SECOND SIR JOHN CRAWFORD MEMORIAL LECTURE

HOPE FOR AFRICAN AGRICULTURE

DR. BUKAR SHAIB

CONSULTATIVE GROUP ON INTERNATIONAL AGRICULTURAL RESEARCH
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INTRODUCTION

I am greatly honoured to have been invited to give the second Sir John Crawford Memorial Lecture. The honour is all the greater because I am following on the footsteps of such an illustrious personality as Mr. Robert McNamara who delivered the first Lecture last year.

I first met Sir John here in the World Bank in 1971 at the inaugural meeting of the Consultative Group on International Agricultural Research (C.G.). At that time I was one of those selected by the FAO Council to represent the Africa Region on the C.G. I keenly followed and took part in the discussions of Sir John's reports as the Chairman of the Technical Advisory Committee (TAC) until I left the C.G. in 1975.

I again had the privilege of working with Sir John on the Board of the International Fertilizer Development Center in Muscle Shoals from 1980 to 1982 and on the Policy Advisory Council of the Australian Centre for International Agricultural Research of which he was the President until his death in 1984.

What impressed me most about Sir John during the long time I had known him was the authority with which he spoke. That, of course, was not surprising because there were very few people who had Sir John's deep grasp of the problems of agricultural development in the developing countries or had done more to find solutions to the problems through the promotion of scientific research and new technologies.

During the 1960s, Sir John was involved in many World Bank missions to developing countries, the most notable of which was the 1964 Bell Economic Mission to India. Sir John was responsible for the agricultural aspects of that Mission's work and he laid down the strategies which transformed Indian Agriculture from a backward, non-productive sector to spectacular self-sufficiency in cereals production. The basis of that strategy was the adoption by millions of small-scale farmers of improved seeds, fertilizers, irrigation, and other modern inputs. Sir John can truly be said to be the prime motivator of the Green Revolution in India.

Development of the C.G. System

As the Chairman of TAC, he brought the full weight of his authority and clarity of vision to bear on the shaping of the policies and priorities of the C.G. It was due mainly to his influence that the network of international research centres grew from four at the inception of the C.G. in 1971 to the present thirteen.

In a discussion paper on policies and priorities which he prepared in 1972, Sir John outlined the basic policy framework for the C.G. System as follows:

"While the terms of reference are broad and TAC is still very young, certain key points of agreement have emerged. These include:

(a) A concentration on research needs relevant to "the problems of developing countries".
(b) A special emphasis on research programmes which lend themselves to international organisations.
(c) A need to ensure that international research programmes have a linkage with national research programmes designed to ensure two-way "feedback" relations as well as support for national research efforts.
(d) An inclusion in this linkage of international and national programmes of training programmes designed to improve the supply of national leaders for research and extension.
(e) A definition of "agriculture" which includes crops, pasture, livestock, forestry and fisheries."
This policy framework was accepted by the C.G. in 1973 and still forms the guiding principle for the work of the international research centres supported by the C.G., and I would like to explore with you today how the practical application of these policy objectives by the centres, especially the IITA, is giving hope for a quiet revolution in food production by small-scale farmers in Tropical Africa.

Why Africa Again?

Last year Mr. McNamara gave a detailed and graphic description of the challenges facing Sub-Saharan Africa and you may ask why I should speak on Africa again this year? I offer no apology for doing so for the following reasons:

First, although the initial shock waves of the crisis are over, the African food problems are still with us and are likely to remain for sometime to come.

Second, so far, attention has been focused mainly on the moving and heart-rending picture of human suffering and misery, and it is necessary to bring out the hopeful side as to find lasting solution to the problems.

Third, I come from Nigeria, the most populous country in Africa and with ecological conditions ranging from the humid tropics to the semi-arid Sahel. I have been involved in the agricultural development of my country since independence in 1960 and have some practical experience of the problems.

Fourth, I participated in the work of the C.G. for five years during its formative stages, first as African regional representative through the F.A.O. and later as the representative of my country when Nigeria became the first developing country to contribute financially to the C.G. in 1974. I have also served on the governing boards of IITA, ILCA and WARDA and have a good idea of the potentials and problems of the Centres' work in Africa.

