Chapter 3

Issues in Technology Development

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The best hope for increasing food supplies in Africa lies with the low-resource farmers and herders who provide an overwhelming proportion of the region's food. Yet can these people be helped to increase their production enough to feed today's populations, let alone the additional millions who will be added as Africa's population grows?

American expertise can have a role in this effort. This section explores the types of technology needed to face this future growth, including the role agricultural research plays in developing suitable technologies. In particular, it looks at what types of technology are suitable for African cultures and environments. Later sections of this report focus on issues in technology transfer, technical assistance, and the responsibilities of the African governments themselves.

The issues examined here include the suitability of existing technologies and their appropriateness for conditions likely in Africa's future, the indirect role that nonagricultural technologies can serve to increase food production, how the United States and other nations can best share their scientific and research expertise, how current research information can be shared most effectively, and the need for food producers to have an expanded role in planning and implementing agricultural research.

Issue 1: Many technical solutions introduced into sub-Saharan Africa for food production are not suitable for present conditions nor for conditions likely to prevail in the near future.

Preliminary Findings

- Increased food production requires increased use of well adapted existing technologies and new ones. The most suitable technologies probably will be consistent with traditional African agricultural methods, reflect local conditions, be affordable, locally produced and repairable, and involve low risks and low inputs.
- Large demographic changes are under way in Africa, and innovative agricultural technologies relevant to these changes—e.g., urban agriculture—are needed but largely unexplored.
- Few technologies have been designed for low-resource food producers who generally seek to minimize risk rather than maximize production. A growing consensus is emerging that developing these technologies deserves high priority.
- Technology development should consider the status of the natural resource base, its inherent capabilities, and the potential impacts of new technologies, but often this is not done. Resources are degraded or susceptible to degradation in many parts of Africa. Important differences exist between the African and U.S. resource base.
- An integrated or "systems" approach to technology development is promising but seldom taken. Too often technologies are developed piecemeal with little regard for long-term sustainability. For example, work on crops and trees is not integrated with animal production systems even though many producers combine them.
- The social and cultural situations into which technologies are introduced are vital but often overlooked—e.g., often women's unique roles in African agriculture, pastoralism, and forestry are underemphasized.
- Conditions in the United States are significantly different, ecologically and socially, for most agricultural technology developed in the United States to be transferred directly to sub-Saharan Africa. Much U.S. technology requires levels of technical and managerial support that now cannot be met in Africa.
- Expanded agricultural research is needed on traditional staple food crops and small-scale food production instead of continued emphasis on cash crops.

Discussion

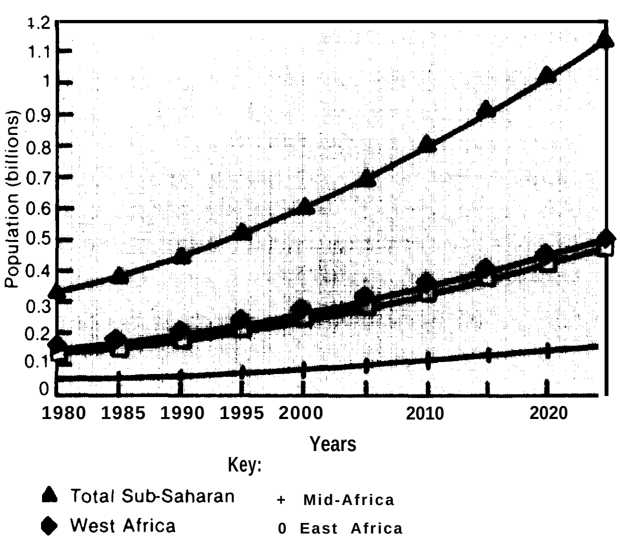
The decline in per capita food production in Africa has stimulated a reexamination of the types of **agricultural** technology chosen for development and transfer. Hindsight has shown that introduction of Western technologies into peasant communities often has proved inappropriate (Altieri, 1984; Harwood, 1979). Some agricultural technology has worked against the natural resource base, further undermining food production (Commins, 1984; Twose, 1984). Also, population distribution between inland/coastal and rural/urban areas is shifting and total population is increasing rapidly (figs. 5 and 6). As such, specialized technologies may be needed to produce sufficient food. Large demographic shifts, continuing environmental degradation, as well as numerous project failures, suggest that some changes in technology development are needed.

A consensus is emerging on the kinds of technology most needed to meet Africa's future food needs. Participants in OTA's workshop described these technologies as: low risk, resource-conserving, small-scale, locally produced, affordable, easily repaired, and based on traditional methods. Also, technologies must be suited to labor conditions because "production cycles alternate short periods of intense work, requiring a *seasonally* effort-saving form of investment and input, with long periods of 'underemployment' " (Lipton, **1977c).** Participants also noted, however, that many technologies must be tailored to the particular site of application and the expected users. Therefore, generalizations cannot be made about the best technology for all types of production, regions, and countries because of the varied conditions and varied agricultural production systems.

