have been planted each year and are cared for by 75% of Zimbabwe's 6,000 schools. The one shortcoming of this program has been the relative lack of participation by local communities. In a search for remedies to this problem, an outreach program called From School to Community has been introduced in 28 schools in one of 55 districts.

CAMPFIRE (Communal Area Management Program for Indigenous Resources) is the acronym of an exciting and more comprehensive environmental program that has been launched in 10 districts. Through this program local communities manage natural resources, such as forests, grass, water, and wild life. Proceeds from these resources are ploughed back into the communities. This has been an extremely popular and successful program and is about to be extended to 12 more districts.

Two secondary schools have pioneered Community Education and Social Centers, each run by a coordinator in association with local schools. Last year the two centers initiated 32 projects and in connection with these provided training. Morale is high among the participants, and they have expressed a keen interest in acquiring skills in areas ranging from soap making to pig production. The centers also serve as community market places and meeting venues. They have become so popular that they have received numerous

inquiries from surrounding communities about organizing workshops relevant to various community needs.

Zimbabwe has a privately owned cooperative seed company, which is able to ensure an adequate supply of good quality seeds. Our two fertilizer companies are also privately owned, though prices are controlled by the government.

The Zimbabwe Foundation for Education with Production (ZIMFEP) runs nine schools and is "mother" to 15 cooperatives for school leavers. Its successful formula is to provide intensive hands-on training in a workshop or farm for two years, followed by a further two years of supervision. The program is also based on the assumption that to develop people's skills without providing them the basic tools of their trade is futile. Thus, upon graduation all ZIMFEP trainees receive a set of basic tools paid for with the work they have done during the training period. Though the program currently operates on a small scale, it seems to have the makings of a successful strategy.

Conclusion

From Zimbabwe's brief experience, it would appear that successful programs involve careful research; generous inputs of technical and managerial training, accompanied by supervision; modest inputs of tools, seeds, and other items (at a cost of $1,200 per trainee); technology that participants can control; full community participation in planning, support, and implementation; and joint efforts by government, parastatals, NGOs, and local communities.

Projects that have failed have been characterized by too much "expert" control and input; technology levels that are beyond participants' control; social and political systems within the community that are unsuitable or hinder project implementation (a common outcome where technically feasible plans are at odds with the prevailing social systems); too much funding and expensive high-tech equipment; too little local expertise; and too little funding and other support directed to small-scale farmers or industrialists.

Approaches to Community Development in Africa

*Ester Afua Ocloo**

The concept of community development is not new to Africans. Before achieving independence from the colonial powers, various countries in the region had developed indigenous approaches to organizing development activities at all levels of society, from the family to the clan, the village, and, finally, the traditional area.

Indigenous Approaches

As I reflect on my childhood days, I remember with deep affection and respect my grandfather's community development philosophy as applied at the family level. He had three daughters and two sons. Every year he would organize his in-laws into a labor force to work on both their farms and his own. For this special occasion (which we called "grandfather's farming day"), he would set aside the biggest yams, the best palm oil, as well as smoked bush meat some months in advance. Then, on the appointed day, the men dedicated their energies to clearing the farm; my grandmother and her daughters-in-law attended to the cooking; and the children were sent into the field to collect firewood. Labor was organized in much the same way for building homes and during the palm fruits season for extraction of oil in large stone pits.

At the clan level, all the families used to come together to work on the roads linking their farms, to dig pit latrines or graves, to put up sheds during funerals, to build markets, and so forth. Those were some of the men's responsibilities. The women were responsible for the upkeep of latrines, cemeteries, rubbish dumps, market places, etc.