Finally, I feel compelled to put across the African point of view on the whole question of the political and economic problems now afflicting the African countries.

When discussing the present plight of Africa, the World Bank, the U.N. and bilateral aid agencies and policy makers in the developed countries generally assume that the problems started after 1960 when most African countries gained political independence. They either conveniently forget or simply ignored what happened before 1960 and I want to put the records straight so that the problems can be seen in their true historical perspectives.

The problems of Africa are complex and deep rooted and go back to the slave trade. During that period, the rural areas of Africa were pillaged, villages were burnt down and defenseless people captured and shipped across the Atlantic in their millions and auctioned like cattle. Rural Africa had to be destroyed so that the New World could be developed.

Even as the slave trade was going on, some European powers were busy waging colonial wars in Africa. By the end of the last century, practically the whole of Africa had been conquered and the colonial powers convened a conference in Berlin and drew up the boundaries of their "possessions" on the map of Africa.

Under colonial rule, Africa became a vast source of cheap mineral and agricultural raw materials for Europe. All agricultural research and extension works were directed towards the development of export crops such as cocoa, oil palm, rubber, groundnuts and cotton. The barest minimum of infrastructures were developed and Africans were barred from holding senior positions in the colonial governments of their own countries. So when independence came in the 1960s and the colonial rulers withdrew, there were very few highly trained Africans to take their place.

Manpower was the built-in political instability which the colonial rulers left behind in Africa. The source of the political instability was the Berlin conference I referred to earlier. At that conference, the European powers simply drew lines on the map of Africa to demarcate their colonies with no regard to the people living on the continent. As a result, different ethnic and linguistic groups were put together in some "colonies" while some people belonging to the same ethnic and linguistic groups were divided. After independence, power struggles ensued in most ex-colonies which in some cases developed into bitter civil wars or cross border fighting.

It is unrealistic to expect African countries to solve in two and a half decades of independence all the problems created for them by the developed countries over two and a half centuries of total domination and exploitation.
However, we in Africa are determined to solve these and other problems. There is a realisation at the highest levels that the policy of concentrating development efforts on industries and physical infrastructures such as expensive construction programmes need to be changed in favour of agricultural development.

At the O.A.U. Summit in Addis Ababa in July 1985, the Heads of States adopted a five-year African Priority Programme for Economic Recovery under which about 90 percent of investment would go to agriculture. Addressing the Special Session of the U.N. General Assembly on Africa last June, President Abdou Diouf of Senegal, who was then the current Chairman of O.A.U. said: "Agriculture is now the priority of priorities for Africa". At that session the General Assembly adopted a resolution on the United Nations Programme of Action for African Economic Recovery and Development 1988-1990, and called upon amongst others, all concerned intergovernmental and non-governmental organisations to support and contribute to the implementation of the Programme of Action.

In this respect I must say that the C.G. System is fifteen years ahead of both the O.A.U. and the U.N. General Assembly in identifying agriculture as the weak link in the chain of African economic development and embarked on serious scientific research to solve the problems and the results so far obtained indicate that progress is indeed possible. I want to tell you today something of the achievements to date in developing new technologies and farming systems that have been found suitable for small-scale African farmers.

AGRICULTURAL RESEARCH IN TROPICAL AFRICA

As I said earlier, the Colonial rulers of Africa concentrated all agricultural research and extension work on export crops which were used as raw materials for their industries at home. Food crops received little or no attention at all. When the European scientists withdrew from the colonies after independence, even the work on export crops stopped or greatly slowed down. Those African countries that could afford to do so have tried to establish more broadly based agricultural research programmes since independence but progress is slow and many countries still lack sound research infrastructure and facilities.

The turning point for Africa came in 1967 when officials of the Ford and Rockefeller Foundations visited Nigeria and proposed the siting of an international research institute that will work on food crops of the humid tropics. We welcomed the idea and the International Institute of Tropical Agriculture (IITA) was established at Ibadan in 1968. As the Permanent Secretary in the Ministry of Agriculture at that time, I represented the Federal Government of Nigeria on the Board of the IITA for ten years and served as the chairman of the Board for the last three of those years. I was therefore closely involved in the planning and development of both the physical infrastructures and the research programmes of the Institute.

