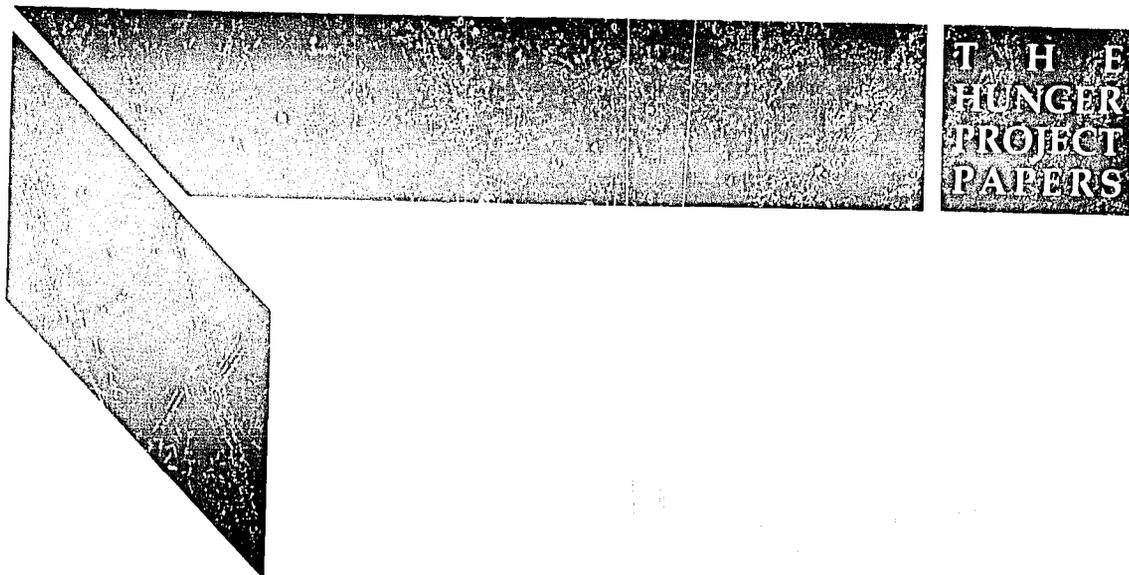


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THE  
HUNGER  
PROJECT  
PAPERS

# Transforming African Agriculture

CARL K. EICHER

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## ■ ABOUT THE AUTHOR

Carl K. Eicher is Professor of Agricultural Economics at Michigan State University, East Lansing, Michigan. Currently he is Visiting Professor of Agricultural Economics at the University of Zimbabwe, Harare, Zimbabwe, and Foreign Francqui Lecturer at the Catholic University of Leuven in Belgium for 1985-86.

Professor Eicher received his B.S. and M.Sc. degrees in Agricultural Economics from Michigan State University and his Ph.D. in Economics from Harvard University. He has served as a consultant for numerous organizations, including: the U.S. Agency for International Development, the National Academy of Sciences, the Economic Commission for Africa, the World Bank, the African Development Bank and the Food and Agriculture Organization of the United Nations.

In addition to teaching at Michigan State University and the University of Zimbabwe, Eicher has taught at Stanford University.

His research and consulting work has taken him to many countries in Africa, including Burkina Faso, Ethiopia, Ghana, Kenya, Niger, Nigeria, Rwanda, Senegal, Tanzania, Zambia and Zimbabwe.

Eicher has published widely on economic development with particular emphasis on some of the critical agricultural development issues facing Africa. These include: human capital, employment generation, technology transfer, agricultural research policy and food security.

His most recent papers and articles in-

clude the widely quoted "Facing Up to Africa's Food Crisis," *Foreign Affairs*, Vol. 61, Fall 1982, pp. 151-74; "Strategic Issues in Combating Hunger and Poverty in Africa," a background paper prepared for the Committee on African Development Strategies, New York, September 1985, to be published in *Strategies for African Development*, Robert J. Berg and Jennifer Whitaker, eds. (Berkeley: University of California Press, forthcoming in 1986); "Assessment of the CGIAR System in Africa," paper presented at the Annual Meeting of the Consultative Group on International Agricultural Research, Washington, D.C., October 28-29, 1985; and "Food Security Policy in Sub-Saharan Africa," co-authored with John M. Staatz, XIXth Conference of the International Association of Agricultural Economics, Malaga, Spain, August 25-September 5, 1985.