The adaptation and use of traditional agricultural methods is expected to be an essential starting point (U.N. FAO, April 1984; Wad, 1984). Traditional agricultural systems include: agroforestry, multiple cropping, minimum tillage, cover cropping, living mulches, small-scale irrigation, and large and small livestock management. Commonly, traditional technologies have been overlooked by researchers, governments, and donors despite their prevalence and advantages. For example, 98 percent of cowpeas grown in Africa are interplanted with other crops (Francis, et al., 1976). Yet intercropping has received little research attention. This is a traditional technology to:

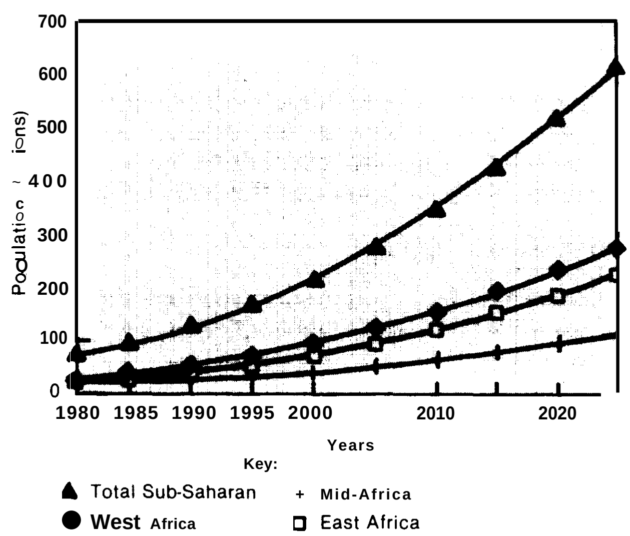
> . . . promote diversity of diet and income source, stability of production, minimization of risk, reduced insect and disease incidence, efficient use of labor, intensification of production with limited

Figure 5.— Population Projections for Sub-Saharan Africa: 1985-2025



SOURCE: United Nations Population Projections, Medium Variant, 1980.

Figure 6.—Urban Population Projections for Sub-Saharan Africa: 1985-2025



SOURCE: United Nations Population Projections, Medium Variant, 1980.

Photo credit" George Scharffenberger, OTA

Traditional agricultural methods are appropriate starting points for developing improved agricultural technologies. IITA is researching the traditional risk-reducing, yet efficient, practice of intercropping (e. g., cowpeas and cassava).

resources and maximization of returns under low levels of technology (Altieri, 1983).

Kitchen gardening, an agricultural activity performed almost exclusively by African women, is another largely neglected traditional technology. These gardens often contribute to household income, show higher per-acre yields than field crops, and are the places where producers experiment with new seeds, new inputs, and new planting technology. Yet often they are perceived by donors and researchers as women's hobbies and usually do not receive funding, inputs, technical assistance, nor research in proportion to their importance (Tendler, 1982).

Urban agriculture is another use of traditional technologies that may be of increasing importance. Almost all African countries are urbanizing more rapidly than other low- and middle-income countries while overall development is slower; most growth is occurring in each country's largest city (PADCO, 1982). Many urban residents face problems obtaining affordable and reliable food supplies, although food prices have been kept artificially low in many urban areas. Urban Resource Systems, Inc., estimates that the incidence of malnutrition is accelerating more rapidly in cities than rural areas of developing countries and that the urban poor consume fewer food calories than their rural counterparts.

"Meanwhile, for millions of the urban poor, the potential capacity of the urban system to produce food may be a factor on which their survival may hinge" (Boyden and Celecia, 1981; Nelson and Mandl, 1978). Methods such as intensive cultivation, rooftop gardening, comporting, urban forestry, irrigation using renewable energy for pumping, aviculture, and aquiculture can be used to increase urban food supplies.

Urban agriculture projects exist in some African countries, their contribution to nutrition is documented, and their special importance during food shortages is easily observed (see Urban Resource Systems, Inc., 1984). For example, open lands are used by the unemployed to grow vegetables and fuelwood in Addis Ababa, Ethiopia (OXFAM, 1983; Wade, 1983). The City Council in Lusaka, Zambia, began an Urban Agriculture and Nutrition Project in 1977 (Wade, 1983), receiving some assistance from UNICEF and an American PVO.

This program maintains demonstration vegetable gardens in several squatter settlements and on urban fringe lands. Lusaka planned a special urban agriculture and nutrition service to promote urban food production (Ledogar, 1978). Home food production also is part of a local development plan for areas near Douala, Cameroon (Barbedette, 1978).