The stable food crops of the majority of people in Tropical Africa are cassava, yams, sweet potatoes, plantains, maize, rice and cowpeas. When IITA started to work on these crops, very little was known about them or the farming systems under which they were produced and it was clear right from the beginning that no quick and spectacular result could be expected.

Now after fifteen years of hard work by the IITA in cooperation with other C.G. Centres and African national programmes, I am happy to say that considerable success has been achieved which offers real hope for increased food production by small-scale African farmers on a sustainable basis. I am grateful to the Director General of IITA and his staff for providing me with the highlights of the work so far done on the following crops.

CASSAVA

It is estimated that cassava provides more than 50 percent of the calorie requirements of over 200 million people on the African continent which also accounts for over half of the world’s cassava-cropping area. But average yields are low at about 6 tons per hectare, and the incidence of diseases is another factor affecting production. Two centres, IITA and CIAT in Colombia have devoted sustained research efforts to cassava crops and the results are really encouraging. Researchers have tackled the basic causes of low yields by breeding varieties which can yield 15-20 tons per hectare, with increased resistance to the major diseases.

Two diseases, cassava mosaic disease and cassava bacterial blight were the scourge of African farmers for many years. Epidemics of the two diseases devastated the cassava crop of many countries. Massive efforts were mounted to secure new planting materials and cultural control methods were formulated and recommended but the real solution eventually came in the form of resistant varieties. Scientists from IITA’s root and tuber improvement program building on earlier work by other scientists,
have succeeded in breeding varieties that are resistant to these diseases. And the breakthrough on these two diseases had a positive "two-in-one" result - selection for resistance to one disease generally results in resistance to the other.

The recent development of tissue culture techniques has permitted the distribution of improved, disease-free clones to over 30 countries in Africa. More than a dozen varieties derived from IITA materials have now been officially released in Burundi, Cameroon, Gabon, Ghana, Liberia, Rwanda, Zaire, Seychelles, Sierra Leone, Sudan, Tanzania and of course Nigeria. The varieties have also spread from Nigeria to the neighbouring Republic of Benin and from Gabon to Congo, Equatorial Guinea and Sao Tome through farmer-to-farmer distribution. So striking is the impact of this work at the farm level that the programme leader, Dr. Sang Ki Hahn, a Korean, was made an honorary chief in the town of Ikire in Western Nigeria, on the recommendation of beneficiary rural farmers. Dr. Hahn also received the Guinness Award for Scientific Achievement in 1982.

**Biological Control**

Just as scientists were getting on top of the problems of cassava bacterial blight and the cassava mosaic disease, two new insect pests emerged. These were the cassava green spider mite and the cassava mealybug. Both were accidentally introduced into Africa from Latin America. The mite was first reported in Uganda in 1971 and the mealybug was identified in Zaire in 1973.

These pests have spread rapidly from the countries into which they were accidentally introduced and are now found in 30 countries, covering over 60 percent of the cassava belt of Africa, a total area that is one and half times the size of the United States. It is estimated that these two pests alone cause economic losses of nearly US$2 billion in years of epidemics.

To combat this new problem, IITA embarked on a biological control project. Biological control is the introduction or manipulation of natural enemies by man to control pests. The natural enemies otherwise known as beneficial insects include parasites or parasitoids (insects that live in, or on an insect pest) and predators.

Effective biological control has two advantages: it does not damage the environment and it does not cost anything once the beneficial organisms are released. It is clearly a most appropriate approach in Africa where the resources of farmers are severely limited and agricultural extension services are poorly developed.

The IITA biological control project is a highly collaborative endeavour involving CIAT, the Commonwealth Institute of Biological Control (CIBC), the Scientific, Technical and Research Commission of the Organisation of African Unity (OAU/SIRC), as well as laboratories and individuals in Europe and the United States. It is also a scale of collaboration that only an international organisation can arrange.

The basic strategy is to search for predators and parasitoids in Latin America, the native land of these pests. Any predators or parasitoids found are sent to CIBC for rigorous investigations to ensure that they cannot possibly constitute any problem if introduced into Africa. After such certification, and with the approval of the Nigerian Plant Quarantine Service, and the Inter-African Phytosanitary Council, they are sent to IITA in Ibadan, where they are reared in large masses using sophisticated insect rearing techniques. Their suitability as predators or parasitoids are studied closely in the laboratory and in the field. Finally successful predators and parasitoids are released from the ground or aerially using an aircraft specially designed and equipped for the purpose.