Because of proper organization at the family and clan levels, organizing activities at the village and traditional-area levels was easy. In those days the major development projects in the traditional areas were construction of feeder roads, upkeep of trunk roads, and digging of wells. For these tasks the paramount chief would summon the village chiefs and *asafo* groups to a meeting by means of a gong, which was sounded throughout the villages. At this meeting work on the roads, for example, was divided among villages. In Ghana the custom was to reserve Fridays for communal labor; in fact, farm work on this day was not allowed. At 5:00 a.m. the gong would be sounded to call all men and women to work. In those days people demonstrated an impressive enthusiasm for community labor; they contributed a great deal of effort and expected no remuneration. Because the spirit of community development stemmed from the family level, communal labor was accepted as a natural part of people's activities.

The expression "community development" came into use after the African countries had achieved

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independence. It is always associated with rural people, who constitute 70 to 80% of the region's entire population and whose main occupation is farming. They make an enormous contribution to their nations' economies, working tirelessly to produce food, much of it for urban populations, and cash crops that earn foreign exchange for development. Despite their important role in society, rural people lack many of its basic amenities, such as potable water, hospitals, toilets, electricity, and good roads.

The Role of Government in Community Development

Since gaining independence, African governments have introduced many policies aimed at bettering the lot of rural people. During Ghana's first republic, for example, the government implemented well-conceived policies resulting in the establishment of an institution for social welfare and community development. President Nkrumah assigned great importance to this institution, and in its early stages it was under his direct supervision. The institution was headed by a director and consisted of two departments, each headed by a technical officer. The main office was located in Accra, and each of the regional capitals had and still does have a training center. In these well-equipped and staffed facilities, boys and girls received vocational training in auto mechanics, the manufacture of concrete blocks, office skills, catering, sewing, handicrafts, hairdressing, and other subjects. To help maintain high standards in private vocational schools, the centers provided in-service training for teachers.

Literacy training for rural people was one of the institution's most popular activities. In addition, it had cinema vans in every region, which went out to the villages in the evenings to show educational films on health, nutrition, sanitation, family planning, and farming. Other programs were established to teach villagers how to make concrete blocks and to assist them in building homes. The institution had equipment in every region to help villagers construct feeder roads linking the farming areas and also helped introduce improved pit latrines, stoves, and wells.

Homes were set up for delinquent boys and girls, and they were taught skills to help them become useful citizens. The lives of many problem children were saved as a result. The institution also ran day nurseries (and still does) and trained teachers for them. The institution's welfare department has a unit whose purpose is to help women get irresponsible fathers to support their children as well as a counselling section that helps women with their marital, economic, and other problems.

The role of women in development was another of the government's concerns in the years after independence. The National Women's Training Center was built some 10 miles from Accra and offers classes in cookery, housekeeping, child care, handicrafts, beauty culture, and business management. Though established primarily for Ghanaians, the center has trained women from many other African countries as well. In addition, the center has a poultry farm, bakery, and garden, which help sustain the institution and form part of its training program.

Though still functioning, the social welfare and community development institution now lacks finances, as a result of Ghana's economic problems, and therefore does not function as effectively as before. In my view this is one of the best institutions for community development in Africa. Those who planned it are to be commended for devising a program that addresss practically all of the needs of rural communities. The program provides one example of how well-conceived government policies, if properly implemented, can improve the lives of rural people.

A New Approach to Assisting Small-Scale Farmers

As is well known, food production in Africa is far below the domestic demand. Production is simply not keeping pace with the average rate of population growth, which is now about 3% per year. The principal purpose of this workshop is to examine ways of increasing and sustaining the continent's food production.

What are some of the primary obstacles to the attainment of these goals? I would say that the biggest problem is Africa's current economic difficulties. Without adequate finances governments are unable to provide good roads, farm inputs, machinery, credit, irrigation, and so forth. Land tenure is another problem being studied by various governments. The areas I would like to address lie more in the production sector. What are the producers' problems? And in what ways can they be empowered to achieve adequate and sustainable growth in food production?

One factor that works against increased food production in some areas is the diminishing number of small-scale farmers, coupled with their rising average age (as young people seek employment in urban areas) and high degree of illiteracy. Since small-scale producers make up the majority of African farmers, however, we must find means of strengthening this foundation of the continent's food production.