His most recent book is *Agricultural Development in the Third World*, co-edited with John M. Staatz, The Johns Hopkins University Press, 1984.

## SUMMARY

Today, 25 years after 1960—the year commonly referred to as the year of Africa's independence—a great deal has been learned about the nature of the development process, the role of agriculture in development, and the time that it takes to develop stable political systems, new technology and the managerial and technical capacity needed to absorb foreign assistance.

Although most African countries have the potential to feed themselves in the long run, Africa's food production has grown at only half its population growth rate from 1970 to 1984. Further, there is no immediate policy lever that can be pulled to slow down the population growth rate in the short run. The challenge facing African agriculture is to double the rate of growth of agricultural production over the next 15 to 20 years to keep up with population growth rates of 3 to 4 percent.

At present, most African states and donors do not have coherent and empirically grounded strategies for rainfed agriculture, irrigated farming and livestock production. Moreover, a careful assessment of the stock of food crop technology throughout Africa reveals a large gap between on-shelf technology and what is needed to double the rate of growth of food production.

What emerges from this analysis of food production and population is an overarching need to step up public investment (by Africans and foreign donors) in national research systems and universities over the next 10 to 20

years. In expanding the knowledge base about African agriculture, public investment in agricultural research is an important part of the process. Investment in science and technology will become even more important as African countries pass through the frontier stage into an era of science-based intensification of crop and livestock production.

It is time to stop thinking about African countries as if they were all the same. There are differences in initial population densities, natural resources (especially rainfall) and the availability of technology. This diversity means that there are vastly different prospects for increasing food and export crop production by region (for example, the Sahel versus Southern Africa) and by individual country. As a result, it is unwise to advance sweeping generalizations that cut across sub-Saharan Africa's 45 countries, 1,000 ethnic groups, and complex farming and livestock systems.

There is increasing awareness among African leaders and donors that the solutions to Africa's agrarian crisis will have to be found within Africa. The proposed research agenda addresses the priorities needed to strengthen the knowledge base of African agriculture. Effective implementation of this research agenda—along with strong African leadership, political will, appropriate policy reforms and intelligent participation by donors—can transform African agriculture over the next 10 to 20 years.

# ■ TRANSFORMING AFRICAN AGRICULTURE\*

CARL K. EICHER\*\*

## INTRODUCTION

Thirty years ago, W. Arthur Lewis observed that "research into African problems is meager when compared with research expenditures in other continents." Twenty years ago, T.W. Schultz's influential *Transforming Traditional Agriculture* did not include any empirical examples from Africa;<sup>1</sup> in fact, Africa was not even cited in the index. Ten years ago, Chenery and Syrquin lamented the poor quality of data from Africa in their global analysis of the patterns of development from 1950 to 1970. Today, the Western development literature is still largely unencumbered by evidence from Africa except for scattered references to Nigeria, Ghana, Tanzania and the Ivory Coast, and Michael Todaro's model of migration, which grew out of his research in Kenya in the late 1960s.

Despite the substantial time lag of economists in gearing up for research on African development problems, there has been a dra-

matic but largely unnoticed increase in social science research on agricultural development in Africa since the mid-1970s. In fact, the research output over the past decade probably exceeds the cumulative output of social scientists over the previous four decades, starting with numerous anthropological studies in the 1930s.

Much of the recent literature on agricultural development in Africa is not included in textbooks for development courses in Africa, Europe and North America because of the perception that the data base is weak in Africa and that the research output is not of high quality. But Doyle Baker and I reached a different assessment after reviewing approximately 4,000 books, monographs, reports, papers and fugitive materials on the socioeconomics of agricultural development over the years from 1970 through 1982 (Eicher and Baker, 1982).<sup>2</sup>

From our review, we reached the following conclusions:

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\*This is a revised and condensed version of a paper, "Agricultural Research for African Development: Problems and Priorities for 1985-2000," presented at a World Bank Conference on Research Priorities for sub-Saharan Africa, February 25-March 1, 1985, in Bellagio, Italy. The research supporting this paper was financed by the United States Agency for International Development (USAID) Bureau for Science and Technology, and Bureau for Africa under a "Food Security in Africa" Cooperative Agreement, with the Department of Agricultural Economics, Michigan State University.

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<sup>1</sup>Africa refers to the 45 states in sub-Saharan Africa; it excludes North African states and the Republic of South Africa.