Steady use of many kinds of existing technologies during the 1980s and 1990s could increase food production substantially. First, however, African countries would need to determine and eliminate non-technological constraints, **such as** pricing policies. Africa also faces a number of special technical problems requiring new technological approaches. Important research areas include: plant breeding for unfavorable environments, **soil and water conservation, environ-** mental **monitoring, mechanization, fodder crops,** livestock immunization, fisheries estimates, and livestock management. The aim should be:

> . . . small scale but highly productive and ecologically sound permanent farming systems that not only take advantage of such modern inputs as better varieties, mineral fertilizers and mechanical equipment, but also make full use of crop residues for animal feedings, and of crop and animal residues and nitrogen-fixing crops to maintain fertility. These are likely to be increasingly based on the close integration of crop, livestock and forestry production, and in some cases fish production as well (U.N. FAO, April **1984).**

Research to help develop such technologies seems to be scarce. As much as 98 percent of the

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world's modern technological capacity is concentrated in the industrialized countries (Singer, 1977). An estimated 90 percent of all scientific research conducted worldwide takes place in developed countries and is directed specifically to their own needs (Perez, 1978).

Trends in American agriculture make it unlikely that most U.S. technologies will be appropriate for Africa. U.S. research on small farms, for example, comprises only a fraction of the annual Federal research budget. Plant breeders in the United States generally have not sought to adapt crops to unfavorable environmental conditions (Boyer, 1982) and research on technologies to limit farm and ranch inputs such as water, fertilizers, and pesticides has not received much attention. A few notable exceptions exist, however, such as research conducted at the Rodale Research Center in Pennsylvania (U.S. Congress, OTA, Oct. 1983). Some experts contend, though, that the technical feasibility of developing "low-input" technology for agriculturally marginal areas is unknown (Ruttan, 1982).

Much American agricultural technology has been described as "high tech. " It involves complex and expensive machinery, integration of large amounts of information from distant sources, and high managerial skills. These features significantly limit its applicability in Africa. In addition, U.S. climate, soils, natural vegetation, and domesticated animals are different in important ways from those in Africa. Therefore, American technology commonly is not suitable for direct transfer overseas, and care must be taken to evaluate its suitability before introduction.

Some argue, however, that much developed-country research is adaptable or transferable to developing countries. Authors of the 1971 U.N. World Plan of Action called for developed countries to divert a specified part of their domestic research efforts toward technology appropriate for developing countries (Singer, 1977). Basic research on plant and animal physiology is one example. If U.S. universities conducted research on important African crops, the results would be expected to be useful in Africa.

In fact, however, Africa's staple food crops have not received major research worldwide (U.N. FAO, April 1984) and different uses of the same crops in different countries may limit widespread use of research results. Sorghum, for example, is used in the United States for livestock feed and syrup. In Africa, it is used for human food and brewing beer. These uses require different crop research strategies. Research programs for millet, cassava, yams, cowpeas, and open-pollinated corn have begun only recently, and "the scale of worldwide research effort on individual staple food crops has been in inverse ratio to their importance in Africa" (U.N. FAO, April ***1984).***

U.S. technology, in its broadest definition, is used extensively to train many African agricultural students in the United States. Such training is often inappropriate for the conditions to which the students will return. Thus the need to provide education and training ***in Africa*** is stressed increasingly. U.S. training is likely to remain necessary in the short term until African educational institutions can fully develop. Indigenous institutions, American faculty, and foreign students in the U.S. could benefit if foreign graduate students at American universities conducted research in their own country or in countries having similar environments.

Congress has attempted to encourage a new generation of technologies for developing countries. In 1975, the Agency for International Development (AID) was directed to support the development and dissemination of "capital-saving technology" in section ***107*** of the International Development and Food and Assistance Act. AID defined this as technology that: requires little capital per worker, is small-scale, easily replicable, easily serviced and operated by untrained users, and involves local people and resources. AID responded by establishing a private nonprofit group, Appropriate Technology International (ATI), providing policy directives to missions, and designing two systems to make technological information available to project staff.

Despite this encouragement, problems in developing, introducing, and using such technologies continue. An analysis conducted by the General Accounting Office (U.S. GAO, 1984) found that AID's management does not encourage use of capital-saving technology, that the information systerns have severe weaknesses, and that ATI is used little by AID country missions. Another analysis found that capital saving technology projects compared favorably with "appropriate technology" projects in the United States but almost all were plagued by planning and/or implementation problems (Associates in Rural Development, 1982). AID evaluated ATI's worldwide work in 1982 and found that it seems to have had little impact in the four African countries studied, but the potential is growing in Kenya (Samper, **1982).**

Issue 2: The development of some types of nonagricultural technologies is important to enable women farmers and herders to increase food production as well as to ensure that foreign assistance reaches the poorest rural residents.

Preliminary Findings

- Poor rural residents without land may benefit more from nonagricultural assistance and technologies—e.g., income-generating projects such as soap-making or crafts.
- Certain labor-saving household technologies could allow women producers to devote more time to agriculture. These include improved water systems, more accessible fuelwood supplies, and improved methods for processing, storing, and preserving foods.
- Improved human and animal health also are important factors in increasing food production.