Africa is not alone in its struggle to attain food security. Many foreign agencies are equally concerned and are involved in finding solutions to problems in agriculture. Identifying new approaches to solving problems in food production was one of the issues addressed during the Food and Agriculture Organization's (FAO) World Conference on Agrarian Reform and Rural Development, which was held in 1979. The conference called for a grass roots People's Participation Program (PPP), featuring active involvement of farmers in cooperation with FAO. A pilot project was launched in 1982 with funding from the Netherlands and later received support from the Italian government. The key element of the PPP is the formation of small, homogeneous self-help groups. Some 560 of these have been formed, almost half in Ghana, and they have an average membership of 13. In other countries the number of groups ranges from 42 to 100. They are run democratically, with regular meetings and election of leaders. This approach has improved farmers' access to credit, extension, and other services.

Government institutions were responsible for implementing the PPP approach in Sierra Leone, Swaziland, Tanzania, Zambia, and Zimbabwe. FAO also made an effort to involve NGOs. With government approval NGOs were

appointed as the implementing agencies in Ghana, Kenya, and Lesotho. In Ghana the project was implemented by the Ghana Presbyterian and Roman Catholic churches, whose involvement drew the attention of members of the communities involved in the project. Many of the farmers taking part belong to these churches. As a result, the project enjoyed the good will of the community, which closely observed the performance of the project coordinators.

One of the conditions for obtaining credit was that the group be held responsible for the repayment of loans made to its members.

To maximize efficiency in the use of resources and promote better understanding of the PPP, FAO encouraged the formation of project coordinating committees. At the field level, these consisted of beneficiaries, project staff, and district administrators, who guided project implementation. At the national level, representatives of government ministries, NGOs, and FAO monitored project performance. All project staff, including the national project coordinator, were Africans trained by FAO. Each project coordinator was recruited directly by the implementing agency. The coordinators included agronomists, economists, and youth workers. Having churches implement the project proved to be a cost-effective strategy.

In my several years of involvement in income-generating activities at the grass roots level, I have found the PPP approach to increasing and sustaining food production to be the most suitable one for community development. The project took into account all the factors that help make individuals and communities in rural areas economically self-reliant. PPP members were encouraged to undertake activities for generating additional income to build up and diversify their economic base. The majority of the groups were engaged in staple food production and came together on individual members' plots or on group farms for land preparation, planting, and harvesting.

To strengthen their economic base, each group had a project (chosen with assistance from the coordinating committee and a group promoter), in which all members worked together once a week. Income derived from the project was paid into the group's account. Additional income was generated through monthly dues. One of the conditions for obtaining credit was that the group be held responsible for the repayment of loans made to its members. If any member failed to repay a loan the whole group was disqualified from receiving further credit. Since group savings could be used to repay outstanding loans, the rates of loan recovery were high. One of the important achievements of the PPP was to enable rural people to gain experience with saving money in banks.

Since farmers generally have very little or no education, any program meant to improve their status must have a training component. In the PPP high priority was given to training, mainly small field workshops, with a view to

improving the members' organizational and production skills. Apart from its emphasis on improved and sustainable food production, the project helped identify opportunities for developing cottage industries, such as the manufacture of concrete blocks, bead making, gari processing, pig production, and so forth.

Women's World Banking

In addition to growing some 80% of sub-Saharan Africa's domestic food supply, women process virtually all of the food production of the continent's small-scale farmers. In many African countries, women are also largely responsible for distribution and retailing of most of the agricultural and marine production.

Thus, women are particularly handicapped by a problem that affects most farmers in Africa, which is the lack of access to credit for land preparation and purchase of inputs. For the most part banks are reluctant to extend loans to food producers because of the generally small size of their farms. But often credit is denied even to growers with medium to large holdings because they lack collateral.

