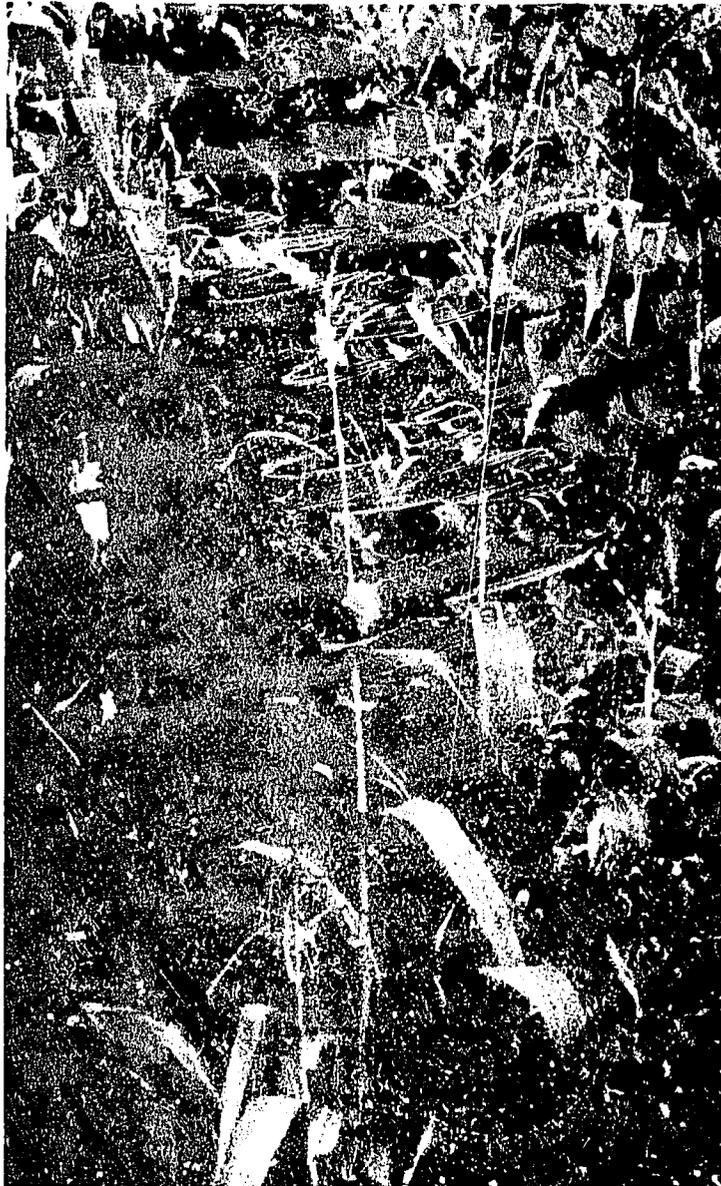


PN-AAU-140
42982

Plan for Supporting Agricultural Research and Faculties of Agriculture in Africa

May 1985



Agency for International Development
Washington, D.C. 20523

May 15, 1985

Plan
for
Supporting Agricultural Research and Faculties of Agriculture
in
Africa

The proposed plan builds on several previous papers including:

- o Africa Bureau Strategic Plan
- o A.I.D. Policy Paper: Food and Agricultural Development
- o Africa Bureau Food Sector Assistance Strategy Paper
- o A.I.D. Sector Strategy for Agriculture
- o Africa Bureau Agricultural Research Strategy Paper
- o A.I.D. Priorities for Research in Agriculture
- o Africa Bureau Strategic Plan for Agricultural Education and University Building (draft)

Executive Summary

Improved technology is necessary to achieve agricultural progress in Africa. However, the research task in Africa is especially challenging because the physical conditions for agricultural production are very difficult, labor is a constraining factor at critical periods during the year, and research on food commodities by African institutions is very recent and generally weak. This document sets forth a two-pronged approach to this problem:

- o Strengthening agricultural research capabilities
- o Strengthening faculties of agriculture

Agricultural technologies are usually location-specific and sensitive to agro-ecological and socio-economic environments of the farmers who use them. Even to borrow effectively, it is necessary to identify, screen, and interpret possible alternatives; borrowing requires some capacity to do research. A period of 20 to 25 years may be the minimum feasible planning horizon to achieve desired results, even in those countries which are highly committed to developing strong national research capabilities. In order to make most effective use of the Agency's scarce resources, this plan aims to:

- a) Strengthen national agricultural research systems in approximately 8 core countries
- b) Build strong applied research capacities in neighboring countries to enable local scientists to screen and borrow technologies and adapt them to local environments

Research networks -- which link national agricultural research systems with international agricultural research centers (IARCs), collaborative research support programs (CRSPs), and other research programs -- will serve as a means of both accelerating research payoff as well as strengthening national systems. The networks link a "critical mass" of scientists to work on aspects of problems which transcend national borders. Support will be given to research networks on four to six priority commodity areas in consultation with interested countries and IARCs.

Shortages of staff trained at the college and post-graduate levels are a major problem of national research systems. Participant training can supplement and reinforce efforts to develop national capabilities. However, the only long-term solution to Africa's severe shortage of trained agricultural personnel is to expand the capacity and improve the quality of national higher educational institutions. Under this plan, long-term assistance will be provided initially to four to six faculties of agriculture. These should be in the same countries where we are strengthening agricultural research systems. Our assistance will be purposefully designed to build linkages between the faculties of agriculture and other research institutions and programs.

In order to mobilize the vast range and amount of resources necessary for this large and long-range effort, the U.S. is facilitating the coordination of support to agricultural research in Africa as part of its participation in the Cooperation for Development in Africa (CDA), an organization of seven major members of the Organization for Economic Cooperation and Development (OECD). We further intend to work closely with multilateral donors, especially the World Bank with respect to university development. AID will seek means within CDA as well as other mechanisms to cooperate with other donors to strengthen agricultural research capabilities and faculties of agriculture in Africa.

Plan for Supporting Agricultural
Research and Faculties of Agriculture in Africa

Introduction	1
I. The Problem	2
II. Why Agricultural Research and Why Faculties of Agriculture?	3
III. Present Program	5
A. Agricultural Research	5
1. Bilateral Projects	5
2. Regional Projects	5
3. IARCs	5
4. CRSPs	6
5. Centrally-Funded Projects	6
B. Faculties of Agriculture	7
1. Participant Training	7
2. Bilateral Projects	7
3. CRSPs	7
IV. Discussion	7
A. Need for Clear Objectives	8
B. Need for Focused Program Priorities	9
1. Country Criteria (Technology Producing Countries)	9
2. Country Criteria (Technology Adapting Countries)	10
3. Commodity and Problem Research Criteria	10
C. Need for Commodity Research	11
D. Need for U.S. to Concentrate on Food Crops Research	13
E. Need for Integrating AID Inputs	14
F. Need for Long-Term Commitment	15
G. Need for Stronger Management and Administration Capabilities	16
H. Need for Financing Recurrent Costs	16
I. Need for Donor Cooperation	17
V. Program Plan	18
A. Agricultural Research	18
1. National Research Systems	18
a. Technology Producing Countries	19
b. Technology Adapting Countries	19
c. Commodity and Problem Research Priorities	20
2. Research Networks	21
B. Faculties of Agriculture	22
C. AID Funding Levels	23
D. Implementation of This Plan	24
VI. The Bottom Line: Food Self-Reliance	25
Annexes: A. Research Funding, Major Crop Zones, and Supporting Data	
B. Production of Major Crops	
C. Population Growth and Projections	
D. Agricultural Research: AID Annual Funding Levels Per Commodity -- FY 1984	
E. External Funding for Agricultural Research to Africa, 1976 and 1980, by Major Donors	

1
May 15, 1985

Plan for Supporting Agricultural Research
and Faculties of Agriculture in Africa

Improved technology is necessary to accelerate agricultural and rural progress in Africa. The exceedingly high return from investment in agricultural research to develop new technologies -- the payoff from research -- is well-documented. Examples of high payoffs to research in Africa include cotton, oil palms in West Africa, and hybrid maize in Zimbabwe and Kenya.

This paper lays out a plan to strengthen the contribution of agricultural science and technology to achieve food self-reliance in Africa.*/ Emphasis will be given to strengthening:

- o Agricultural research capabilities
- o Faculties of agriculture

In order to make most effective use of Agency financial and human resources, criteria are needed to guide choices among countries and commodities to support. Twenty to 25 years of continuous support are required to build the research and human capital base to achieve desired results. Our effort will, therefore, draw on the resources of the entire Agency -- Missions, the Africa Bureau, and AID/W central bureaus -- working with African countries and other donors in a sustained, cooperative, focused program. National agricultural research systems will be strengthened in approximately 8 core countries. Strong adaptive research capacities will be built in neighboring countries to enable local scientists to screen and borrow technologies and adapt them to local environments. Networks will link national systems, international agricultural research centers (IARCs), regional research programs, collaborative research support programs (CRSPs), centrally-funded projects, and other-donor assistance on selected, high-priority topics. Four to six faculties of agriculture will be selected initially for long-term assistance.