Among the biological control agents introduced so far for the control of the cassava mealybug is a parasitic wasp, Epidinocarsis lopezi, that has been released and established in over 880,000 square kilometers of cassava growing areas of Africa. The countries in which releases have been made include Congo, Gambia, Ghana, Guinea-Bissau, Ivory Coast, Malawi, Nigeria, Rwanda, Senegal, Sierra Leone, Togo, Zaire and Zambia.

Reduction in the number of cassava mealybugs to below the injury level has been observed in every zone colonized by the parasitic wasp. In those zones, mealybugs now reach peak population densities of only 10 to 20 per terminal cassava shoot compared with peak population of more than 1,500 per shoot before the introduction of the wasp.

However, one would not rely only on one beneficial insect; the ideal is to establish a complex of enemy species that will eventually provide lasting, permanent and economical control of the mealybug across the cassava belt. It is my understanding that IITA and its collaborators are pursuing this objective vigorously, within the limits of the financial resources available to them.
Work on the control of cassava green mites is still at an early stage. Three phytoseiid mite predators have been introduced from South America and are in culture at IITA. They are yet to be established permanently in the field. More are being sought.

A recent FAO report issued earlier this year states that the Biological Control Project is one of the major factors contributing to increased cassava production in Africa, especially in West and Central Africa where production has increased by about six percent in 1985. It is my belief that the project has helped contain the problem of these pests and served to protect the production of one of Africa’s major staple crops.

**MAIZE**

Maize is a major cereal crop in Africa and its real potential has yet to be exploited in many of the tropical ecologies throughout the continent. In 1984, an estimated 19 million hectares of maize were grown in Africa. A recent survey of agro-ecological zones, undertaken by the FAO, indicates that a total of 424 million hectares in Africa is suitable for maize production. Thus the scope for increased production of this crop is enormous. However, maize yields have traditionally been low in Africa and while many factors such as climate, soil limitations, poor genetic materials and limited availability of inputs contribute to the low levels of production, diseases have always been recognized as a major cause of low yields.

Maize streak virus (MSV) is one of the most difficult and devastating diseases of maize in Africa. Its occurrence is erratic and its effects vary from minimal damage in some years to total devastation of crops in others.

It is therefore understandable that farmers are often reluctant to commit expensive inputs to a crop that could, depending on circumstances outside their control, fail completely. Maize yields, especially in West African countries, have therefore remained static at about one tonne per hectare.

While it is unrealistic to expect average African yields to equal the world average of 3.3 tonnes per hectare, the potential certainly exists to double yields and expand considerably the cropping area allocated to maize production. I can make this encouraging statement only because of the hope and scope for increased production offered by a major breakthrough in agricultural research in Africa. IITA and CIMMYT scientists, after ten years of dedicated research, have made a major breakthrough that can help to realize the potential of maize in Africa. The solution is based on the development of over 100 improved varieties that are both high-yielding and resistant to maize streak virus disease.

In recognition of this achievement, the IITA has been selected to receive the King Baudouin International Agricultural Research Award for 1986. Knowing the quality of work in the IITA, I assure you that this award is richly deserved and I congratulate the Director General and his staff for the excellent performance.

The impact of IITA’s maize research work is already being felt in many African countries but I will give the examples of my own country and Zimbabwe. This year it is estimated that a quarter of a million hectares were seeded to 13 improved streak-resistant varieties in Nigeria and our National Seed Service is confident that this area will expand to two million hectares by 1990.

In 1982 the Federal Government of Nigeria requested IITA to initiate a project on hybrid maize research in cooperation with the Federal Ministry of Science and Technology, and the Federal Ministry of Agriculture, Rural Development and Water Resources, and provided funds for the project. The project sought to develop inbred lines with high combining ability, adaptation to tropical stresses and resistance to the major African diseases, particularly maize streak virus disease.