At the United Nations Conference for Women, held in Mexico in 1975, lack of access to credit was identified as one of the major obstacles to women's economic advancement. Some of us who were interested in seeking solutions to this problem formed a committee to study the possibility of setting up some kind of financial institution for women. With strong support from the government of the Netherlands and the United Nations Development Program (UNDP), Women's World Banking (WWB) was established in 1980. I was elected as the first chairwoman of WWB's board of directors, a post I held for five years. More than 60 countries, 11 of them in Africa, are currently participating in the scheme. In Ghana WWB works through the Agricultural Development Bank and Barclays. In addition to guaranteeing loans made to women organized into groups, the program provides management training and extension services.

Groups of women who wish to participate in the program need to notify WWB headquarters in New York. The women's group must raise 25% of the funds required for loan guarantees. The WWB in New York, which is supported by UNDP and various foundations and governments, contributes 50%, and the remaining 25% is provided by banks willing to support the scheme. If the finance committee of the local WWB organization finds that a woman's business is viable, it will recommend that she receive a loan. In Ghana particularly high priority is given to loans for women engaged in farming and fishing.

The Sustainable End of Hunger Foundation

I have already mentioned the declining number of small-scale farmers in some areas and the contribution of this problem to Africa's food crisis. The decrease started a few years after independence, when education was made compulsory in many African countries. Students who cannot make it into institutions of higher learning find it difficult to turn to farming, so not enough young blood is injected into the food production sector. The problem is becoming worse as more and more young people leave school every year. If they

fail to find employment, they are exposed to a variety of social evils, such as drugs, theft, etc. Therefore, any amount of money invested in turning these young people into a strong farm labor force will not only help increase food production but contribute to a safe, stable, and progressive society.

When I was awarded the 1990 Africa Leadership Prize for a Sustainable End of Hunger, I used part of the award money to set up the Sustainable End of Hunger Foundation (SEHUF), which is aimed at strengthening the food production capacity of African women and encouraging unemployed youth to take to farming. The foundation is also interested in helping women reduce postharvest losses through domestic food preservation and toward that end has launched a national food preservation campaign, involving courses for the field workers of institutions who work with women. SEHUF is registered as a public trust and works through churches to organize groups of 10 to 20 village youths for acquiring and preparing land and obtaining loans for purchasing inputs. The very young group members (those who have just left school) are given pocket money for six months. Though these funds are not recoverable, money for land preparation and the purchase of inputs must be repaid after harvest. Group members are given a one-day orientation course before starting work. The project is monitored by staff of the Foundation, which has an office in Accra. The response from the public has been encouraging. The Foundation is receiving assistance from the government of Ghana through its agricultural extension service as well as donations from churches, private foundations, public institutions, and individuals.

The Sustainability of SG 2000 Project Activities

One of the issues to be addressed in this workshop is the sustainability of activities undertaken by the Sasakawa-Global 2000 (SG 2000) Projects after these programs have come to an end. In visiting and working in many African countries, I have found that almost all of them have policies for effective community development and institutions that can support the work of such projects. I believe the evaluation team that visited Ghana recently will agree.

The challenge in Ghana is to learn from the mistakes made in the project's first phase and on this basis to develop policies and institutional structures that will make it possible to sustain project activities. Networking with existing institutions will also be necessary for sustaining the program.

Experience gained in phase one shows that rural people are receptive to the program and are prepared to cooperate. To them sustaining the program means sustained improvement in their incomes. My experience in working with rural people shows that they enjoy working in groups, a result, I think, of the strong family orientation in Africa. Working in groups has a number of advantages. It makes for easy dissemination of information, facilitates monitoring and evaluation, reduces operating costs, and enhances productivity. It also helps identify talent and potential leaders. With a proper approach and adequate training, these people can undertake considerable responsibilities, a point demonstrated by the People's

Participation Program. I recommend that the SG 2000 Projects adopt an approach similar to that of the PPP.