Policy, credit, input supply, marketing, extension, and other support services also are important to agricultural progress. This plan, however, specifically addresses agricultural research and faculties of agriculture, and is presented to show what is needed to obtain technical breakthroughs in African agriculture. To translate this into production breakthroughs will require concomitant investments in infrastructure, input supply systems, marketing, and substantial policy reform. The other complementary development activities will be reviewed separately, taking into consideration the approach in this plan for research and faculties of agriculture.

*/ Self-reliance in food is defined as the ability of a country to assure continuing food security to its population from a combination of domestic production, storage, and importation of food at commercial terms paid from foreign exchange earnings.

I. The Problem

Agriculture provides income and employment for over two-thirds of the population of Africa. Nearly all countries are dependent upon agriculture for the major part of foreign exchange earnings. Increased agricultural productivity is essential for raising government revenues and is necessary for improvements in nutrition, health, and the general quality of life.

The performance of African agriculture has been dismal; per capita food production has declined during the last two decades. Since 1960, growth in aggregate food production has averaged less than two per cent per annum. Yields per unit of land for food commodities are the lowest of any region in the world. The result has been growing dependence on food aid and increasing use of scarce foreign exchange for food imports rather than for other pressing development needs. A close examination of the African agricultural situation indicates that the causes of the poor performance include difficult physical and harsh climatic conditions; restrictive economic policies; weak institutions; critical shortage of scientists, teachers, and agricultural managers; and few farmer-tested high-yielding technologies.

Physical Environment and Climate While Africa has some highly fertile and productive areas, there are vast areas where growing conditions are unfavorable because of difficult physical and climatic conditions. The extension of agricultural production has often been accompanied by devegetation that has depleted soil fertility and reduced the water-holding capacity of the fragile African soils. The arid land of the Sahel and the soils of the coastal and central tropics of Africa present unusually difficult physical environments for agricultural production. Irrigation will be a long-term and then only partial answer to meeting Africa's food needs. The tropical soils of Africa present management problems that have not yet been properly addressed.

Government Policies Unfavorable economic policies have contributed to the present agricultural crisis in three key areas. First, trade and exchange policies have overprotected industry, held back agriculture, and absorbed too much administrative capacity. Second, many governments have created large state production and marketing and input supply organizations that are incapable of efficiently performing their assigned tasks. Finally, most African governments have not established an economic incentive structure for increasing agricultural production. Rather, price, tax, exchange rate, and investment policies reflect a consistent bias against agriculture.

Institutions The basic institutions required to step up agricultural production are weak in financial and manpower resources in most countries of sub-Saharan Africa. The colonial powers in Africa underinvested in human capital, food crop research, and internal transportation networks to strengthen internal market linkages for inputs or commodities. In the twenty-five years of independence, little progress has been made by African governments in correcting these past mistakes, in part due to lack of political commitment and lack of resources. Today most countries do not have adequate infrastructure to support a major expansion in agricultural

development. Donors have also been short-sighted by focusing on discrete projects and by pursuing an on-again, off-again approach to supporting basic agricultural institutions.

Indigenous Scientific Capacity There is consistent evidence across the continent that there is not enough qualified human capital to carry out a sustainable agricultural development effort. Since independence, African governments have made little progress to improve the situation. Opportunities for professional growth are limited. Lack and underutilization of trained human capital, ranging from farmers to senior administrators and scientists, coupled with poor management of existing resources, are major factors in the present agricultural crisis.

Technologies Lack of productive research institutions in most African countries has resulted in a dearth of farmer-acceptable improved technologies needed to increase agricultural production and productivity. The expatriate-led export research capacity developed under colonial rule has deteriorated. With the single exception of maize, "African agriculture has probably been less affected by technology change in the past twenty years than agriculture on any other continent." (USDA: 1981)

II. Why Agricultural Research and Why Faculties of Agriculture?

The process of modernization or development is inevitably a process of de-agriculturalization. While the absolute size (in total GNP) of the agricultural production sector increases, other sectors (including agricultural support and processing industries) grow even faster so that the relative share of agriculture in GNP decreases. Thus, the U.S., which is the outstanding example of this process, moved from an economy in which practically the entire population was engaged in direct agricultural production to one in which less than two percent of the population is now engaged in that occupation -- while in the process, becoming the major agricultural exporter in the world. This transition was not achieved by neglecting agriculture; on the contrary, agriculture received substantial public support which enabled it to "finance" the development transition.

Research, initially largely supported by public funds, was a powerful contributor to the development transition in the U.S. Although the beginning of a formal public-supported agricultural research process dated to 1861, results in terms of increased yields did not begin to appear until the 1930s with the introduction of improved soil husbandry and the spread of hybrid corn. From then on, productivity increases have been the principal contributor to U.S. agricultural growth. As time has passed, privately-financed research has become an increasingly active contributor, complementing and, in some cases, replacing public research programs.

Much has been written about the failure of the Green Revolution to emerge in Africa. But recent studies have shown that agricultural technologies are usually location-specific and sensitive to agro-ecological and socio-economic

environments of the farmers who use them. Africa's disappointing experience with technology generation and transfer since independence adds further evidence to the historical record that "only a country that establishes its own research capacity in agriculture can gain access to the advances in knowledge that are available to it from the global scientific community and embody that knowledge in the technology suited to its own resource and cultural endowments." (Ruttan; 1984) When one asks "why put more money into agricultural research in Africa?", the clear answer is that strong support for agricultural research is necessary to promote African development.

National agricultural research institutions and programs in Africa vary in both size and effectiveness; in general, however, they are weak and poorly staffed, equipped, financed, and managed. Most national agricultural research programs in Africa are structured along disciplinary lines. Until recently, research was oriented toward export crops and animal health, with food crops and animal husbandry largely neglected. The research programs concentrated on the physio-biological aspects of crop and livestock production with limited attention to socio-economic aspects of African farming. Most of the research has been -- and, to a large degree, continues to be -- done in laboratories and on experiment stations with few direct linkages with, or participation by, extension service personnel or farmers. Linkages among national systems, international agricultural research centers, and other external sources of technology are limited. These orientations are beginning to change, but much more needs to be done.

Shortages of staff trained at the college and post-graduate levels are a major problem for national agricultural research systems. Participant training may be a short-term answer and has an important longer-term role if used to supplement and reinforce efforts to develop local capabilities. Higher education capacity is increasing (about 10 per cent per year) but is still inadequate. The only long-term solution to Africa's severe shortage of trained agricultural personnel is to expand the capacity and improve the quality of higher agricultural educational institutions.

Universities in Africa have much in common. They generally are small institutions which concentrate on teaching. Entering students are poorly grounded in science and require extensive remediation which takes attention away from the regular curriculum. With few exceptions, little research is carried out at universities and the quality of research is low. Resources are scarce and there is little opportunity for collegial interaction or peer review. As yet, research activities in universities and government ministries are not closely linked. As a result, a scarce and valuable resource, the better trained scientists who often locate at the universities, is underutilized.

Efforts to achieve economies of scale through regional universities have consistently failed. Each nation wants its own major institution, which is understandable in terms of national prestige considerations. But, in some cases, the broader objective of African agricultural development has been ill-served by this approach.

Support to agricultural research and to faculties of agriculture in selected countries will respond to the major problem areas inhibiting African agricultural development. Research will produce farmer-tested high yielding technologies adapted to the difficult physical and harsh climatic conditions. Sustained support to research systems and faculties of agriculture will promote stable productive institutions and improve the supply of trained scientists, teachers, and agricultural managers. Improved agricultural research systems and stronger faculties of agriculture, while not sufficient by themselves, are necessary for African agricultural progress.

III. Present Program

Agriculture is the central focus of AID's long-term development assistance strategy for Africa. Agricultural projects, in general, accounted for 47 percent of African Bureau obligations in FY 1984. Support to agricultural research and faculties of agriculture is a large part of this assistance.

A. Agricultural Research

AID uses a number of tools to support agricultural research in Africa including bilateral projects, regional projects, international agricultural research centers (IARCs), collaborative research support programs (CRSPs), and centrally-funded projects. The Agency currently funds almost \$100 million of agricultural research in and on Africa annually.

1. Bilateral Projects

To improve agricultural research in Africa, AID works to strengthen national agricultural research capacities to generate and utilize technology. Included in a "national system" are all public and private institutions involved in conducting research to develop agricultural technologies. For FY 84, fifty five mission-funded projects located in 25 countries had agricultural research components. Annual expenditures for the research components are estimated at \$51 million.

2. Regional Projects

AID supports regional projects promoting the sharing of research, the exchange of other types of information, and the cooperation of donors. For FY 84, eight regionally-funded agricultural projects had research components. Three of these are located in the Sahel, two are in the Southern zone, and three cover the whole continent. Annual expenditures for the research components are estimated at \$22.4 million.