Discussion

With the New Directions legislation of 1973, the goal of helping those most in need in developing countries became an explicit part of U.S. foreign assistance. The results of this directive are far from clear, however, and questions remain about the size and structure of the poorest populations in sub-Saharan Africa and elsewhere (Tendler, 1982). These unanswered questions have important implications for technology development. A large part of the income of the poorest farm households may be earned in nonagricultural activities (Chuta and Liedholm, 1984). For these people, activities such as small-scale trading, crafts, fishing, and peddling, may be important (Tendler, **1982).** Only some of these activities require agricultural technology.

Time to devote to agriculture can be a limiting factor for women producers in Africa. Increasing agricultural production may depend, therefore, as much on developing improved technology to save them time in other activities and at crucial periods during the growing season as it does on improved agricultural technology.

Most rural African women work **9** to 10 hours a day in the fields, then spend as many as 7 or **8** more hours fetching water, collecting and carrying fuelwood, looking after children and the

Photo credit: World Bank Photo by Ray Witlin

A woman in Burkina Faso roasting groundnuts while watching her child. Nonagricultural technologies that reduce some of the labor constraints that women face in fuelwood and water collection could allow them more time for agricultural activities.

elderly, cooking and preserving food, and helping to store and market crops (Carr, 1978). Also, they may grow vegetables or make soap to earn cash for school fees and food items such as salt and sugar. And they take part in community projects such as building roads.

Technologies intended to provide lighting and increase the efficiency of cooking have attracted much attention as ways to lighten women's burdens. Planners felt that improved stoves, for example, could decrease alarming deforestation and reduce time spent on fuelwood collection. Many of these projects have been less successful than was hoped, however. It seems that the time women spent collecting fuelwood and the magnitude of deforestation attributed to their activities were overestimated (Tinker, 1982). In addition, sometimes the perceived needs of women differed from what projects offered. More recent efforts—e.g., to introduce solar ovens and make simple adjustments to currently used stoves—are more successful (Tinker, 1982).

African women themselves have identified the need for new water technology to ease the burdens of carrying water daily for drinking, cooking, washing, and irrigation:

> Evidence shows that life for the rural woman has been getting harder over recent years. Worsening drought conditions in many African countries mean that women have to walk further distance and for more months during the year to collect water. A recent study in Ethiopia revealed that in 75 percent of the households under survey, the women spent 3 hours or more on a single journey to collect water. Women in many villages in Upper Volta set out to collect water at dawn and rarely return with their daily supply before noon (Carr, 1978).

Evidence exists that food production may increase when water technology improves. In Kenya, for example, the installation of tin roofs for rainwater collection saved 2 to 10 hours per day per household. Women expanded their gardens and raised more chickens and pigs for urban markets as a result (Tinker, 1981).

African women also have noted the need for technologies suited for transporting small loads of fuelwood, water, and produce, and improved technologies for food processing. The latter include grinding mills for producing flour from corn, millet, sorghum, and rice, a task that can take 1 to 2 hours each day (Carr, 1978). Some estimates suggest that food processing and preparation take more time and energy than either collecting firewood or water (Tinker, 1982).

Considerable evidence exists that disease is an impediment to agricultural development and thus food production in some parts of Africa (Ruttan, May **1984).** Agriculture is impossible due to onchocerciasis (river blindness) in some fertile *river* valleys in West Africa. It appears that disease vectors increase as cultivation increases, eventually causing abandonment of the cleared land. Trypanosomiasis, carried by the tsetse fly, is a serious public health problem, and it makes livestock production impossible on approximately **6** million square miles of land. Technologies are available to prevent or cure some tropical diseases but often their application is costly. Research in biotechnology may make new low-cost technologies available but its application is, in some cases, decades away (U.S. Congress, OTA, 1985).

Issue 3: Disagreement exists regarding the optimal way for the United States to support scientists and provide funds for research on African food production.

Preliminary Findings

- An integrated system of national and regional agricultural research institutions in developed and developing countries tied to the international research network has great potential but has yet to be achieved.
- U.S. contributions of personnel and funds to the International Agricultural Research Centers have been vital to their substantial successes.
- National agricultural research centers in Africa need strengthening and this could require a major U.S. commitment.
- American institutions have played and continue to play important roles in educating African scientists. The tailoring of certain programs could be improved to fit the situations students face at home—e.g., by providing in-country

training or training in comparable developing countries.

- Few U.S. universities can sustain the long-term commitment required for African technology development and transfer because: 1) funding is tied to short-term contracts and assignments, 2) the number of American scientists with training and experience under conditions different from the U.S. temperate zone is limited, and 3) few U.S. universities and colleges provide incentives for faculty to conduct overseas agricultural research.
- Arguments exist regarding the best roles for American scientists and universities to play in African development. Some universities are attempting to "internationalize" their charters and to increase their involvement in development. At the same time, some developing countries seek to decrease the role of expatriates, limiting opportunities for U.S. personnel.
- Non-land grant universities and smaller land grant institutions have not played a large part in international agricultural development efforts.
- The 1890 colleges have conducted research for small, low-resource farmers in the U.S. Their expertise may prove to be relevant to developing countries. Long-term overseas work may jeopardize their local programs, however, because their scientific staff usually is small.