One of the project's aims is to improve people's diets and living conditions through agriculture. For the program to be successful in attaining this goal, it must include detailed economic analysis at the planning stage. The focus of this analysis should be on means of producing enough grain to meet the food demand and leave enough surplus to satisfy the requirements of small agroindustries. In West Africa the growth of such industries is hindered by a lack of raw materials.

Farmers face many difficulties in marketing agricultural produce. For that reason Ghana has established the Food Distribution Corporation, a state enterprise with branches in many parts of the country that provides a market to serve the producers of agricultural commodities and the industries that purchase them. Government institutions like this one as well as agroindustries can play an important role in national food production campaigns, such as that of the SG 2000 Project. By consulting with these groups, the project's planners can gain a fuller knowledge of the size of the market for a given commodity and of the type and capacity of the facilities available for handling produce. In some cases this information may be critical in deciding which crops to emphasize. Consultation of this sort at the planning stage is essential for mobilizing farmers to increase production and for ensuring that production surpluses bring them economic benefits.

Low rates of loan recovery undermine the sustainability of any economic venture. One of the main reasons that African farmers are sometimes unable to pay back their loans is a lack of rainfall at critical times in the growing season. There are several ways of dealing with this problem.

One may be to place more emphasis on cassava. In Ghana both maize and cassava are important sources of carbohydrates in the human diet. But maize is more sensitive to the amount and distribution of rainfall. If the rains fail, cassava yields will be reduced, but the losses will not be as severe as with maize. To better enable Ghanaian farmers to repay input loans, equal attention should be given to improving production of maize and cassava.

Another important advantage of cassava is that women can process it into gari and store it for as long as a year and even export it. Increased cassava production would alleviate the problem of obtaining sufficient raw materials at a low enough price. From May to June, gari is just as expensive as maize. So, if the maize crop fails, proceeds from cassava production can help farmers repay their input loans.

A second way of helping farmers repay their loans is to encourage them to adopt the PPP concept explained above. An entire group would be responsible for repayment of loans given to its members. Having a joint responsibility would motivate group members to find collective ways of earning money. One way for these groups to raise capital is the indigenous approach to credit (*susu*), in which an agreement is reached as to

the amount to be paid weekly or monthly. As this money is collected, it could be given to one group member at a time.

As I mentioned earlier, well-conceived government policies, along with proper planning and effective implementation, can help raise the living standards of rural communities and provide them with an incentive to become more productive. The policies of Ghana's present government have not only raised morale among the country's rural people but strengthened their productive capacity. Though previously neglected, Ghanaian farmers are now being recognized for their important contribution to the nation's economy. One way in which the government helps farmers gain greater recognition is to observe regional and national farmers' days, on which deserving farmers are awarded prizes, such as pickup trucks, video cassette players, and farm implements.

Access to credit in rural areas can be improved through the government's efforts to encourage the central bank to assist in opening rural banks. Farmers are encouraged to buy shares in these banks, and some even serve on the boards of directors.

The Ghanaian government is concerned about the continued drift of rural youth into the urban centers. As part of its effort to address this problem, the government has established a policy of providing new industries with incentives to locate their facilities in rural areas.

Another recent government policy has led to the introduction of district assemblies, which give rural people the opportunity to become involved in decision making. Though the assemblies have been in place for only three years, they have already aroused keen interest among rural people. With the help of assembly members, a considerable amount of rural development work is being carried out in support of the government's new educational reforms. One way of drawing on the tremendous goodwill of rural people is for high-ranking officials to maintain personal contact with them, sharing in both their successes and failures. This is the approach taken by Ghana's present head of state and other officials, including the secretaries of agriculture. Regular visits by extension officers are also important for securing the participation of African farmers in development programs.