Literally thousands of inbred lines have been produced and tested for adaptability, vigor, and disease resistance in many locations representing different ecologies. These experimental trials led to the selection of elite inbred lines that were used to produce hundreds of experimental hybrids. The experimental hybrids were again assessed in many locations on research plots and then on farmers’ fields. The result is that 25 good hybrid maize varieties are now available and appropriate ones have been recommended in all 19 States of Nigeria. Two private companies have started the commercial production of hybrid maize for which there is now a huge demand.

The second example relates to Zimbabwe where, following independence in 1980, the government upgraded extension services, rural markets and other agricultural services, particularly for small holder subsistence farmers who were neglected under colonial rule. In 1980, smallholders supplied only 5 percent of marketed maize. By 1995 this had increased to 30 percent of the total marketed maize and smallholders are also the major purchasers of hybrid maize seed. The experience of Zimbabwe illustrates clearly what can be achieved by family farmers in Africa. And let me add that this success
cannot be attributed to any natural advantages for agriculture which Zimbabwe possesses over many other African countries. The essential ingredients for success in Zimbabwe are high quality seed materials and enlightened policies to stimulate production through incentives and appropriate market development.

The achievements of Nigeria, and Zimbabwe are concrete examples of what is attainable in African agriculture today.

YAMS

Yams are a traditional crop in West Africa which accounts for over two-thirds of world production. In parts of Nigeria we even have yam festivals when the new yam harvest starts. A revolution in yam production is in the making as a result of the development of the minisset and microsett techniques of "seed" yam production. The new technology is the outcome of the collaborative efforts between the National Root Crops Research Institute of Nigeria and IITA. Traditionally, about 2.5 tons of yams are required to plant one hectare. The cost of this amount of "seed" yam constitutes 20-30 percent of the total cost of yam production.

In the minisset and microsett systems of seed yam production, only 0.5 and 0.1 ton of yam, respectively, are required to plant a hectare. These technologies are being promoted in conjunction with the use of plastic mulch which obviates the need for weeding and staking. Seed yam yields of up to 40 tons per hectare can be obtained in five months. Profits are reported by farmers who have adopted the technology to be exceptionally high because of the current high prices of yams.

The technology is being rapidly adopted in Nigeria where the Seed Yam Growers Association was formed in October 1984. The technology generated tremendous interest at the Caribbean Farm Tech 85 Exhibition in Kingston, Jamaica, where it was demonstrated in January, 1985.

Yam acreage has hitherto been limited by the scarcity and cost of planting materials. The minisset and microsett systems will remove this constraint and large-scale yam production has become a feasible proposition. The new technology produces yam tubers with more uniform shapes that are more readily amenable to mechanical processing. Here again, the practical benefits of appropriate technologies for improved production of a major West African staple crop ensued from soundly based cooperative research efforts.

COWPEA

Cowpea is a protein rich grain legume that originated in West Africa where the seeds are used to prepare a variety of highly relished dishes and the leaves and stems are fed to livestock. When grown alone, traditional varieties of cowpea are infested by many diseases and are attacked by various insects at all stages of growth and in storage. But now, diseases can no longer be considered as an important constraint to cowpea production in Africa. This is because IITA has, over the years, bred varieties that are resistant to virtually all the economically important diseases of the crop. Resistance to many diseases have been combined in individual varieties. These varieties have been released in 31 countries in Africa, Latin America, Asia, and the Caribbean.

Normally, it takes more than 100 days after sowing for cowpea to mature to harvest. New varieties that mature in only 60 days after sowing have been developed. These cowpea varieties can grow on the residual moisture of irrigated paddy after the rice has been harvested. They therefore offer great possibilities for intensified food production in rice-based cropping systems enabling farmers to grow two crops where only one was grown before, or to grow three crops where now two are grown. This production system has been enthusiastically received in central Nigeria, and I understand that trials being jointly organised by IRRI and IITA in Southeast Asia indicate great promise.

The collaborative work of IITA and ICRISAT to develop high-yielding and drought-resistant cowpea for the Sahel has already identified some varieties that out-yield traditional ones by a factor of three or more under conditions of very low rainfall (150 mm for the entire growing season).