Discussion

Many experts acknowledge that the global agricultural research system has weaknesses that need to be improved (Eklund, 1983; World Bank, 1984a). However, they have not agreed on the best way to achieve this nor the optimal roles of the different institutions that comprise the system: the international agricultural research centers, national and regional agricultural research institutions in Africa, and developed-country research facilities, especially universities.

Most American assistance for multilateral agricultural research is channeled through the global network of international agricultural research centers funded by the Consultative Group on International Agricultural Research (CGIAR). Thirteen centers exist; four are located in Africa and most of the others have significant programs there (table 3; app. A). The United States has provided 19 to 28 percent of the annual core funding for CGIAR since 1972 (CGIAR, 1983).

The Centers have contributed to increases in food production in developing countries and generally are regarded as successful innovations (Schultz, 1984). Their greatest impact has been in breeding high-yielding varieties of wheat and rice (Plucknett and Smith, 1982). The perception exists that they have made the "easy" research gains, though, and are beginning to lag in using recent biological advances (Ruttan, 1983), Funding is expected to remain relatively constant after spectacular increases in the 1970s.

Debate continues regarding the proper level and form of U.S. support for CGIAR. Some note the increase in U.S. bilateral assistance and fear that the longstanding U.S. commitment to CGIAR is waning (Scharffenberger, 1984). On the other hand, some U.S. university officials contend that AID allocates money to the international centers at the expense of support for American institutions (Campbell, 1983).

Most experts, however, recognize the need for a cooperative, not competitive, global agricultural research system. Also, a consensus exists that national and regional facilities in Africa deserve increased support in order to make the entire system most effective (Lele, 1981; World Bank, 1984a). Links between the international and national centers are important as well as links among national institutions (Ruttan, Sept. 1984).

National agricultural research centers in developing countries expanded greatly in the last decades. Most of the growth occurred in a few countries, however, and Nigeria is the only African nation among them. Ruttan (Sept. ***1984)*** lists several concerns regarding these national efforts in Asia, Latin America, and Africa:

- investment in facilities appears to exceed that in scientific staff development,
- administrative burdens stifle research,
- frequently locations are chosen without adequate regard for factors that contribute to success,
- often research budgets do not reflect the economic importance of particular commodities,

Table 3.-Centers Supported by the CGIAR, 1984

Acronym (year established)	Center	Location	Research programs	Geographic focus	1984 budget[a] (millions of dollars)
IRRI (1960)	International Rice Research Institute	Los Banes, Phillipines	Rice	Global	225
			Rice based cropping systems	Asia	
CIMMYT (1966)	Centro International de Mejoramiento Maiz y Trigo	Mexico City, Mexico	Maize	Global	**21,0**
			Bread wheat	**Global**	
			Durum wheat	**Global**	
			Barley	**Global**	
			Triticale	**Global**	
IITA (1967)	International Institute of Tropical Agriculture	Ibadan, Nigeria	Farming systems	Tropical Africa	21 2
			Maize		
			Rice		
			Sweet potato, yams	Global	
			Cassava, cowpea, lima bean, soybean	Tropical Africa	
CIAT (1968)	Centro International de Agricultural Tropical	Cali, Colombia	Cassava	Global	23,1
			Field beans	Global	
			Rice	Latin America	
			Tropical pastures	Latin America	
CIP (1971)	Centro International de la Papa	Lima, Peru	Potato	Global	109
WARDA (1971)	. West African Rice Development Association	Monrovia, Liberia	Rice	West Africa	2 9
ICRISAT (1972)	International Crops Research Institute for the Semi-Arid Tropics	Hyderabad, India	Chickpea	Global	221
			Pigeonpea	Global	
			Pearl millet	Global	
			Sorghum	Global	
			Groundnut	Global	
			Farming systems	Semi-Arid tropics	
ILRAD (1973)	International Laboratory for Research on Animal Diseases	Nairobi, Kenya	Trypanosomiasis	Global	***9.7***
			Theileriosis	Global	
IBPGR (1974)	International Board for Plant Genetic Resources	Rome, Italy	Plant genetic sources	Global	3 7
ILCA (1974) .,	International Livestock Center for Africa	Addis Ababa, Ethiopia	Livestock production systems	Tropical Africa	12,7
IFPRI (1975)	International Food Policy Research Institute	Washington, DC, U.S.A.	Food policy	Global	4 2
ICARDA (1976)	International Center for Agricultural Research in the Dry Areas	Aleppo, Syria	Farming systems	Dry areas of West Asia and North Africa	20.4
			Wheat, barley, triticale, broad bean, lentil, chickpea, forage crops		
ISNAR (1980)	International Service for National Agricultural Research	The Hague, Netherlands	National agricultural research	Global	**35**

[a]CGIAR Supported core budget, net of capital, at the bottom of the bracket (from 1983 Integrative Report)

SOURCE: Consultative Group on International Agricultural Research 'The CGIAR in Africa " Washington, DC 1984

- analysis of research priorities is not well-informed,
- leaders of some research systems appear to presume that research can be done without scientists,
- a number of national systems are vulnerable to cycles of donors' development policies.