3. IARCs

International agricultural research centers (IARCs) -- the institutions supported by the Consultative Group for International Agricultural Research (CGIAR) plus associated centers funded by

international donors outside the CGIAR -- provide a research system that works on most of the major food crops and animals, food policies, and improvement of national research systems. Four CGIAR-sponsored activities are located in Africa: the International Institute of Tropical Agriculture (IITA), the International Livestock Center for Africa (ILCA), the International Laboratory for Research on Animal Diseases (ILRAD), and the West African Rice Development Association (WARDA). A substation of the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and associated centers, i.e., the International Center for Insect Physiology and Ecology (ICIPE) and the International Center for Research on Agroforestry (ICRAF), are also located in Africa. Other IARCs carry out research which applies to African problems and are linked to African national research systems. For FY 84, AID provided \$45.3 million (approximately 25 percent of the total) for core support to the CGIAR-sponsored IARCs. Of this amount, approximately \$14.4 million is estimated to be directly or indirectly supportive of African agriculture. In addition, AID provides \$4 million annually to the International Fertilizer Development Center (IFDC), of which approximately \$500,000 is directly or indirectly in support of agriculture in Africa.

4. CRSPs

Collaborative Research Support Programs (CRSPs) provide a means by which the talents of research scientists from the U.S. and developing countries can be mobilized to focus their collective efforts on solving long-term agricultural research problems of common interest. In FY 84, approximately \$5.3 million of CRSP expenditures were directly or indirectly in support of agriculture in Africa -- sorghum and millet (\$1.6 million), beans and cowpeas (\$1.6), small ruminants (\$0.8), tropical soils (\$0.7), peanuts (\$0.5), and aquaculture (\$0.1).

5. Centrally-Funded Projects

By means of contracts and cooperative agreements, AID maintains and strengthens the technical competence of U.S. universities and other institutions in specialized areas so that the institutions, in turn, may better serve AID regional bureaus and missions by providing an array of expertise needed for high-priority tasks. For FY 84, 20 centrally-funded (S&T/AGR) projects provided direct or indirect support to agricultural research in Africa. Annual support was approximately \$2 million in eight areas: crop production (\$0.3 million), livestock production and health (\$0.3 million), pest management (\$0.1 million), post-harvest loss (\$0.4 million), soil and water management (\$0.3 million), bio-technology (\$0.1 million), fisheries and aquaculture (\$0.2 million), and economic policy and planning (\$0.4 million).

B. Faculties of Agriculture

AID supports faculties of agriculture through participant training, bilateral projects, and CRSPs. The Agency funds approximately \$20 million in support of faculties of agriculture in Africa annually.

1. Participant Training

AID currently provides approximately \$6.8 million for long-term training for 250 additional Africans each year pursuing B.S., M.Sc., and Ph.D. degrees in the various disciplines of agricultural sciences. This represents an increase in numbers of trainees of almost 40 percent since 1979.

2. Bilateral Projects

For FY 1984, AID obligated \$12.7 million for strengthening institutions involved in higher education in agriculture. Three institutions offering degrees in agriculture at the B.S. level and higher received \$9.2 million (Cameroon, Uganda, and Zimbabwe). In addition, three post-secondary institutions offering technical training (including certificate and diploma levels) received \$3.5 million (Kenya, Lesotho, and Liberia).

3. CRSPs

Several CRSPs are active in universities in several African countries. The degree training in the CRSP contributes to improved research capabilities and leadership at the national program levels.

IV. Discussion

For the past 15 years or more, AID and other donors have attempted to reverse the declining per capita food production in sub-Saharan Africa. The Agency has been investing in agricultural research capacity development by providing technical assistance, training, and other physical support to national research institutions. This support has been given to some 25 African nations addressing scores of different commodity and factor-specific research problems. However, these investments have been erratic and the results have been disappointing because they have not built adequate African agricultural research capacity nor have they generated the farmer-relevant technology needed.

The Africa and S&T Bureaus are rethinking approaches to technology and manpower development in Africa to improve the effectiveness of investments in agricultural research and faculties of agriculture. Our past experience in

Africa provides strong guidance for shaping future investments. The following broad points are crucial:

1. We need explicit objectives for agricultural research.
2. We need focused program priorities to emphasize selected countries, commodities, and problems.
3. We need to give greater support to commodity research.
4. We need to concentrate on food crop research, recognizing that food crop production can contribute significantly to income and export growth.
5. We need to improve the complementarity among AID's various mechanisms for undertaking investments in agricultural research and faculties of agriculture.
6. We need to make a long-term commitment toward the development of agricultural research and higher education.
7. We need to assist countries to develop their management and administration capabilities in research.
8. We need to be willing to finance a portion of recurrent costs of research programs and faculties of agriculture, where appropriate.
9. We need to cooperate with other donors in planning and carrying out these investments.

A. Need for Clear Objectives

AID's overall objective is to assist African countries to develop improved technologies for farmers which can increase agricultural production and incomes. Africa's nations differ substantially with regard to population, size, economic stability, commitment to agricultural development, institutional capacity, and a number of other factors that influence a nation's ability to benefit from donor assistance. Moreover, some countries are simply too small or too resource-poor to provide the base needed to develop and sustain full-fledged agricultural research systems. In recognition of this, AID intends to pursue a dual strategy. In those countries having the natural and economic base to develop basic and adaptive research, the Agency will make investments to build this capacity so that the technology generated can be used at home and transferred through networks to neighboring countries. In a second group of countries that lacks the economic resource base to develop and finance a large national agricultural research service, investments will be made to strengthen the manpower capacity of the research service to borrow technologies generated in other countries and research centers and to adapt the technologies to local needs and conditions. This basic division will be discussed below.

B. Need for Focused Program Priorities

To assure that AID's investments are in areas of high potential and payoff, a set of criteria has been developed to make sound decisions in allocating limited research resources.

1. Country Criteria (Technology Producing Countries)

At present, AID provides resources to strengthen national research institutions in about 25 countries. Project investments have supported a wide range of commodities, as well as provided a number of expatriate scientists. This broad-gauged support was considered necessary because of the weak scientific manpower base in most small countries, but the effect has been to fragment and reduce the impact of our agricultural development resources. So far, the payoff in terms of relevant technology has been disappointing.

Therefore focus will be given to a limited number of key countries with a high payoff potential for generating new technology. The technology producing countries would each meet the following criteria:

- (1) Cultivated area of at least 100,000 hectares in each commodity for which research assistance is planned.
- (2) A research staff of 100 or more scientists (it takes a minimum of 8 to 12 scientists to make progress on one commodity).
- (3) Three or more functioning research stations located in the important agricultural areas of the country.
- (4) A national research system pursuing prioritized commodity and problem solving research.
- (5) A national research system having working relationships with IARCs, CRSPs, neighboring national programs, and regional programs.
- (6) A national agricultural research budget that demonstrates a history of steady support and reasonable per-scientist funding.
- (7) A faculty of agriculture with capacity to teach and do research, providing B.S.-level graduates qualified to pursue graduate study at universities in Africa or under the aegis of U.S. participant training programs and producing (or with potential to produce) M.Sc. graduates who have capacity to do research.

In countries that satisfy these criteria, AID will provide support for both technology generation and adaption/utilization. It will support faculties of agriculture in those countries where opportunities for training M.Sc.-level graduates exist.

2. Country Criteria (Technology Adapting Countries)

Countries with small national research programs will be provided assistance to strengthen their capacities to screen, borrow, and adapt technology from technology producing countries, regional networks, IARCs, and CRSPs. The Agency will make investments in technology adapting countries which meet the following criteria:

- (1) Cultivated area for priority crops of about 100,000 hectares.
- (2) An agricultural research staff of 20 to 80 scientists, which could be organized into commodity teams of eight to twelve professionals capable of adapting technology from the IARCs, CRSPs, and regional networks.
- (3) Two or more operating research stations.
- (4) A national research system willing to establish research priorities.
- (5) A national research system interested in and willing to establish regularized working relationships with IARCs and other research institutions outside the country.
- (6) National leadership that indicates a willingness to consider funding recurrent and operational costs of national research institutions and to provide reasonable per-scientist research support.
- (7) A faculty of agriculture with some capacity to provide B.S.-level graduates to serve on research commodity teams and to qualify as participants for graduate training.

In countries meeting these criteria, AID will provide support for technology adaptation/utilization. If a specific national commodity research team requires a particular discipline (soil fertility or agronomy) to strengthen its capacity to borrow technology from a regional network, consideration would be given to providing the needed professional assistance. Participant training will be used to build the numbers and quality of trained researchers. Countries failing to meet these minimum criteria will receive limited assistance for agricultural research, primarily participant training.

3. Commodity and Problem Research Criteria

Any research allocation system, regardless of how intuitive or how formal, cannot avoid making judgments about two major questions. The first question is: what are the possibilities of producing scientific and technical advances if resources are allocated to research on a particular commodity, a particular resource problem, or a particular disciplinary or scientific field? The second question is: what will be the value to society of the new knowledge or the new technology if the

research effort is successful? To help ensure that the Agency's research investments will have a technological and production impact, investments will be focused on a handful of key staple foods and related problems which are central to Africa's food needs. The criteria by which commodities and research problems will be selected include:

- (1) The extent to which the commodity contributes to present and projected (taking into account future demand) calorie intake in rural and urban populations.
- (2) The likelihood that improved farmer-relevant technology can be developed to increase production, given the expertise and state-of-the-art in the U.S. and the IARCs.
- (3) The availability within the national research system of a minimum cadre of four M.Sc. or Ph.D. scientists backstopped by a staff of eight B.S. level specialists to work on priority research problems.
- (4) The comparative advantage of the U.S. in making available knowledgeable scientists and relevant technology that can be incorporated into ongoing national research programs.