A beetle that infests cowpea in storage causes as much as 30 percent loss in dry weight within a storage period of six months. It is a major problem worldwide and annual losses caused by this beetle in Nigeria alone is estimated at about US$30 million. After screening 7,000 out of its world germplasm collection of more than 12,000 cowpeas’ cultivars, IITA scientists identified a single source of resistance to this storage pest. This resistance trait has now been bred into many varieties. As a result of international agricultural research, we are witnessing considerable increases in this crop that is much needed for its protein.
SUSTAINABLE PRODUCTION SYSTEMS FOR AFRICAN FARMING

Perhaps the greatest challenge to the international agricultural community is posed by the question: How do we develop productive farming systems suitable for Africa that are sustainable and ecologically sound? In putting a title on this section of my address to you, I decided that sustainable production systems for African farming would be most appropriate and you may well ask why. Well, African farming is different from that of Europe, North and South America, and Asia. The conventional transfer of agricultural concepts and technologies, from these continents to Africa is often inappropriate and sometimes disastrous.

Based on past experience, not just in research but in agricultural development generally, there is an urgent need to take a long-term view of research priorities and capacities in Africa. In doing so, there are three compelling realities that must be understood and accepted.

First, Africa’s traditional agriculture is complex with many food crops grown across a wide diversity of ecologies. In fact the inherent complexity is such that I think it is high time that we accept the reality of Afro-agriculture—a term that may appropriately distinguish the agriculture and farming of our continent.

Second, the dilemma facing African agriculture is how to achieve substantial increases in food production from fragile soils of low fertility that are already threatened by environmental degradation and erosion. Traditionally, farmers have coped with these difficulties through “shifting cultivation”—the practice of shifting crops to new ground every few years and relying on prolonged fallow periods to restore soil fertility.

Third, increasing populations in Sub-Saharan Africa are putting existing traditional farming systems under mounting pressure. Traditional systems proved stable for centuries because low population density permitted extended fallow periods that allowed for a slow but natural process of restoring soil fertility.

Population pressures today, however, have major implications for forests and farmlands in Africa. Overall about 3.6 million hectares of African forests, currently about half of one percent of remaining forests, are cleared each year. According to FAO, shifting cultivation accounts for 70 percent of the clearing of closed canopy forests and 60 percent of savannah forests. Two major factors are contributing to the increasing pressure to clear more forests. First, the need to clear more land for farming and second, the increasing demand for fuelwood.

Land clearing, which involves the direct removal of forest, has become the focus of much attention in recent years and it is important to understand why. Once land is cleared in the tropics, fragile soils are exposed to the threat of erosion and if inappropriate clearing methods are used the most precious resource—the soil—can be washed or blown away in a very short time. In tropical Africa estimates of soil erosion from cropland range from 10 to 100 tonnes per hectare per year which far exceeds the tolerable limit that is estimated to be between one and five tonnes per hectare per year. Erosion control is therefore a major priority in land management.

Research on land clearing systems at IITA indicates that manual clearing followed by appropriate burning is the least damaging method. Where this is not possible, clearing with shear blade is the most effective method as it leaves tree roots in place to retain the soil structure. With all methods, however, it is vital to minimize damage and protect soil through the quick establishment of vegetative cover. These land clearing methods are now used widely in Agricultural Development Projects (ADPs) funded by the World Bank in Nigeria and other African countries.

Two promising technologies for erosion control and sustainable farming systems in Africa, have been developed and tested in the recent past. These are minimum tillage and alley farming.

Minimum tillage is a method of planting and growing crops without plowing or cultivating the soil. Crops are planted directly into stubble mulch and, through the use of herbicides for weed control, losses due to soil erosion are reduced to virtually zero. This method also increases the capacity of the land to retain water and can reduce the labour inputs required to produce a harvest.

Soil conservation and fertility restoration are also aided by growing highly vegetative leguminous plants which achieve a high degree of ground cover and contribute nutrients and organic matter to tropical soils. Also known as "live-mulching", this system is a natural method of soil protection and fertilization. I believe that these developments offer considerable scope to African farmers to control erosion, replenish soil fertility and, most important of all, sustain crop production profitably.
There is another recent development in agricultural research, however, which has many of the features of a farming system ideally suitable for tropical Africa. Alley farming involves the growing of crops in alleys formed by deep-rooted leguminous trees or shrubs. Prunings from the trees provide mulch for the crops and return nutrients to the soil. Fast-growing, nitrogen-fixing trees like leucaena work well in this system; they improve the soil, prevent erosion and provide fodder and fuelwood. The International Livestock Centre for Africa (ILCA) is testing this system for livestock farming as the prunings are very suitable feed for the small ruminants of the tropics such as goats and sheep.