Ruttan notes further that both African governments and donors will face critical questions as they develop national agricultural research facilities. Most smaller countries, with populations ranging from 2 million to 10 million, have the resources to develop their own research systems in 10 to 20 years. National research systems in smaller developing countries, such as Sierra Leone, may require a generation to reach their ultimate size—little larger than a branch station in Texas. They will remain dependent on the international agricultural research centers, multinational firms, and developed countries for much agricultural technology. But they need the scientific capacity to draw on the global research system.

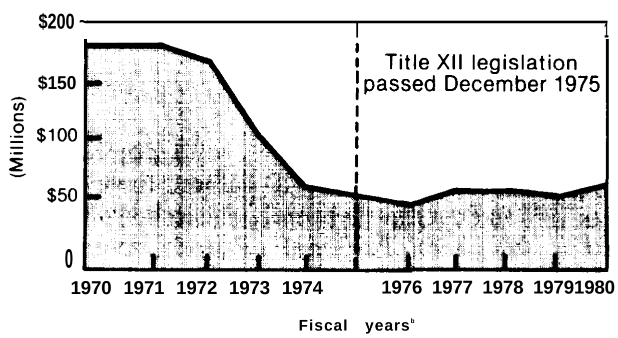
U.S. universities are an important part of that global system and have been involved in international work for decades. Massachusetts State College worked with Japan in 1876; other universities followed in the early 1900s. The pace accelerated after 1949, when President Truman dedicated the United States to helping developing countries. Large numbers of U.S. university faculty work in developing countries now. Washington State University, for example, has formal exchange agreements with 17 countries, and more than 120 faculty had foreign assignments in 1983 (Yates, 1984).

The type of international work that universities conducted has shifted with time. **In the 1950s many universities attempted to transfer American agricultural technology directly. By the 1960s their attention shifted to institution-building. These activities decreased and research efforts increased in the late 1960s and early 1970s when AID funding for universities peaked (figs. 7 and 8). More recently, universities and individual American scientists have worked with the global network of international agricultural research centers and contracted for AID mission-oriented work (Perez, 1978).**

Many evaluations of universities' involvement in international activities were completed in the 1960s and 1970s. U.S. personnel made a large contribution to overseas successes, but some common problems were noted. These included: lack of long-term planning, difficulties in the AID / university relationship; lack of social, cultural, and political sensitivity on the part of the U.S. personnel; lack of planning and coordination by funders, universities, and developing country institutions; and inappropriate education for developing-country students in the United States (Perez, 1978). Some of these evaluations recommended new American institutions to remedy these problems. The Gardner Report (1964), for example, suggested forming a National Institute for Education and Technical Cooperation to take over U.S. development-related research and mobilize university involvement in developing countries.

The Federal Government provides substantial assistance to U.S. universities for international agricultural development. Few State governments have supplied the charter or the funds for similar efforts. Citizens in some States feel that their universities should work on State problems and that international work leads to increased competition for markets between local farmers and ranchers and their developing country counter-

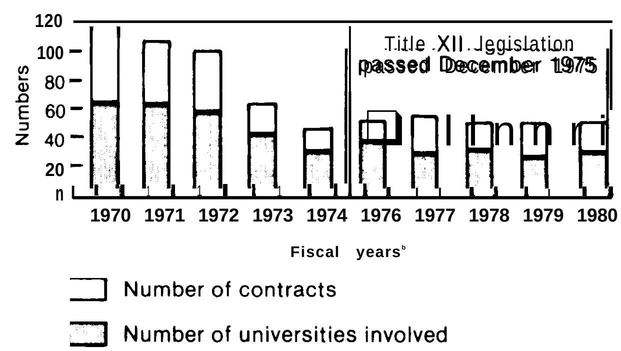
Figure 7.—AID-Financed University Contracts and Grants for Technical Assistance to Host Countries–In Millions, Fiscal Years 1970-8@



[a]Data do not include AID grants and loans involving host country contracts with U.S. universities.
[b]Data for fiscal year 1975 are not available.

SOURCE: General Accounting Office, *AID and Universities Have Yet to Forge an Effective Partnership to Combat World Food Problems, ID-82-3,* Oct. 16, 1981.

Figure 8.—AID-Financed University Contracts and Grants for Technical Assistance to Host Countries—In Numbers of Contracts and Institutions, Fiscal Years 1970-80[a]



[a]Data do not include AID grants and loans involving host country contracts with U.S. universities.
[b]Data for fiscal year 1975 are not available.