<sup>2</sup>Approximately 1,400 of the 4,000 items reviewed are included in the bibliography of the monograph, which is available in English and French.

■ There has been a large and generally unacknowledged increase in the quantity and quality of social science research output over the past decade.

■ The choice of research topics pursued by African and expatriate researchers is closely linked with the perceived priorities and the operational needs of donors and international organizations, and the desire of scholars in industrial countries to gain access to data from Africa. Examples of donor-inspired research topics include employment, integrated rural development, women in development, farming systems and food security.

■ Social science research has been concentrated in a few English-speaking countries (such as Nigeria, Tanzania, Kenya and Botswana) with a 50-year tradition of social science research and a conducive climate for foreign researchers.

■ The number of African social scientists engaged in research is small relative to the number of Western social scientists engaged

in such research. Moreover, the number of Africans producing new knowledge through research is small relative to the number of Africans who are members of feasibility teams and evaluation missions.

■ The results of research are often inaccessible to scholars in Africa and around the world because they are reported in working papers and government reports that are published in limited numbers of 50 to 300 copies.

The purpose of this paper is to identify core research problems and research priorities for transforming African agriculture over the next 10 to 15 years. The central question that this paper addresses is: What technical and social science research is needed to lay the foundation for doubling the growth rate of agricultural production from the current 2 percent to 4 to 5 percent per year? The proposed research agenda directly or indirectly contributes to the solution of this overarching problem.

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## ■ THE AGRARIAN CRISIS AND DONOR RESPONSE

A relevant socioeconomic research program for transforming African agriculture can only flow from a deep understanding of the place of agriculture in the current stage of African economic history, an analysis of current problems and a vision of the evolving agrarian structure as it adjusts to increasing population pressure. This section briefly reviews the roots of the present crisis and the donor response.

One hundred years ago, the colonial powers met in Berlin and decided how to partition Africa. From 1885 until independence in 1960,<sup>3</sup> Africa's open economies relied heavily on export agriculture as a major source of agricultural growth and foreign exchange earnings. At independence, Africa was a net exporter of food products—mainly groundnuts and oil palm from West Africa (Paulino, 1986). But 20 years after independence, many states in Africa had lost their capacity to feed themselves, Africa had lost world market shares in export crops and per capita income in 1983 was estimated to be about 4 percent below its 1970 level. Twenty-five years after independence, Africa is importing food (7 million tons in 1985), while vast tracts of land lie idle and foreign assistance is at record levels. More-

over, because of foreign exchange constraints, food aid accounts for a large share of total food imports.

Since food needs arising from population growth represent the driving force in the food-population equation, it is appropriate to consider future population growth. Two demographers recently concluded that:

Sub-Saharan Africa may well differ from other regions of the world in the nature and timing of its demographic transition. No national population in tropical Africa displays any signs of fertility decline . . . [and] population projections show Africa moving from about 10 percent of the world's population at the present time to close to 25 percent before global demographic transition is complete. [Caldwell and Caldwell, 1984, p. 1]

Donors have responded to Africa's economic crisis by increasing Official Development Assistance (ODA) from 25 percent in 1975 to 30.6 percent in 1983 (of that year's total ODA of \$7.7 billion) (OECD, 1984, p. 31). Annual ODA in several Sahelian states is \$50 to \$100 per person, a level substantially higher than in other regions of the world. In fact, in

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<sup>3</sup>Although the Gold Coast won its independence in 1957 and was renamed Ghana, 1960 is commonly used as the date of independence because 16 African nations became independent during that year.

India per capita foreign aid was only \$1.50 per year over the 1951 to 1970 period (Mellor, 1979, p. 89).

There is a growing awareness that foreign assistance is no substitute for poor macroeconomic policies; that Africa is flooded with donor-financed projects that consume its scarcest resource, skilled managers; and that donor coordination is a mirage. Kenya, for example, is finding it difficult, if not impossible, to manage its 1,000 development projects. Tanzania's development model was an apparent beacon for other African states until the early 1980s. Studies by Coulson (1982), Ellis (1982), Lele (1984) and others provide solid evidence that Tanzania's agricultural strategy is unsound, and that much of the \$2.7 billion of aid received over the 1973 to 1982 period has been unproductive. Recent studies of the Sahel covering the 1975 to 1985 period suggest that the recovery program has lost its momentum, several key regional institutions (for example, the Permanent Inter-State Committee on Drought Control in the Sahel (CILSS)) are overstuffed and adrift, and there is little political support among Sahelian states for regional development activities (Development Associates, 1984).