If ever a farming system, embracing appropriate technologies, was devised in the right place at the right time for Africa, it is this one—a system that permits continuous cultivation and sustained food production. Here is an example of a system that combines the ancient wisdom and experience of African farmers with the science and technology appropriate to tomorrow’s African farming. I am pleased to note that an alley farming network in Africa is being established to ensure rapid testing and adaptation of this system. I personally place much hope and confidence in these exciting developments.

TRAINING

The training of personnel at different levels is crucial to progress in African agriculture and it is imperative that Africans are trained to the highest levels of expertise in agricultural research, extension and management. And, of course, it is equally important that the quality of training is very high and that tomorrow’s scientists and agronomists acquire expertise in the most modern and relevant technologies for Africa.

The international agricultural research centres (IARCs) have played a pioneering role in the training of scientists and agronomists for Africa throughout the seventies and eighties. I must say that this training is potentially the most enduring contribution of the C.G. system to Africa because it trains people who can transfer, and also develop farming systems and technologies, and the benefits of both, to farmers.

Over 6,000 people in Africa had been trained by the 13 international centres up to the end of 1984 (Table 1). This is an immense contribution to agriculture in our continent and I want to say here today how much we appreciate it. Over 1,300 of my fellow Nigerians have been trained by the IARCs and I know that many of those trained are making an important contribution to our agricultural development.

Table 1. Number of participants from countries of Sub-Saharan Africa in technical and skill development activities of IARCs through 1984. (In-country training not included)

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There is also a critical need to train our own African people to replace foreign experts. This is in the interest of Africa and those developed countries that generally provide expertise. The need for training throughout African agriculture can only be described as huge. We need more resources to develop our own people to make agriculture the best developed science in Africa. I plead with those of you who control, direct or commit aid resources to Africa to give special consideration to training for agriculture at this time for, most certainly, it is the most crucial investment in the future of our continent.
FILLING THE GAPS

One of the main objectives of the C.G. System is to fill in gaps in agricultural research needs in the developing countries. From what I have so far said, it is quite clear that such gaps are being effectively filled in the humid tropical zones of Africa, where some important breakthroughs have been made. Unfortunately the same cannot be said of the semi-arid Sudan-Sahelian zone where desertification, recurrent droughts with crop failures and general environmental degradation due to growing human and livestock population have resulted in acute food shortages and famine. Here unless urgent steps are taken to intensify scientific research on all these factors, the threshold may be crossed and the damage to the environment may become irreversible with greater disasters than the world community has so far seen in Africa.

I therefore recommend that either a new C.G. supported research centre be established in the Sahel region or the existing ICRISAT station in the Niger Republic be expanded into a fully fledged centre so that the scope of its research activities can be widened to cover the problems of desertification, droughts, agro-forestry, etc. on a long-term basis.

The second gap is the development of irrigation in Africa. There are abundant water resources and low lying areas which can be developed for irrigated crop production, especially rice. Here my recommendations are that the research programmes of IITA and WARDA should be strengthened to include irrigation and the World Bank and its affiliates should support irrigation projects in Africa where they have been proved feasible by studies.

The last gap to which I want to draw attention is the weakness of national research programmes in many African countries, thus making it difficult for them to take advantage of the new materials and technologies that are coming out of the C.G. System. Unless African countries develop the capabilities to adapt the results of research from the C.G. Centres to their peculiar conditions, there can be little or at best very slow progress in agricultural development in Africa. I therefore recommend that ISNAR should be mandated by the C.G. to carry out a systematic study of the agricultural research facilities in all African countries and the World Bank, the UNDP and bilateral aid donors should fund the strengthening of the national research infrastructures on the recommendation of ISNAR.

Finally, I wish to thank the Government of the Commonwealth of Australia for sponsoring the Sir John Crawford Memorial Lecture, and the Chairman of C.G., Mr. Shahid Husain, for inviting me to deliver this year's Lecture. Thank you all.