In general, AID intends to increase support to commodity research. However, the objective of this commodity research should be to develop higher yielding varieties based on management and input intensities appropriate to African circumstances. Besides increasing genetic potential, due attention must be given to economic and cultural problems such as labor availability and to disease and pest resistance, germination/maturation, soil and water management, and other matters that are particularly significant in the African setting.

There is general agreement that livestock production plays an important role in African agriculture. Livestock raising is carried out under mixed farming (crop/livestock) and range-type conditions. Interventions have characteristically been focused on range management, disease control, and improved nutrition. Lessons learned in the last 10 to 15 years of experience demonstrate that western range management approaches have been found ill-suited to the African context. Consequently, initiatives in livestock research should be promoted slowly and should focus on animal health and nutrition in mixed farming systems where animal traction and income generation through improved production are the central thrusts. In the absence of major animal diseases, nutritional stress is the major constraint to efficient livestock production. The solution to this problem lies in either increased fodder from food crops or improved grasses and forages.

C. Need for Commodity Research

The magnitude of food production increases required to meet Africa's overall population growth of about 3.5 percent annually suggests that some combination of a large number of marginal production improvements and a few major breakthroughs in staple foods are urgently needed.

The very promising new sorghum varieties in the Sudan and the prospects for biological control of mealy bugs and green spider mites (major cassava pests) are examples of extended, continuous research cooperation that are bearing their fruits now. A major technical breakthrough can only come about by improving the genetic characteristics of crops and knowledge of soil and water management relationships. Dramatic improvement in genetic materials and soil and water relationships requires a time frame of ten to fifteen years. In the short term, the outlook for many major technical breakthroughs is limited because of the long lead-time required to develop a sound research program. Hence, it appears that during the next five to ten years, food production increases must result primarily from marginal production improvements. These marginal improvements will most likely be achieved through improved agronomic practices and pest control.

Consequently, commodity research plans need to be focused on dual objectives: (a) a modest continued investment in the short-term to take advantage of whatever marginal production improvements can be generated and (b) major investment on genetic improvement and soil and water relationships for the long-term. A continued emphasis on marginal production improvements will help build the scientific knowledge base and provide opportunities for newly-trained scientists to gain practical experience, thus providing a base for the long-term emphasis on commodity work which will eventually lead to major technical breakthroughs. Major production breakthroughs are needed, eventually, to gain the required confidence of African governments and convince them that increased investments in agricultural research are justified over the long-term.

Farming systems research is not an end in itself, but rather a means of improving the overall technology generation and diffusion process contributing to production improvements. A knowledge gap exists between on-station commodity research work, the technology-transfer mechanisms, and the farmers as end-users of technology. Information on farming systems is needed in each commodity area to better understand the production system, the diversity and interrelationship of crops grown, the farmer's decision-making process, and potential areas where technological changes are most needed in the farming system. Farming systems research, by which we mean on-farm research with a farming systems perspective, offers a cost-effective means to fill this knowledge gap.

On-farm research should be aimed specifically at strengthening the on-station research being conducted by national institutions. Cost effectiveness is achieved by emphasizing a few priority enterprises, by bringing biological and socio-economic concepts together early in the research process, by implementing much of the research on farm, and by linking experimental station work and technology transfer activities to the research. Balance between commodity and farming systems research must be sought in any national research program.

There is general agreement that agro-forestry will play a role in agricultural development in most African nations. Agro-forestry has already been an accepted practice by farmers in many countries;

interventions include alley cropping, shelterbelts, random tree plantings, and tree border plots. AID assistance to agro-forestry research should support and complement research on the priority commodities using tree planting technology already developed at the IARCs for soil and water conservation. The priority commodity and agro-forestry work should be carried out at the farm level through national on-farm testing activities.

D. Need for the U.S. to Concentrate on Food Crops Research

Growth prospects for African agriculture depend ultimately on response to commercial opportunities. Nearly all farmers in Africa are engaged in some form of commercial agriculture. Farm families participate in commercial transactions through sale of food commodities, export crops, livestock, labor, and in other ways as well. Exports generate foreign exchange to import production inputs -- fertilizers, pesticides, and petrochemical fuels -- for food crop production. Sales of crops generate income to purchase food. Thus, there is a need to understand, at the national level and at the household level, how farm families participate in commercial transactions and how this influences food crop production.

The U.S. has a comparative advantage in food crop research. We have a base of knowledge about most of the major food crops grown in Africa and we also have the capacity for training scientists to research food commodities. Other donors, particularly the European countries and the IBRD, we believe, have a comparative advantage in providing technical assistance for research on many traditional African export crops (e.g., coffee, tea, and oil palm). Therefore, it seems appropriate over the next twenty to twenty five years for AID to focus on food crop research with the expectation that the private sector and other donors will also support food crop research as well as traditional export crop research. Such assistance should be coordinated to strengthen national research systems.

In suggesting this division of responsibility, several observations should be borne in mind. First, food crops can contribute significantly to cash sales, including exports. For example, many small farmers market part of their food crop production, and several of the surplus-producing southern Africa countries export maize to neighboring countries. Second, there are several ways, in addition to research, that AID can encourage commercial agriculture. For example, policy changes through exchange rate adjustments and improving efficiency of marketing parastatals can be powerful export stimulants. Third, private sector activity can be promoted. Firestone, Uniroyal, Del Monte, and United Brands, to name but a few, have research knowledge and capabilities of value for Africa in food and cash crops. Satellite farming -- agribusiness organizing small farmers to produce high-value cash crops by providing inputs, credit, technical advice, and, most importantly, a market -- shows considerable potential.

E. Need for Integrating AID Inputs

AID relies on bilateral projects, international agricultural research centers (IARCs), collaborative research support programs (CRSPs), and regionally and centrally-funded projects to provide its support. Each mechanism has strengths and weaknesses, and the relative advantages and disadvantages of these mechanisms are continually evolving.

The bulk of Africa Bureau funding for research is provided through bilateral projects, mostly implemented by Title XII institutions. Bilateral projects enable AID to respond directly to host country needs and give the on-the-ground presence required for sound institution-building. During the past decade, U.S. universities have made progress in developing cadres of scientists knowledgeable about agriculture and working conditions in Africa and about AID operations. They have a comparative advantage in (1) education and training of research personnel and (2) institution building. They provide the major means of training Ph.D. level researchers for Africa at present. However, the effectiveness of this mechanism is reduced by (a) the generally short duration of projects; (b) frequent contractor staff turnover; (c) difficulty in obtaining fully-qualified staff including deficiencies in French language capability; and (d) tendency for project formats to distort and/or fragment host country research programs.

IARCs provide access to worldwide stores of germplasm, to a small but very significant group of international agricultural scientists whose collective LDC experience is invaluable, and to specialized non-degree training. They have a comparative advantage in (1) technical backstopping with long-term field staff, (2) on-the-ground network coordination, and (3) linkages with other international centers. But the IARCs tend to give attention to elite as opposed to local breeding materials and focus on input and management-intensive yield improvement rather than on labor-conserving technologies and other desirable plant qualities.

CRSPs focus on research with a long-term payoff and provide access to high-level expertise and training. However, integration into national programs and coordination with bilateral projects and IARCs could be improved.

Regionally and centrally-funded projects provide access to specialized technical skills and help develop U.S. institutional capacity. However, it is sometimes difficult to coordinate the use of these resources when financed by different AID/W offices, and, as a result, confusion can exist among host country counterparts and contractors regarding roles, responsibilities, and program directions.

All these mechanisms provide resources that are important to African agricultural research and development. The effectiveness with which these resources are deployed should be improved by refining and adjusting their roles in an evolutionary way based upon the lessons of experience. AID intends to:

- Improve coordination in the delivery of assistance -- by giving increased support to the development of coherent, balanced, long-term national research plans into which diverse inputs can be fitted and by ensuring clear program direction for regionally-funded and centrally funded projects;
- Improve the quality of Title XII participation by giving sustained and stable support to four to six U.S. institutions that are best placed to support our commodity and country priorities, thus enabling the institutions to develop their technical staff, managerial capacity, and base of knowledge of African agriculture needed to effectively implement bilateral projects;
- Expand the capacity of the IARCs to support national program development by establishing and funding special projects -- especially where these projects incorporate a regional networking component; and
- Improve the integration of CRSPs into the national and university research programs in Africa.

F. Need for Long-Term Commitment

There is now substantial empirical evidence that agricultural development in Africa is a slow, evolutionary, stepwise process. Similarly, agricultural research is a long-term process that should be conceptualized in time spans of decades rather than years because:

- Even if major efforts are initiated now, it will take a minimum of 20 to 25 years, depending on the country, to train and upgrade an adequate level of human capital for the major agricultural institutions.
- It takes an average of 10 years between the initiation of expenditures on agricultural research and the availability of new technology and another 5 to 10 years to gain widespread adoption.
- It will probably take a period of 5 to 10 years in most countries to build the political support for a fundamental redirection in development strategies to give increased financial support to agriculture.