Supervisory missions and audit reports are raising questions about the performance

of rainfed agriculture, irrigated farming and livestock production projects and agricultural research projects in the western Sudan (USAID, 1984), Senegal (Eicher, 1982) and other countries. Respected agriculturalists point to one outstanding success story in rainfed agriculture over the past 15 years, the Minimum Package Project in Ethiopia. The project spread rapidly in the period from 1972 through 1976, but atrophied in the late 1970s as a result of political turmoil following the 1974 coup. Donors are discovering that food production projects in many Sahelian countries are running ahead of available technical packages and local managerial and accounting skills (USAID, 1984a). Three donors' recent decision to terminate the Dosso rainfed farming project in Niger as expeditiously as possible<sup>4</sup> dramatizes the need for applied research on dry-land agricultural intensification projects in West Africa.

The performance of irrigated farming in 25 years of independence is also sobering. In the Sahelian states of West Africa, the amount of new land being brought under irrigation each year (around 5,000 hectares) is roughly equal to the amount being abandoned each year because of neglect and lack of maintenance (Club du Sahel, 1983, p. 34).

Hard questions are being raised about the

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<sup>4</sup>The project was in the province with the best agricultural potential in Niger, and it was preceded by a reasonably successful pilot phase.

■ lack of farmer-tested food crop technology for extension agents and farmers (Spencer, 1985), the international transfer of agricultural technology and the performance of the major International Agricultural Research Centers (IARCs) working in Africa—WARDA, IITA, ILCA, CIMMYT and ICRISAT (Eicher, 1984).<sup>5</sup> The crisis in agricultural technology, however, goes beyond food crops. Evidence from Zaire, Ghana and Nigeria reveals that the genetic stock for tree crops is deteriorating as these institutes are nationalized, local budgets are consumed in paying salaries and local research priorities shift to food crops.

#### **AGRICULTURAL DEVELOPMENT SINCE INDEPENDENCE**

Agricultural development is a historical process, and the constraints of the process should be examined carefully in the preparation of research and action programs. More than two decades of agricultural development experience provide valuable insights into persistent problems that should be addressed by researchers, managers of production projects and donors.

#### **The Place of Agriculture in African Development**

The historical record reveals that heads of African states and donors have seriously mis-

understood both the role of agriculture in national development at this stage of Africa's economic history and the strategic importance of a reliable agricultural surplus as a precondition for the expansion of the industrial sector. There is agreement that agriculture is a declining industry when economic growth occurs in the long run. In Africa's current state of development, however, it has been a fatal mistake for African political leaders to impose excessively harsh taxation rates on farmers.

#### **Political Leadership**

While there is validity in the observation that a political logic often exists for seemingly irrational agricultural policies (Bates, 1981), the evidence shows that development is a gradual process of learning. As a result, excellence in research, extension services and running a government will be achieved only through experience. Many of the decisions made over the past two decades regarding ranches, state farms, settlement schemes and government tractor hire-schemes were partly a function of the ignorance and inexperience of political leaders and their foreign advisors. A few African political leaders are having second thoughts about their decisions. In a recent interview with the editor of the *Third World Quarterly*, Julius Nyerere, former president of

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<sup>5</sup>WARDA—West Africa Rice Development Association; IITA—International Institute of Tropical Agriculture; ILCA—International Livestock Center for Africa; CIMMYT—International Maize and Wheat Improvement Center; ICRISAT—International Crops Research Institute for the Semi-Arid Tropics.

Tanzania, said:

There are certain things I would not do if I were to start again. One of them is the abolition of local government and the other is the disbanding of the cooperatives. We were impatient and ignorant. [Nyerere, 1984, p. 828]

### **Agricultural Production Technology**

The debate over food and export crops is largely a false issue because economic policy has neglected or discriminated against both subsectors in many countries such as Ghana, Nigeria and Tanzania. Moreover, in most countries, the biochemical research base is seriously inadequate for both food and export crops. Hence, improved agricultural production technology is a *sine qua non* for expanding food production for home consumption and generating new income streams from the sale of food, livestock and export crops. Given that the Consultative Group on International Agricultural Research (CGIAR) concentrates on food crops, who will assist in rebuilding the research base for Africa's export crops?