SOURCE: General Accounting Office, *AID and Universities Have Yet to Forge an Effective Partnership to Combat World Food Problems, ID-82-3,* Oct. 16, 1961.

parts. A few State universities, however, have changed their original charters to reflect their view of more global responsibilities, and Federal programs have increased universities' interest and ability to fulfill them.

> The university must provide educational opportunities that will enable the citizens of our state and nation to make sound decisions based on an awareness of the global environment in which we live and work , . . .Our students and clientele [must be] able to see the relationships that will continue to bind this country more closely to the global community . . . this 1 believe to be one of the premier responsibilities of the global university (Yates, Executive Vice President and Provost, Washington State University, 1984).

Title XII of the Foreign Assistance Act, passed in 1975, provides the rationale and means by which universities have become more involved in international agricultural research and development. It committed U.S. universities and colleges to help soIve food problems in developing countries. The General Accounting Office reports that "Title XII has been instrumental in bringing new vigor and awareness to international work in the U, S.-university community" (U.S. GAO, 1981). But GAO also notes that U.S. universities have limited capacity to take part effectively in these AID programs due to deterrents to faculty overseas assignments, sporadic funding from AID, income tax burdens on faculty, and cumbersome AID contracting procedures. AID faces similar constraints due to skepticism in AID missions about the relevance of involving U.S. universities as "partners in development" and some experiences with poor university performance.

Some universities have not been drawn into this international work extensively, and concerns exist that Title XII contracts are awarded on the basis of geographic politics more than expertise. In addition, some technologies—e.g., biotechnologies —are being developed largely outside of the land-grant system in private universities and research firms. This raises questions whether certain technologies may be unavailable to developing countries because of the funding structure for international agricultural work in the United States. Similarly, some experts contend that the 1890 Land Grant Colleges (table 4) have not participated in overseas research in proportion to their potential. Since their creation, the 1890 institutions have been involved extensively in domestic community development under conditions that parallel those in developing countries (Williams, 1979). Shortage of qualified personnel, however, has led them, like some other universities, sometimes to substitute outside contractors on AID

Table 4.—The 1890 Institutions Were Added to the Land-Grant System to Compensate for Exclusion of Blacks From the 1862 Land-Grant Universities

Institution	Location
Alabama A&M University	Normal, AL
Alcorn State University	Lorman, MS
University of Arkansas—Pine Bluff	Pine Bluff, AR
Delaware State College	Dover, DE
Florida A&M University	Tallahassee, FL
Fort Valley State University	Fort Valley, GA
Kentucky State University	Frankfort, KY
Langston University	Langston, OK
Lincoln University	Jefferson City, MO
University of Maryland-Eastern Shores	Princess Anne, MD
North Carolina A&T	Greensboro, NC
Prairie View A&M University	Prairie View, TX
South Carolina State College	Orangeburg, SC
Southern University	Baton Rouge, LA
Tennessee State University	Nashville, TN
Tuskegee Institute	Tuskegee, AL
Virginia State College	Petersburg, VA

SOURCES B D May berry, "Mechanisms for the Delivery of Appropriate Technology —Extension," *The* Unique *Resources* of *the 1890 Land-Grant Institutions and Implications for International Development,* Thomas T. Williams (ed) (Baton Rouge, LA: Southern University Unemployment-Underemployment Institute, 1979), p 42; Southeastern Consortium for International Development, Washington, DC projects and has resulted in an uneven achievement record.

U.S. agricultural colleges are in transition, with more women, minority, and urban students entering. The effect of these trends on the conduct and content of domestic and international research and development activities is unknown.

Issue *4:* Research information on science, technology, and development is less effective than it could be because it is not adequately coordinated, shared, or disseminated.

Preliminary Findings

- Limits to the flow of research information result in needless duplication of effort and slower progress.
- Research findings sometimes are not disseminated across national boundaries and institutional affiliations.
- Advancing information technologies, such as communication satellites and microcomputers, have the potential to make large amounts of information available at low cost to users scattered around the world.
- This potential remains largely unrealized in developing countries because many lack the infrastructure to provide adequate power or to repair programming.

Discussion

Leaders in developing countries called upon the U.N. Education, Scientific, and Cultural Organization (UNESCO) for a "new world information order. " One of their concerns was ensuring access to information technology. Evidence exists that problems with sharing information continue and that some of the thornier policy issues remain. For example, problems are expected to arise from different national philosophies and laws regarding flow of data and from connecting information systems across national boundaries (U.S. Congress, OTA, 1981).

Traditional methods of sharing agricultural information exist and some contend that international cooperation in agricultural research is increasing. Today, some 100 international agricultural networks exist worldwide, ranging from international nurseries to teams working on specific problems (Plucknett and Smith, 1984). Communication problems affect these groups, although most publish newsletters and hold workshops to disseminate their findings. Feedback within the network may be slow and links between networks and outside scientists may be weak.