In conclusion, I would point out that phase one of the SG 2000 Project in Ghana has succeeded in getting farmers to accept and appreciate the use of new technologies for increasing food production. This is no mean achievement. The key to sustaining this effort is for project organizers to work closely with existing institutions to organize farmers into groups, provide group members with training, and offer them indigenous incentives to take on new responsibilities.

Closing Remarks

Hon. John S. Malecela
Prime Minister and First Vice-President of Tanzania

I would like first of all to express my sincere thanks to the Center for Applied Studies in International Negotiations and the Sasakawa-Global 2000 (SG 2000) Project for selecting Tanzania and specifically Arusha to be the venue for this workshop. I am also especially grateful to President Jimmy Carter, General Olusegun Obasanjo, Mr. Yohei Sasakawa, Dr. Norman Borlaug, and to the leading scientists, politicians, and resource persons here for your active participation in this workshop. I am glad you were able to see our country and its attractions and that we were able to benefit from your wisdom at this special gathering. The objectives of the workshop were to review the SG 2000 and Global 2000 Projects in Tanzania, Ghana, Sudan, Zambia, Benin, and Togo and to discuss problems whose resolution is central to the sustainability of project activities.

I wish to express my deep appreciation of the workshop participants' clear recognition of Africa's food crisis. As some rightly mentioned, many people on this continent lack sufficient food, do not derive enough energy and protein from the food they do have, and, as a result, are undernourished and highly susceptible to a multitude of diseases. In extreme cases people in African countries are denied access to food by the socioeconomic and political circumstances in which they are entangled. I am genuinely touched by the concern and dedication that all of you have shown to find lasting solutions to Africa's food crisis.

Tanzania has struggled on all fronts to eradicate food problems, and I am proud to say that we are succeeding. Even so, at times we do not produce enough food to feed our people, whose number is growing year after year. And even when we do produce enough in years of good weather (which is a prime determinant of our agricultural production), we fail to move that food from areas of surplus to areas where there are large concentrations of consumers and serious food deficits. Moreover, since the food that remains in the hands of our farmers is not safely stored for future utilization, pests and vermin claim their share. So, for us any effort aimed at increasing food production, improving its transportation and marketing, and minimizing postharvest losses is an important undertaking that all Tanzanians should support.

At the beginning of this workshop, we were fortunate to make a field trip to King'ori village, where we saw a flourishing maize crop. It is interesting to note that the crop was doing well not only in the Management Training Plots but even in other farmers' fields as well. This shows that farmers are adopting improved maize production technology

and that food production can be increased dramatically. We are grateful to the SG 2000 Project for demonstrating these possibilities. For farmers seeing is believing, and practice is learning. The farmers are more enthusiastic than ever before and are working to realize maximum returns from their efforts. I believe that our task as leaders is to do everything possible to provide technology packages and support services, to offer our farmers good prices, and to work toward sustainable increases in food production.

In his welcoming address, President Mwinyi highlighted Tanzania's efforts to increase agricultural production. The president pointed out that Tanzania's struggle to achieve sustainable growth is hampered by unfavorable weather, inadequate supplies of inputs and extension services, limited credit facilities for small-scale farmers, a poor transportation network (which constrains crop marketing), and poor processing and storage techniques. The government of Tanzania is committed to eliminating these obstacles to improved agricultural production. We attach great importance to agriculture as the backbone of our economy, the major employer of our people, a source of raw materials for our industries, a key foreign exchange earner, and, even more important, as the source of our food.

In the course of this workshop, we have heard from prominent individuals, such as President Jimmy Carter and General Olusegun Obasanjo, and from many distinguished resource persons. I share their views that the prerequisites for increased and sustainable agricultural development in Africa are the existence of peace and democratic participation of the people in all types of social, political, and economic activities; well-conceived policies that promote the active participation of producers in agriculture; a clear understanding of the production limitations and pertinent socioeconomic problems that confront the people; substantial investment and resource allocations to agriculture; a well-developed marketing infrastructure; and appropriate technologies that small-scale farmers can afford and manage. Our hope is that these prerequisites can be fulfilled in all African countries and indeed in all Third World countries that have serious problems in securing adequate food supplies.