### **Commercial Farmers and Policy Reform**

Although empirical support is growing for a smallholder-led agricultural strategy (Byerlee et al., 1983 and Johnston, 1985), an examination of successful agricultural policy

models—the Ivory Coast, Zimbabwe, Malawi and Kenya—shows that both smallholders and commercial farmers have contributed to agricultural growth. For example, the historical role of the medium-size cocoa farmers in the development of the Ivorian cocoa industry is well documented (Gbetibouo and Delgado, 1984). In Zimbabwe, commercial farmers have played an important role in producing maize, cotton and tobacco and a constructive role in agricultural policy dialogue.<sup>6</sup>

Recently in Zimbabwe, the Commercial Farmers Union, representing approximately 3,500 farmers, pressed for a large increase in the government maize price and supported their position with detailed cost-of-production information generated by their in-house agricultural economist. The outcome of the negotiation was a 28.5 percent increase<sup>7</sup> in the official government price of maize (Z\$140 to Z\$180 per ton), which was announced by the government several months before the October planting date for the 1984/85 season (Eicher, 1985).

### **Foreign Assistance and the Absorption of Aid**

Donors are an integral part of Africa's agrarian crisis. Donor agencies are frequently as misguided about the role of agriculture in

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<sup>6</sup>The role of commercial farmers in promoting policy reform is often overlooked by those who advocate abolishing middle- and large-size farms in order to achieve employment/equity goals.

<sup>7</sup>Inflation was estimated to be about 20 percent in 1984, leaving real maize prices slightly higher for the 1984/85 season.

development as their hosts, and members of the diplomatic community from industrial countries are often poorly informed about the role of agriculture in the history of their own nation's development. A Western ambassador recently directed the agricultural officer in his aid mission to develop a portfolio of agricultural projects that would yield "high visibility and quick returns" (Eicher, 1985).

Further, donors have been reluctant to come to a shared view of the consequences of their actions. For example, donors have avoided assessing the aggregate impact of donor-financed agricultural projects on an African state's ability to administer the projects, to provide technical staff and to pay recurrent costs during the lifetime of the projects,<sup>8</sup> let alone to pay recurrent costs after donor assistance has been phased out. At the same time, however, donors are pressing for policy dialogue to reduce the role of the state, which has been expanded with project aid.

The absorption of project aid in agriculture has been a major problem in many countries for the past 25 years. In 1984, for example, the United States Agency for International Development (USAID) had approximately 1,000 active projects in 35 countries in Africa. (It has subsequently taken aggressive steps to reduce the number of projects in its portfolio.)

In Rwanda, there were 67 agricultural projects in 1982. Professional agriculturalists in many donor agencies privately admit that more project aid cannot be absorbed "with integrity" in crop and livestock projects in many African states. The reasons for the absorptive capacity problems are directly linked to Africa's stage of economic history, where political maturity and scientific, financial and managerial capacity are scarce factors.

#### **Time Span for a Meaningful Response to the Agricultural Production Crisis**

Most African states are barely two decades old, but some important lessons have already been learned about the nature of the development process and Africa's limited absorptive capacity. Perhaps the most painful lesson of the past 25 years is how long it takes to develop stable political structures, a competent civil service of high integrity, an indigenous scientific capacity, locally financed agricultural research services, profitable technology for rainfed farming, and local M.Sc. and Ph.D. programs to reduce dependence on technical assistance.<sup>9</sup> Experience has shown, for example, that it takes an average of about ten years to produce a new plant variety and another five to ten years for it to gain widespread adoption. This time span and the need for

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<sup>8</sup>One important study of recurrent costs was undertaken by the Club du Sahel/CILSS (Gray and Mariens, 1983).

<sup>9</sup>Because the cost of technical assistance from OECD countries is high—\$80,000 to \$140,000 per person per year—some African states are turning to Asia and Latin America.

continuity of investigation are ill-served by project aid. Is it not ironic that donors provide long-term core funding to the IARCs in Africa, which are staffed with expatriates, while they offer only short-term, often erratic project aid to develop an indigenous scientific capacity in Africa's agricultural research services and faculties of agriculture?