A long-term commitment must also be made to U.S. institutions to enable them to participate more effectively in an effort to strengthen agricultural research and faculties of agriculture in Africa. This would enable the U.S. institutions to hire additional permanent faculty for the particular purpose of interacting professionally with selected African institutions in such a way that the interaction is compatible with, in fact is supportive of, the U.S. academic incentive system.

Long-term commitments to research, training, and donor relationships are mutually reinforcing. AID should begin planning now for a sustained commitment of a minimum of 20 to 25 years to African agricultural research

systems and faculties of agriculture in key countries where the potential for technological payoff is high. Once a long-term commitment is made to a country, AID should not act precipitously to terminate that support for short-term political or other reasons.

G. Need for Stronger Management and Administration Capabilities

In most African countries there must be significant improvement in the management and administration of agricultural research programs so that national systems can handle increased levels of support and so they can improve the effectiveness with which funds and staffs are utilized. Evaluations of our current generation of agricultural research activities indicate that poor management and administration are frequently constraining the available technical talent. Although specific country and organizational needs will vary considerably, strategies to improve management and administration will need to be built upon some combination of the following interventions: upgrading the managerial capacity of key individuals; improving the financial planning and budgeting process to align financial resources with research objectives; setting in place cost-effective systems to evaluate effectiveness of research expenditures; improving personnel management systems, performance incentives, and career paths to retain and make the best use of scarce staff; and making managers and scientists accountable for results or lack thereof.

In addition, explicit attention must be given to establishing reliable relationships between research organizations and other organizations upon which they depend (e.g., Finance Ministries, Planning Ministries, and Civil Service Commissions) as well as to establishing sound avenues for the exchange of information with groups they are expected to serve (extension workers and farmers). This is a broad but indispensable agenda that must be pursued in AID projects to build a technology development or adaptation capacity in African nations.

H. Need for Financing Recurrent Costs

Renewed attention to management and administration will go some way towards addressing the troublesome issue of recurrent funding by making better use of existing resources. But in the future agricultural research activities should explicitly tackle the recurrent cost issue by (a) ensuring that host countries are placing adequate priority on funding for agricultural research organizations; (b) taking advantage of opportunities to generate revenues (e.g., through user-fees or contributions in labor or in-kind); and (c) exploring opportunities to contract out ancillary support activities (e.g., maintenance of facilities) that might be done more efficiently by the private sector.

However, missions should be prepared to finance the recurrent budget of essential agricultural research activities provided that there is (a) an acceptable set of country policies (or movement toward these) so that the

effectiveness of recurrent support is not in doubt; (b) an assurance that recurrent cost support has higher development impact than new investments; and (c) a clear inability of the host country to undertake recurrent cost financing. Even so, recurrent cost financing must be provided in the context of a carefully phased plan to shift the entire burden to the host country over a period of time not to exceed ten years. AID's Policy Paper on Recurrent Costs provides guidance on this complex area.

I. Need for Donor Cooperation

With many donors working in Africa, duplication of effort is a serious problem. If donors meet prior to project planning, conflicts of interest and duplication of effort can be minimized. Also, donors can work together and share costs in order to allocate sufficient donor resources to large-scale problems. For example, a logical division of resources would be for the U.S. to use its grant funds for technical assistance and training to complement financing from other donors for buildings, other infrastructure, and equipment. Similarly, the U.S. might direct support to research on food crops to complement research assistance on traditional export crops by European donors or the private sector. Special initiatives should be undertaken by AID missions to work with and strengthen collaborative efforts among countries. The responsibility to nurture regional collaboration is of primary importance to ensure that the contributions of IARCs, CRSPs, and centrally- and regionally-funded activities are fully utilized in achieving Agency agricultural development objectives. Donor coordination can help prevent the fragmentation of national programs that results when diverse projects are put in place without considering redundancy and complementarities.

Cooperation for Development in Africa (CDA) -- an informal association of the seven major bilateral donors to Africa who provide 65 per cent of direct development assistance -- represents one organized effort of donors to cooperate. Within CDA, AID, the largest donor to agricultural research systems, serves as overall coordinator of assistance in agricultural research. AID and the World Bank have agreed to cooperate in exploring development of faculties of agriculture in Africa. AID is supporting World Bank initiatives to promote IARC-led commodity networks in Africa. AID also works through World Bank Consultative Group meetings, UNDP Round Table meetings, and other opportunities.

AID believes that, in the last analysis, donor cooperation will only be successful when host country governments take the lead in establishing coherent programs into which donor resources may be placed. Hence, AID will work with African colleagues and counterparts to establish strong national research strategies or plans and seek to use them as the framework for coordinating donor assistance to research and faculties of agriculture.

V. Program Plan

AID support in Africa for agricultural research and faculties of agriculture should adhere to five guiding principles, which are key to effective agricultural technology development in Africa.

1. Explicit Program Objectives and Priorities We will focus the bulk of our resources on a relatively limited set of countries, commodities, and research problems (particularly on soil and water relationships to the key commodities) where sustained assistance is most likely to achieve high payoff in producing new technology and income streams for producers.
2. Balanced and Integrated Commodity and Socio-Economic Research We will give increased attention to the development of strong commodity research programs, while refining the role of farming systems research to ensure that on-station research programs respond to the real concerns of African farmers. This includes renewed attention to the problems and potentials of commercialization of agriculture and to labor availability and utilization.
3. Sustained and Stable Support for U.S. and International Institutions We will increase the capacity of several lead Title XII institutions to support Agency country, commodity, and problem priorities. We will also encourage and assist IARCs to establish a stronger presence in the development of African national research systems as well as regional commodity networks.
4. Long-Term Commitment We will adopt a period of 20 to 25 years as the minimal acceptable planning period for assistance to African agricultural research systems and faculties of agriculture as well as our support for the U.S. and international institutions upon whose expertise we depend.
5. Donor Cooperation We will continue to facilitate donor cooperation in African agricultural research and faculties of agriculture. Our efforts will have two emphases: effective collaboration among donors and development of long-term national agricultural research strategies or programs into which diverse donor resources can be effectively placed.

A. Agricultural Research

Strengthening agricultural research capabilities will be based on a two-pronged approach to national agricultural research systems and zonal research networks.

1. National Research Systems

The dual task of capacity building and technology development will be addressed in two distinct ways depending upon the potential for payoff.

a. Technology Producing Countries

A few countries already have relatively strong bases in the areas of manpower, financial resources, area planted in priority food crops, and other-donor support. The following countries are top priority where agricultural research can be expected to have the largest potential and earliest payoff for development: Cameroon, Kenya, Malawi, Senegal, Sudan, Zaire, Zambia, and Zimbabwe. While still meeting the criteria for technology producing potential, the following countries should receive lower priority due to relative economic, social, and political considerations: Tanzania, Uganda, Ghana, Ivory Coast, and Nigeria. In order to benefit from active networking, at least one technology producing country should be located in each CDA-designated ecological zone. The proposed match is as follows: Sahel - Senegal; Coastal West Africa - Cameroon; Sudan - Sudan; East Africa - Kenya and Malawi; Zaire Basin - Zaire; and Southern Africa - Zambia and Zimbabwe. Missions in these eight countries are encouraged to assist the countries in developing strong national food crop research programs.

Within these programs, the short-term objectives will be to train scientists, build institutional capacities, and operationalize zonal networks to produce improved technologies. Agency investments will focus on two to four food crops that are predominant in the zone in which the country is located and which meet priority commodity criteria.

The long-term objective will be to produce improved technologies on a sustained basis. This will require several components. Each national system should develop sound management plans and long-term research agendas. Collaborative zonal networks will help to make research more cost-effective, reduce country-by-country duplication of effort, and improve testing and dissemination among scientists of research information. M.Sc. and Ph.D. participant training programs should take into account the scientific manpower needs of the selected country as well as the broader manpower requirements of the zone. In those countries where opportunities exist, AID will support development of faculties of agriculture to train M.Sc. scientists in specific disciplines needed to meet the commodity research objectives of the country and, to the extent possible, zone.

b. Technology Adapting Countries

The technology adapting countries generally need assistance to strengthen their capacities to import technology and adapt it to local micro-environments. The technology adapting countries tend to group into two categories. The countries with natural and human resources approaching minimal research requirements include Burundi, Madagascar, Mali, Togo, Sierra Leone, Liberia, Niger, Rwanda, Burkina Faso, The Gambia, Botswana, Lesotho, and Swaziland. In a

second category of relatively less promising countries are Chad, Benin, Somalia, Mauritania, Guinea, Guinea Bissau, Central African Republic, Cape Verde, and Djibouti. Within each category, the countries are not listed in any order of priority. There is a presumption in favor of program and project assistance to the first group of technology adapting countries where it is feasible to consider long-term commitments to agricultural institutions. For the time being, our assistance to the second group of technology adapting countries will concentrate primarily on participant training.