The people and government of Tanzania sincerely believe in democracy and in the right of any individual to participate in all social, political, and economic undertakings, and we cherish peace, unity, and political stability in our country. The government of Tanzania has tried over time to formulate agricultural development policies with the central objective of enabling small-scale farmers to modernize their crop and livestock production techniques and achieve increased yields and productivity. We have also encouraged our rural people to form producer and marketing cooperatives in the villages, through which agricultural inputs (such as seed and fertilizer) can be channelled to farmers and they can market their produce. We have established factories, both in the public and private sectors, for manufacturing farm implements, fertilizers, and insecticides. We are currently engaged in the reorganization of our agricultural research system, with a view to making it more responsive to farmers' needs. Our agricultural extension system is also undergoing rehabilitation through the National Agriculture and Livestock Extension Rehabilitation Program.

Tanzania has implemented structural adjustment programs to revitalize her economy. The current economic recovery program has given promising results toward achieving economic growth. Under this program we aim to offer producers attractive prices for agricultural products, to liberalize the marketing of agricultural commodities, and to encourage the active participation of the private sector.

The far-reaching measures Tanzania is taking to create an environment that is conducive to increased production and sustained agricultural development have so far produced impressive results. The ultimate success of these efforts, however, is not guaranteed. To carry out all the measures I have mentioned requires sufficient funding, streamlined institutions, and trained technical personnel, all of which are lacking. We do receive funds and technical personnel through donor aid, bilateral agreements, and loans from international financial agencies, and these have contributed significantly to agricultural development in our country. Nonetheless, these gains are not sustainable, since little has been done to establish a local technological base, strong service institutions, and the technical personnel required to run them.

The sustainability of development programs has been the central issue dealt with in this workshop, and it is a goal to which the SG 2000 Projects are contributing importantly. My hope is that the knowledge and experience shared by the distinguished participants in this important workshop will guide us in developing strategies that, if properly carried out, will lead to sustainable agricultural development in Africa.

One thing is clear: Most African governments, with their limited resources, can do very little by themselves. Neither can the crop-based development projects financed through loans or grants or the projects run by nongovernmental organizations achieve sustainable development alone. I would therefore call upon all the actors in agricultural development programs to join forces and coordinate their plans and objectives for attaining the common goal of increased and sustainable agricultural production.

Once again I would like to express my sincere gratitude to all of you for coming to Arusha and spending your valuable time discussing issues that are basic to the social and economic development of African people and to their very survival. I hope your stay in Arusha has been pleasant and entertaining, and I wish all of you a good and safe safari home.

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Abstract: This publication provides a record of the fifth in a series of workshops that have examined measures for helping countries in sub-Saharan Africa achieve greater food security. The papers included fall into two categories. One group describes the progress and evaluates the performance of the agriculture projects established over the last five years by SAA and Global 2000 in cooperation with the governments of six African countries. The other papers address diverse issues—national and international governance, environmental conservation, primary health care, education, and community development—that impinge on the continent's agricultural development and on the prospects for sustaining this development in the 1990s.

Correct citation: Russell, N.C., and C.R. Dowswell, eds. 1992. *Africa's Agricultural Development: Can It Be Sustained?* Mexico, D.F.: CASIN/SAA/Global 2000.

AGROVOC descriptors: Africa, agricultural development, agricultural policies, innovation adoption, development aid, plant production, research projects.
AGRIS category codes: E14, A50
Dewey Decimal classification: 338.1896

Design: Miguel Mellado E.
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Photography: Christopher R. Dowswell (cover, p. 20, 44, 72, 96, 116, 126, 150, and 174) and Camerapix (p. vi, 10, 14, 18, 21, 69, 101, 185, and 198)

Printed in Mexico

January 1992