The accumulated evidence of the past 25 years suggests that an appropriate response to Africa's agrarian crisis should be conceptualized in terms of at least two decades (Eicher, 1985). Increasingly, African scientists and administrators are taking the long view on building an indigenous scientific capacity. For example, Dr. H. Mwandemere, director of Malawi's national agricultural research service, recently reported that "it will take until the end of this century to achieve the desired target level of academic training" for his Malawian research staff (Mwandemere, 1984, p. 68). But today the 70 to 80 donors and international organizations operating in Africa are designing discrete projects within a conservative three- to six-year time period.

### **RESEARCH AGENDA FOR TRANSFORMING AFRICAN AGRICULTURE**

Africa's agricultural production must be

doubled within the next 15 to 20 years. But unless scientific and technical advances are generated through agricultural research in Africa, no amount of political will and policy reform can double the current 2 percent growth rate of agricultural output and sustain it.

Although it would be easy to recommend 40 to 50 research projects for the agricultural sector, I will concentrate here on six major areas. The first of these deals with short-term, applied research agricultural projects. The remaining areas represent research on the fundamentals, the prime movers of agricultural development: agricultural research as a source of new production technology; human capital; biological capital; physical capital; and the economic incentive environment. I focus on agricultural research policy and agricultural production constraints because of my conviction that new production technology is central to doubling agricultural output and to producing new income streams for rural people through the sale of food, livestock and export crops.

### **Applied Research on Project Design Issues**

Because of the urgency of the agrarian crisis, applied research should focus on a number of complex problems such as the recurrent cost dilemma, the decline in export crop pro-

duction and the seemingly intractable rainfed farming problem.

The conceptual task is to formulate three or four interrelated studies that will both guide donors and help African states (Ghana, Senegal, Guinea, Mali, Tanzania, Niger) to move through what I believe to be the inevitable, and necessary, decompression stage as they phase out or abandon about 30 to 40 percent of their agricultural projects, reduce the size of the state bureaucracy and examine how local communities can pay recurrent costs of social services (such as rural water supply schemes in Tanzania). This adjustment process is a necessary step in correcting the imbalance between donors' assumptions in the 1970s about Africa's capacity to absorb project aid and the painful realities of the 1980s.

### **Agricultural Research Policy**

There is an urgent need for a major study of agricultural research policy which consists of the following interrelated components: basic science research requirements for African agriculture, improving the efficiency of technology transfer, rebuilding tree crop research capacity, analysis of human capital requirements in national research services and assessment of what can be done to strengthen the performance of the IARCs in Africa.

*Stock of Food Crop Technology.* A careful assessment of the stock of food crop technology reveals a large gap between on-shelf technology and what is needed to double the rate of growth of food production. First let us examine two major food imports: wheat and rice. Because of the high temperature in West Africa in March, when wheat is flowering and tillering, wheat yields are extremely low; under present technical packages, growing wheat in West Africa is unprofitable unless subsidized. But wheat can be grown in the highlands of Ethiopia and Kenya and in northern Tanzania. During the temperate winter months of April through September, it can also be grown under irrigation in Zimbabwe.

With respect to rice, a major import in West Africa, the present situation is bleak. After ten years of trials, WARDA recently concluded that only 2 of over 2,000 imported varieties were yielding as well as the best local varieties (WARDA, 1984). Research on cassava by IITA is promising, however, and some varieties have been released to small farmers.

Sorghum and millet are important crops in low rainfall areas in West Africa, the Sudan, Ethiopia and Southern Africa. The French began research on these crops in West Africa in 1931, but the failure to achieve any noticeable improvement in sorghum and millet yields in

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over 40 years (1931 to 1975) partially explains why Sahelian countries encouraged ICRISAT to set up a sorghum and millet research program in the Sahel in the mid-1970s. A decade later, Dunstan Spencer reports that "probably less than 2 percent of total sorghum, millet and upland rice area in West Africa is sown to cultivars [improved varieties] developed through modern genetic research" (Spencer, 1985). In the Sudan, however, a promising new hybrid sorghum was released in 1984 after a 12-year research program in which 5,000 varieties were tested; 3 of the 5,000 turned out to be promising, and one has been released. Seed multiplication is now in progress.<sup>10</sup>

Maize is the most promising but neglected food crop in national research services in West Africa. IITA has done some good research on maize streak virus. But IITA and CIMMYT have been slow in developing a long-term (20-year) research program on maize in West Africa. There is an urgent need to double or triple annual research expenditures on maize in West Africa.