Within these programs, the short-term objective will be to concentrate on building multi-disciplinary teams of 8 to 12 scientists who will develop commodity research programs in one or two staple foods. The commodities to be researched will be the predominant food crops in the particular ecological zones, e.g., sorghum, millet, and edible legumes in arid and semi-arid regions, maize in the eastern and southern zones, upland rice in the western coastal zones, and roots and tubers in the humid zones. Participant training initially will be focused on increasing the numbers of M.Sc. level scientists. Training graduate-level scientists at neighboring faculties of agriculture will be encouraged at the M.Sc. level, but Ph.D. training will be supported in the U.S. for the next 10 to 15 years. Little, if any, investments will be made to develop faculties of agriculture in the technology adapting countries.

The long-term objective will be to build minimum-size national research institutions capable of planning and managing at least two to three commodity programs. Attention will be given to cost-effective management to promote technology transfer through the research networks. A research institution in an adaptive research country may have special capacities to conduct research in particular areas, e.g., biological nitrogen fixation, as well as to screen plant materials for disease or pest resistance in collaboration with IARCs, CRSPs, or centrally-funded projects. M.Sc. participant training will be phased out as rapidly as possible in the U.S. as African faculties of agriculture expand their capacity to offer relevant, stable, and cost-effective training.

c. Commodity and Problem Research Priorities

Commodity and problem priorities are determined by the crops most important in the caloric intake of the rural and urban population, land area sown to particular crops, and current and prospective demand for the food crop in each respective ecological zone. The following commodities have highest priority for Africa: maize, sorghum, millet, upland rice, roots and tubers (cassava and potatoes), and edible legumes (beans and cowpeas). Relative importance would differ by ecological zones. Forages and trees are considered important in mixed farming situations, i.e., mixed food

crop and livestock farming and agro-forestry. AID will not provide support for research on other crops (e.g., groundnuts, soybeans, horticultural crops) that are important in some local circumstances but which are relatively unimportant in terms of Africa's overall food needs.

2. Research Networks

Because of the large number of small countries in Africa, it is not cost-effective to approach agricultural research problems entirely on a country-by-country basis. Most of the national agricultural research systems in small countries are thinly-staffed and poorly-financed. Agricultural research is costly. A "critical mass" of scientists is needed to produce new knowledge through basic and applied research. In many cases they are not always available at the national level. It is, however, possible to build a critical mass of scientists through the collective joining of scientific manpower in the small countries and focusing their work on a specific problem. Problems that transcend national borders or even regional groupings often may be addressed more effectively by institutions that are interregional or global in nature. These institutions, in turn, can provide support for national programs in specific program areas.

AID will facilitate agricultural research cooperation on a zonal basis to complement national research efforts. The major national research institutions producing new technologies will be encouraged to help implement collaborative networks with other national research systems and regional and international research centers. These collaborative networks will be inter-country working relationships facilitating the planning and coordination of research and the backstopping of national programs. In most instances, the IARCs will take a leadership role in development of networks. In some cases, it may be necessary to support small African regional institutions to coordinate with IARCs to lead network development. Over time, strong African national agricultural research systems must assume leadership roles in these scientific networks.

The development of networks in sub-Saharan Africa will plan strategic components of research to solve problems, foster the exchange of scientific knowledge, and facilitate cost-effectiveness; they will not be means for building large operational staffs or physical facilities. Several topics are especially promising for collaborative networks. On-farm research with a farming systems perspective is one of these. In addition, we plan to support, initially, four to six commodity networks, each in one or more zones. The following appear to have highest potential:

- o Maize - Eastern Highlands, Western Coastal, Zaire Basin, and Southern Zones

- o Sorghum and Millet -- Southern, Sahelian, Sudanian, and Eastern Highlands Zones
- o Roots and Tubers -- Zaire Basin and Western Coastal Zones
- o Edible Legumes (particularly beans and cowpeas) --- Eastern Highlands, Western Coastal, and Sahelian Zones
- o Upland Rice -- Western Coastal Zone and Madagascar
- o Forages in Mixed Farming Systems -- Sahelian, Sudanian, Eastern Highlands, and Southern Zones.

B. Faculties of Agriculture

We propose to improve the quality and increase the numbers of trained scientists to carry out research by supporting faculties of agriculture in four to six technology producing countries. The focus will be upon university building in higher agricultural education at graduate degree levels through the provision of support to university research, teaching, and linkages to agricultural production. Concentration will be upon agricultural sciences, other sciences related to agricultural production, agricultural and rural social sciences, food utilization, and university administration and management.

The ultimate objectives of support to higher agricultural education are twofold: first, to develop institutions of higher education and research that are responsive to commodity research priorities and agricultural production problems; and second, to produce a critical mass of well-trained, practically-oriented scientists willing and equipped to work on high-priority commodities and research problems.

Types and amounts of support will vary from institution to institution depending on their relative levels of development and areas of expertise and may include staff development and long-term training; classroom, laboratory, and dormitory facilities; curriculum and administrative development; research support; library development; support for networking with other professionals; and linkages to agricultural production. This will require a minimum of a 20 to 25 year commitment of support for each institution.

The following criteria will be considered in selecting faculties of agriculture:

- a) Relative institutional strength in terms of quality of education offered;
- b) Institutional recognition of the need for links among research, teaching, and agricultural production;

- c) National budgetary support with a demonstrated history of steady support and reasonable per-faculty funding;
- d) Potential for collaborating with and supplementing national agricultural research services and independent research institutes;
- e) Potential for playing a leadership role in the country and region and a national policy which supports it.

The focus on faculties of agriculture is complementary to agricultural research and therefore the criteria also should take into consideration an attempt to strengthen at least one faculty of agriculture in each ecological zone; the zonal priorities for commodity and problem research; and the potential of selected faculties of agriculture to establish themselves to prepare professional resources to serve research needs at both national and regional levels, e.g., if maize research has been identified as a priority in Southern Africa, an AID-funded training institution in that region should provide professional support to such research.

Disciplinary priorities will be identified to support the commodity and problem priorities identified for each institution as well as the teaching function and agricultural production linkages of the university. Specific departments and units to be strengthened in each institution will vary from country to country. However, the following criteria will be applied in determining priorities upon which to focus support:

- a) Priority attention will be given to development of those departments in scientific agricultural fields which most clearly meet the commodity and problem priorities identified for the institution, e.g., agronomy, soil science, plant pathology.
- b) Choice of content focus will also be aimed at strengthening the institution's capability to conduct research and link that research to the agricultural production systems of the country and the region. Therefore, such departments as statistics and computer science may require strengthening in order to support viable research efforts while departments such as agricultural economics, rural sociology, and rural education may require strengthening to ensure linkage to agricultural production and farming systems research.

C. AID Funding Levels

Funding requirements for the plan to support agricultural research and faculties of agriculture in Africa can be separated into four components: (1) national agricultural research systems and zonal research networks; (2) faculties of agriculture; (3) IARCs, CRSPs, and other centrally-funded projects; and (4) a small set of U.S. Title XII institutions.

AID's experience in supporting national research systems and regional research networks in Africa provides some guidance in determining the funding requirements for these components, at least with respect to the Africa Bureau's and the S&T Bureau's roles in providing technical assistance, training, and essential equipment and commodities. For national programs, we plan to commit \$50-75 million annually and \$800 million over the next 15-year period. Of this amount, a relatively large proportion will be spent on (a) major efforts to establish a technology producing capacity in a handful of countries where this is warranted; and (b) major efforts to establish a technology adapting capacity in a handful of promising countries that are currently without such capacity. In other countries (the majority of cases), lesser amounts will be spent on training or making improvements to existing capacities to produce and/or adapt agricultural technology. For the zonal networks, we plan to commit \$2-3 million per year for each of five networks, for a total of \$10 to \$15 million annually and \$200 million over the 15-year period. In sum, a commitment of \$60 to \$90 million annually and \$1 billion over the next 15-year period is planned for these two components. For the most part, these funds will be found through reallocations of resources.

About \$20 million annually, or \$300 million over the next 15-year period, will be provided to support the work of the IARCs, CRSPs, and other centrally-funded projects in Africa.

The anticipated cost of developing the faculties of agriculture in four to six countries is approximately \$30 million per institution for the first 5 years with decreased support for the next 15 years or a total of \$25 to \$35 million annually for all the faculties over the first 5 years and perhaps \$10 to \$15 million annually over the remaining period or a total of \$250 million over the 15-year period.

We do not have estimates yet of support to Title XII institutions.

We emphasize that these estimates are by no means the total resource requirements of research and faculties of agriculture in Africa. For example, we have not completely estimated the costs of participant training in the U.S. or more than the most minimal research investments in the moderate-to-low potential countries and lower priority commodities and problems. This underlines the importance of achieving major improvements in donor cooperation and the urgency of improving host country capacities to formulate and adhere to strong national research objectives and priorities.