Information dissemination on small-scale technologies is considered critical. Both Volunteers in Technical Assistance (VITA) and Volunteers in Asia organize data bases on these technologies (U.S. AID, 1981). The nature, scope, and level of information needed by various recipients varies as widely as the sources of information. "To build reliable, comprehensive, and up-to-date services is obviously a major undertaking and will be quite costly" (Singer, ***1977).***

Groups such as the United Nations Industrial Development Organization (UNIDO) and the International Development Centre in Ottawa, Canada, also stress the need for information technologies as development tools. In March, UNIDO suggested that developing countries build indigenous capabilities for information management. One concept it endorsed was a low earth orbit satellite as a low-cost communication tool for a variety of uses by widely scattered people (VITA, 1984). Uses might include broadcasting messages and transmitting documents, thus circumventing cumbersome international mails.

Satellite systems, like many contemporary communication technologies, rely on computers. While some developing countries have computer systems that are reliable, stories abound of computers idled because no one can use them or because simple repairs cannot be made locally. Agricultural problems in sub-Saharan Africa often result from the lack of basic infrastructure: services and facilities such as roads, tools, and repair and storage facilities may be missing. The role for elaborate technology such as computers and satellites and their actual costs must be evaluated carefully if they are to compete for funds with infrastructural development.

Generally, the United States has well-developed services for sharing agricultural research information via mail systems, telephones, libraries, and publishing houses, and the United States is a leader in advanced electronic communications. These systems are being used to benefit African countries, but problems remain. For example, computer use in the United States by government donors and private voluntary organizations (PVOs) is accelerating. Many PVOs face "significant problems in the selection of hardware and design of software" (Biddle, 1984). The Agency for International Development has a computerized system to make project descriptions and other information available. It is beset by problems, however, including lack of completeness, definitional inconsistency, and incompatibility with other data sets. The holdings of American libraries related to Africa are relatively weak. The Library of Congress, for example, does not have an extensive collection of African national documents (Moris, 1984).

Issue 5: Food producers have a limited role in agricultural research and this decreases the effectiveness of the research.

Preliminary Findings

- Experts increasingly call for greater producer involvement in identifying problems for research and in developing and testing new technologies.
- Examples suggest that this approach better ensures that research meets the needs of its users and increases the likelihood of a project's success.
- Methods of conducting and evaluating on-farm research are not well-developed.
- Many institutions working with subsistence producers are not structured to encourage involvement of farmers and herders.
- Participatory research and planning requires formal coordination among food producers, extension workers, and researchers.

Discussion

Experts in agricultural development have a growing belief that the present organizational framework of agricultural research and development does not serve the interests of many developing countries. This has prompted a search for new structures that will reach more rural people.

It is generally accepted that farmers and herders must be involved in later stages of technology transfer such as technology evaluation and extension. Studies of technology transfer in the last 30 years show that failure often resulted because clients were not involved effectively (Jedlicka, 1977).

Recent evidence indicates that producers' involvement in earlier stages—i.e., in identifying agricultural problems for investigation and planning and participating in research—is crucial also. Subsistence farmers have been effective in planning and designing research, especially in identifying important environmental features (Jedlicka, 1981). Also, farmers have carried out their own experiments, sometimes making agronomic breakthroughs before researchers (Howes and Chambers, 1979) and integrating biological, economic, environmental, and social factors in their decisions (Francis, 1981).

The challenge is to devise a system of research that involves small producers and integrates on-farm work with established national programs (Whyte, 1981). Some research of this type combines: 1) research on multiple cropping systems instead of monoculture, 2) research on the role of animals in farming systems, 3) on-farm testing in addition to experiment station work, 4) an emphasis on interdisciplinary collaboration, and 5) the participation of people responsible for extension and economic development.

This type of research has had some notable successes. The value of involving farmers in all stages of project work in Ethiopia, Egypt, Pakistan, and India has been noted (Lowdermilk and Lattimore, 1981). The unique vitality of Israeli agricultural research in which farmers are also researchers was identified recently (U.S. Congress, OTA, May 1983).

Numerous factors make such research difficult. These include nonsupportive research organizations and government agencies and the complexities of conducting on-farm research. Participatory research is a more complex form of interdisciplinary research and requires high levels of competence and experience. Few successful models of interdisciplinary research exist (Rhoades and Booth, 1983). Also, lack of political and administrative continuity among local groups and international donors is a major problem. Economic and cultural gaps between producers and researchers also may hinder cooperation.

In the United States, farmers and ranchers are involved in setting research priorities through government agency users' groups and through their representatives in farm, ranch, and commodity organizations. Attempts to involve the rural poor by developing similar organizations in Africa generally have not succeeded. Some attribute these failures to the imposition of organizations by "outsiders." They contend that meaningful participation must come about through the emergence of local people's own organizational choices, but few examples exist yet (Oakley and Marsden, 1984).