In East and Southern Africa, because of the durability of germplasm that was developed during the colonial period,<sup>11</sup> the genetic research base for maize is generally adequate. Maize yields are running about four tons per

hectare on commercial farms in Zimbabwe, and one ton per hectare for smallholders in Zimbabwe, Zambia and Malawi. The major research priority for maize in East and Southern Africa is to find out how to overcome the yield gap on smallholder farms.

Research on grain legumes—phaseolus beans, cowpeas and soybeans—has been modest until recently. Fortunately, several regional research projects on these crops are getting underway in East Africa and in Southern Africa. In summary, the stock of on-shelf, farmer-tested, food crop technology is meager, and the situation is particularly bleak in West Africa.

*Analysis of Scientific and Technical Advance in Historical Perspective.* A research program on agricultural research policy issues should be grounded in Africa's history. The starting point is a comparative analysis of major agricultural research advances during the 1930 to 1959 colonial period and the 1960 to 1985 period of independence. Although at least 50 empirical studies have been carried out by economists on the rate of return on investment in agricultural research in Asia, in Latin America and in industrial nations, no study has yet been done on the payoff to research on any commodity in any country in Africa. What

<sup>10</sup>The new hybrid, Hageen Dura-1, has produced an average yield of 2,968 kilograms per hectare, or 52 percent higher than local varieties over four crop seasons on an experimental station. Because hybrid seed must be replaced every year, the challenge now is to develop a seed industry. Only a few countries in Africa, such as Zimbabwe and Kenya, have developed a reliable and efficient seed industry thus far.

<sup>11</sup>Southern Rhodesia carried out research on hybrid maize for 17 years (1932 to 1949) and became the first country after the United States to release a hybrid variety—SR1—for commercial farmers. Eleven more years of

research produced improved hybrids, and in 1960 the SR-52 variety was released. Today, SR-52 is still the dominant variety used by commercial farmers (Eicher, 1984).

**N** explains this void in the literature? Are there no success stories to report? Or are data insufficient to compute rates of return? An analysis of the historical literature reveals an interesting paradox. Two major Green Revolution-type breakthroughs occurred in the colonial period—hybrid oil palm in Zaire, Nigeria and the Ivory Coast and hybrid maize in Zimbabwe and Kenya<sup>12</sup>—but no comparable breakthroughs have taken place in the 25 years of independence (Eicher, 1984).

A comparative study of scientific and technical advance in the colonial period and in the period since independence should go beyond the computation of benefit/cost ratios or internal rates of return on research investment and should examine the following factors:

- ▣ Time span between the inception of research and the release of technology.
- ▣ Continuity of investigation (such as funding and scientific leadership in the two periods).
- ▣ Training and experience of key scientists.
- ▣ Role of international transfer of plant material.
- ▣ The degree of concentration of research (for example, 17 years of continuous research on one commodity, hybrid maize, in Zim-

babwe versus IITA's mandate for eight commodities and a recent World Bank-financed project in Rwanda that covers 17 crops).

- ▣ Number of scientists in the national research services in the two periods.

*The Basic Science Gamble.* In the year 2000, when agricultural historians look back at African agriculture in the last third of this century, they will probably conclude that donors erred in committing too many resources to applied research (for example, farming systems research) in the IARCs and national research services and too few to commodity research and basic science research in support of agriculture.<sup>13</sup>

Virtually all of the IARCs are now functioning in Africa. However, only 1 of the 13—the International Laboratory for Research on Animal Diseases (ILRAD)—is committed to basic science research. Established in Nairobi in 1974, ILRAD is concentrating on long-term research on two livestock diseases, trypanosomiasis and theileriasis (East Coast fever), that primarily affect cattle in Africa. ILRAD anticipates results in 20 to 25 years. The other IARCs are concentrating on applied research and shorter term studies.

The modest donor investment in basic science research in African universities and re-

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<sup>12</sup>Research on hybrid maize was carried out in Kenya for roughly a decade, 1955 to 1964. The first hybrid, H611, outyielded local varieties by 40 percent.

<sup>13</sup>Donor investment in applied research in the IARCs and national research services will probably total several billion dollars for the years 1960 to 2000.

search institutes can be described as “the basic science gamble”; it assumes that international technology transfer and applied research (for example, farming systems research) are adequate to solve the problems of African agriculture. I hypothesize that the donors (and the CGIAR) have underestimated the technical problems in African agriculture<sup>14</sup> that will require concentrated attention through long-term basic research.