D. Implementation of This Plan

This plan clearly implies some degree of restructuring of our assistance to African agricultural research. This restructuring is to be achieved in an evolutionary way, in the ordinary course of program and project development. For ongoing activities, the provisions of the plan will be incorporated into the scopes of work of teams undertaking mid-term

evaluations and developing second-phase projects. Such evaluations will then be done with an eye toward the priorities developed in the plan. For new starts, the provisions of this plan will be factored into reviews of CDSSs and ABSs. This will ensure that programs and projects that are congruent with plan priorities receive appropriate support in the process of Africa Bureau and S&T Bureau resource allocation, and it will also ensure that inconsistent proposals are identified early at a time when differences of emphasis can still be effectively reconciled.

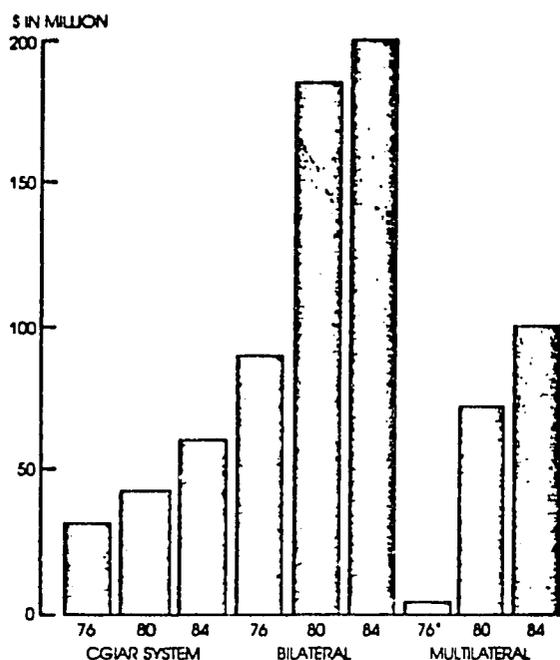
AID's policy paper on Institutional Development states that projects of this type may be authorized for ten years. This has important implications for the development of African capacities to undertake agricultural research and to improve faculties of agriculture because long-term commitments of this sort will engender fully supportive responses on the part of host country administrators and will call forth equally supportive responses from the U.S. Title XII community and other involved institutions. Thus there is a presumption in favor of ten-year authorizations for future AID assistance to Africa in the areas of agricultural research and faculty development.

VI. The Bottom Line: Food Self-Reliance

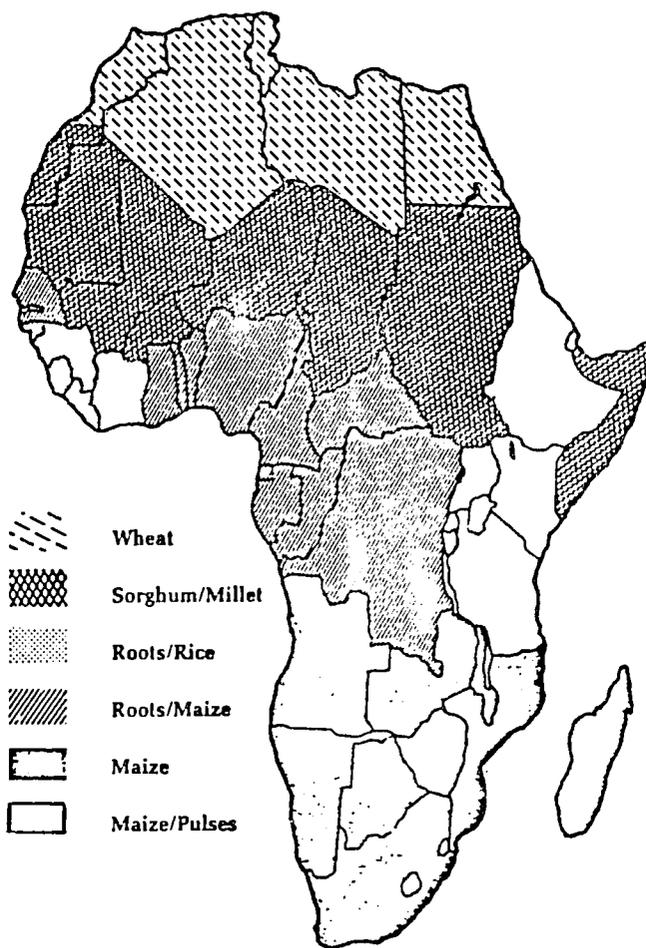
The ultimate objectives of U.S. assistance in food and agriculture are to enable African countries to become self-reliant in food, assure food security, and achieve economic growth.

There is no certainty that these objectives can be achieved by African countries. However, there is certainty that the objective will not be achieved unless fundamental efforts are initiated now.

Technology alone cannot do the entire job. Institutional innovations, policy supports, and infrastructure investments must occur if agriculture is to develop and benefits are to spread widely among rural populations. However, without improved agricultural technologies, resulting from research, few development programs will move very far or have lasting effect.



*1976 multilateral data incomplete
 1984 bars are estimates based on partial 1984 reporting
 Sources: World Bank, IFPRI, CGIAR



Major Crop Zones and Supporting Data

Key	Food Crop Zone	Predominant Agroclimatic Condition and Geographical Location	Total Population (millions)	Total Agricultural Population (millions)	Agricultural Population Density per ha of Cultivated Area	Average Yield of Primary Cereals (kg/ha)	Number of Food Emergency Countries in Total Countries for Each Region
///	Wheat	Mediterranean Winter Rainfall	95.91	45.24	1.77	1219	1 of 5
XXXX	Sorghum/Millet	Semi-Arid Tropics—Sahelian Belt	141.08	88.88	1.42	544	9 of 11
.....	Roots/Rice	Humid Tropical—Coastal West Plus Madagascar	29.84	22.92	2.07	1416	5 of 7
////	Roots/Maize	Humid Tropical—Equatorial Lowland	81.29	53.14	1.82	692	5 of 11
■	Maize	Sub-Humid Tropics—Central and Southern	24.11	16.26	1.43	1187	2 of 7
□	Maize/Pulses	Modified Tropical—Equatorial Highlands	93.48	74.00	2.49	1585	6 of 6

March, 1985

Sources of Data: World Bank, IFPRI, FAO and IADS; 1982 or latest available data.

Source: News from CGIAR, Volume 5, Number 1, March 1985

Production of Major Crops

Crop ^a	Average annual volume (thousands of metric tons)			Average annual change in volume (percent) ^b		
	1969-71	1977-79	1980-82	1969-71 to 1977-79	1977-79 to 1980-82	1969-71 to 1980-82
Cereals						
Maize						
Sub-Saharan Africa	12,132	13,438	13,774	1.3	0.8	1.2
Oil exporters	1,691	1,814	1,904	0.9	1.6	1.1
Other countries	10,441	11,624	11,870	1.4	0.7	1.2
Millet						
Sub-Saharan Africa	8,875	9,178	9,615	0.4	1.6	0.7
Oil exporters	2,870	3,083	3,299	0.9	2.3	1.3
Other countries	6,005	6,095	6,316	0.2	1.2	0.5
Rice (paddy)						
Sub-Saharan Africa	4,735	5,936	6,248	2.9	1.7	2.5
Oil exporters	380	856	1,268	10.7	14.0	11.6
Other countries	4,335	5,080	4,980	1.9	-0.7	1.3
Sorghum						
Sub-Saharan Africa	8,591	9,768	10,834	1.6	3.5	2.1
Oil exporters	3,632	3,768	3,783	0.5	0.1	0.4
Other countries	4,959	6,000	7,051	2.4	5.5	3.2
Wheat						
Sub-Saharan Africa	1,243	1,220	1,369	-0.2	3.9	0.9
Oil exporters	33	31	35	-0.8	4.1	0.6
Other countries	1,210	1,189	1,334	-0.2	3.9	0.9
Total cereals						
Sub-Saharan Africa	35,576	39,550	41,840	1.3	1.9	1.5
Oil exporters	8,606	9,552	10,289	1.3	2.5	1.6
Other countries	26,970	29,998	31,551	1.3	1.7	1.4
Oil and oilseeds						
Coconuts						
Sub-Saharan Africa	1,451	1,563	1,528	0.9	-0.8	0.5
Oil exporters	86	90	90	0.6	0.0	0.4
Other countries	1,365	1,473	1,438	1.0	-0.8	0.5
Groundnuts (in shell)						
Sub-Saharan Africa	5,194	4,826	4,325	-0.9	-3.6	-1.7
Oil exporters	1,699	503	625	-14.1	7.5	-8.7
Other countries	3,495	4,323	3,700	2.7	-5.1	0.5
Palm kernels						
Sub-Saharan Africa	711	664	743	-0.9	3.8	0.4
Oil exporters	306	310	362	0.2	5.3	1.6
Other countries	405	354	381	-1.7	2.5	-0.5
Palm oil						
Sub-Saharan Africa	1,112	1,321	1,372	2.2	1.3	2.0
Oil exporters	579	718	734	2.7	0.7	2.2
Other countries	533	603	638	1.6	1.9	1.7
Other crops						
Pulses						
Sub-Saharan Africa	3,861	4,207	4,709	1.1	3.8	1.8
Oil exporters	925	923	963	0.0	1.4	0.4
Other countries	2,936	3,284	3,746	1.4	4.5	2.2
Roots and tubers						
Sub-Saharan Africa	66,694	77,026	81,026	1.8	1.7	1.8
Oil exporters	27,674	31,488	32,056	1.6	0.6	1.4
Other countries	39,020	45,538	48,970	1.9	2.4	2.1
Seed cotton						
Sub-Saharan Africa	2,279	1,867	1,705	-2.5	-3.0	-2.6
Oil exporters	268	195	113	-3.9	-16.6	-7.6
Other countries	2,011	1,672	1,592	-2.3	-1.6	-2.1
Sugar						
Sub-Saharan Africa	2,303	2,806	3,203	2.5	4.5	3.0
Oil exporters	179	109	139	-6.0	8.4	-2.3
Other countries	2,124	2,697	3,064	3.0	4.3	3.4

a. Major crops that are totally or nearly totally exported (such as coffee, tea, cocoa, and rubber) are shown in table 24, which covers exports of agricultural commodities.

b. End point growth rate.

Source: The World Bank, *Toward Sustained Development in sub-Saharan Africa*.
World Bank, Washington, D.C. September 1984.

Annex C.

Population Growth and Projections

	Average annual growth of population (percent)			Population (millions)			Hypothetical size of stationary population (millions)	Assumed year of reaching net reproduction rate of 1	Population momentum 1980
	1960-70	1970-82	1980-2000	1982	1990*	2000*			
Low-income economies	2.4 w	2.8 w	3.3 w	217 t	278 t	386 t			
<i>Low-income semiarid</i>	2.5 w	2.6 w	2.7 w	31 t	37 t	48 t			
1 Chad	1.9	2.0	2.5	5	6	7	22	2040	1.8
2 Mali	2.5	2.7	2.8	7	9	12	42	2040	1.8
3 Burkina Faso	2.0	2.0	2.4	7	8	10	35	2040	1.7
4 Somalia	2.8	2.8	2.4	5	5	7	23	2045	1.8
5 Niger	3.4	3.3	3.3	6	8	11	40	2040	1.9
6 Gambia, The	2.2	3.2	2.3	1	1	1	3	2045	1.9
<i>Low-income other</i>	2.4 w	2.9 w	3.4 w	186 t	241 t	338 t			
7 Ethiopia	2.4	2.0	3.1	33	42	57	231	2045	1.9
8 Guinea-Bissau			2.3	1	1	1	4	2045	1.8
9 Zaire	2.0	3.0	3.3	31	40	55	172	2030	1.9
10 Malawi	2.8	3.0	3.4	7	8	12	48	2040	1.9
11 Uganda	3.0	2.7	3.4	14	17	25	89	2035	2.0
12 Rwanda	2.6	3.4	3.6	6	7	11	47	2040	1.9
13 Burundi	1.4	2.2	3.0	4	5	7	27	2040	1.9
14 Tanzania	2.7	3.4	3.5	20	26	36	117	2030	2.0
15 Benin	2.6	2.7	3.3	4	5	7	23	2035	2.0
16 Central African Rep.	1.6	2.1	2.8	2	3	4	13	2040	1.9
17 Guinea	1.5	2.0	2.4	6	7	9	28	2045	1.8
18 Madagascar	2.2	2.6	3.2	9	12	16	54	2035	1.9
19 Togo	3.0	2.6	3.3	3	4	5	17	2035	2.0
20 Ghana	2.3	3.0	3.9	12	17	24	83	2030	2.0
21 Kenya	3.2	4.0	4.4	18	26	40	153	2030	2.1
22 Sierra Leone	1.7	2.0	2.4	3	4	5	16	2045	1.9
23 Mozambique	2.1	4.3	3.4	13	17	24	82	2035	2.0
Middle-income oil importers	2.7 w	3.3 w	3.3 w	57 t	74 t	101 t			
24 Sudan	2.2	3.2	2.9	20	25	34	112	2035	1.8
25 Mauritania	2.3	2.3	2.6	2	2	3	8	2035	1.8
26 Liberia	3.2	3.5	3.5	2	3	4	12	2030	1.8
27 Senegal	2.3	2.7	3.1	6	8	10	36	2040	1.9
28 Lesotho	2.0	2.4	2.8	1	2	2	7	2030	1.8
29 Zambia	2.6	3.1	3.6	6	8	11	37	2030	2.0
30 Zimbabwe	3.6	3.2	4.4	8	11	16	62	2030	2.1
31 Botswana	2.6	4.3	3.6	1	1	2	6	2025	1.9
32 Swaziland	2.7	3.2	3.9	1	1	1	5	2030	2.0
33 Ivory Coast	3.7	4.9	3.7	9	12	17	58	2035	2.0
34 Mauritius	2.2	1.4	1.6	1	1	1	2	2010	1.8
Middle-income oil exporters	2.4 w	2.6 w	3.4 w	111 t	144 t	203 t			
35 Nigeria	2.5	2.6	3.5	91	119	169	618	2035	2.0
36 Cameroon	2.0	3.0	3.5	9	12	17	65	2035	1.9
37 Congo, People's Rep	2.4	3.0	3.8	2	2	3	10	2025	1.9
38 Gabon	0.4	1.4	2.6	1	1	1	3	2035	1.7
39 Angola	2.1	2.5	2.8	8	10	13	44	2040	1.9
Sub-Saharan Africa	2.4 w	2.8 w	3.3 w	385 t	496 t	690 t			
All low-income countries	2.3 w	1.9 w	1.7 w	2,269 t	2,621 t	3,097 t			
All lower middle-income countries	2.5 w	2.5 w	2.4 w	673 t	816 t	1,023 t			
All upper middle-income countries	2.6 w	2.3 w	2.1 w	490 t	588 t	718 t			
Industrial market economies	1.1 w	0.7 w	0.4 w	723 t	749 t	780 t			

Note: For data comparability and coverage see the technical notes.

a. For the assumptions used in the projections see the technical notes.

Source: The World Bank, Toward Sustained Development in sub-Saharan Africa. World Bank, Washington, D.C. September 1984.

Annex D

Agricultural ResearchAID Annual Funding Levels per Commodity - FY 1984
(Obligations)

<u>Commodity</u>	<u>Regional</u> \$000 (%)	<u>Bilateral</u> \$000 (%)	<u>IARCs</u> \$000 (%)	<u>Cent-Fund</u> \$000 (%)	<u>CRSPs</u> \$000 (%)	<u>Total Ann</u> \$000 (%)
Cereals	18,820 (84)	35,410 (70)	5,330 (37)	840 (42)	2,330 (44)	62,730 (72)
Roots/ tubers	540 (2)	3,730 (7)	2,300 (16)	180 (9)	- -	6,750 (6)
Pulses (legumes)	2,500 (11)	2,250 (4)	1,870 (13)	140 (7)	1,640 (31)	8,400 (7)
Oilsds/ Hort	- -	1,200 (2)	290 (2)	160 (8)	510 (10)	2,180 (2)
Animals	540 (2)	8,410 (17)	4,610 (32)	680 (34)	800 (15)	15,040 (13)
TOTALS	22,400	51,000	14,000	2,000	5,300	95,100

Source: Africa Bureau and Science and Technology Bureau, AID

Annex E

External Funding for Agricultural Research to Africa 1976-80 ^{1/}
 (Constant 1975 U.S. 000 dollars deflated from 1981 IMF Yearbook)

	<u>1976</u>	<u>1980</u>
Australia	--	--
Belgium ^{2/}	n.a.	5,552
Canada	11,877	6,932
Denmark	--	59
Finland	11	5
France	30,589	42,090
Japan	32	297
Netherlands ^{3/}	2,824	5,289
New Zealand	--	--
Norway	52	1,918
Sweden	608	1,737
Switzerland ^{3,4/}	567	234
W. Germany ^{4,5/}	4,827	4,827
United Kingdom ^{4/}	978	302
United States ^{4/}	5,800	72,000
Total Bilateral	<u>58,165</u>	<u>141,242</u>
EEC	n.a.	8,700
IBRD	2,660	18,500
IDB ^{5/}	--	--
UNDP/FAO ^{4,5,6/}	n.a.	23,300
Total Multilateral	<u>2,660</u>	<u>50,500</u>
Total Bilateral and Multilateral	<u>60,825</u>	<u>191,742</u>
CGIAR System	--	--
Overall Total	<u>60,825</u>	<u>191,742</u>

^{1/} Does not include base costs of technical assistance organizations of donor countries or agencies.

^{2/} Data provided for 1980 only.

^{3/} Includes contribution to core budgets of CGIAR.

^{4/} Includes some global projects not identified by region.

^{5/} Five-year total pro-rated by year.

^{6/} UNDP data for regions apply only to FAO; additional allowance for non-FAO projects included in 1976 and 1980 UNDP totals.

Sources of data: Country reports to FAO and/or IFPRI; World Bank, UNDP, FAO data supplied to IFPRI, IDB data supplied to IFPRI, Bilateral Agency Reports, Marchés Tropicaux (France). Compiled by Peter Oram of IFPRI.