Low soil fertility, especially in West Africa, is an example of a problem that requires sustained basic research. Several scientists claim that Africa needs an international soils research center to carry out basic scientific research on the causes of low soil fertility and problems such as striga<sup>15</sup> for 10 to 15 years.<sup>16</sup> Water management is another area that requires long-term basic research.

The following issues require further study and debate: the transferability of basic science research output from industrial nations to agricultural research institutes in Africa; the state of the art of basic science research in support of agriculture in Africa; the adequacy of basic science research in the IARCs, national research services and universities in Africa; and recommendations to donors on the mix of basic science and applied research over the next 20 to 25 years.

*The IARCs and Food Crop Research.* Since 1980, the main IARCs in Africa have come under increasing scrutiny because the expected breakthroughs in food crop technology have not been forthcoming. My assessment of their performance is as follows:

- There is a gap between the expectations and the performance of the IARCs working in Africa.

- The direct international transfer of plant material has been ineffective.<sup>17</sup>

- The mandates of the IARCs are too ambitious in terms of geographic coverage and number of commodities. The IARCs in Africa are spread over such diverse agricultural ecosystems, so many crops and so much land area that they probably will not be able to match the earlier successes of colonial research services that carried out highly focused research on one commodity, such as maize in Southern Rhodesia.

- The absence of a strong indigenous scientific community in Africa is a serious barrier to the ability of national agricultural research services to screen and borrow technology from the global agricultural research system and adapt it to local conditions (Ruttan, 1982 and Eicher, 1984).

<sup>14</sup>In many countries in Africa, donors are overinvesting in farming systems research and underinvesting in commodity research—especially long-term (10-20 years) commodity research programs.

<sup>15</sup>Striga is a parasite that attaches itself to the roots of millet and sorghum plants, thus greatly reducing yields.

<sup>16</sup>Research on soil fertility over 15 years would cost approximately \$100 to \$150 million.

<sup>17</sup>The Director-General of ICRISAT recently summarized ICRISAT's experience in importing improved sorghum and millet varieties from India to the Sahel in the mid-1970s: “The results were generally disappointing. Very little of the introduced material was adapted to West African conditions. It was obvious that the project had to go back to basics to plan a longer term program” (Swindale, 1984, p.77).

*Perennial Crops.* The decline in agricultural exports from numerous African states over the past decade has usually been attributed to faulty pricing policies. But, increasingly, evidence suggests that some of this decline might be a function of the deteriorating genetic resource base for perennial crops such as coffee, cocoa, coconut palm and oil palm. Historically, perennial crop research has been financed by France, Belgium and the United Kingdom as part of their worldwide research networks. The Belgian government, for example, established a research system in the Belgian Congo in 1933—INEAC,<sup>15</sup> which eventually became the largest research organization in Africa. INEAC was independent of the colonial administration and was financed partly by the private plantation sector and partly by the Department of Colonies in Belgium. In 1959, just prior to Zaire's independence, INEAC employed 420 European researchers and technicians and 12,000 Congolese laborers at its 17 research stations (Drachoussoff, 1965). Moreover, INEAC's budget that year was approximately one billion Congolese francs (about US\$20 million in 1959 prices).<sup>19</sup>

INEAC's pioneering research on hybrid oil palms laid the foundation for the modern oil palm industry in West Africa. Basic information on oil palm genetics was transferred to

Nigeria and after a decade of adaptive research in the 1950s, Nigerian hybrid varieties became the centerpiece of the eastern region's small-holder oil palm scheme in the early 1960s. The Nigerian hybrids yielded 300 percent more than local (wild) varieties under farm conditions (Eicher and Miller, 1963).

INEAC's research on crossing Robusta and Arabica types of coffee led to a new type called Arabusta. But soon after Zaire's independence, INEAC's productive research program faded away in the transition from Belgian management. Some of the coffee breeders moved to the Ivory Coast and continued the research, and Arabusta coffee is now well established there.

When Senegal became independent in 1960, France was asked to continue managing Senegal's national research service until 1975. Senegal's transition from French to local leadership and financing of its research system has been difficult (Eicher, 1982). Today, Senegal has a research staff of 218 scientists and an unskilled labor force of 1,300. The basic question is whether Senegal will assign sufficient political priority to finance a modern agricultural research system without an indefinite infusion of foreign assistance.

In the Ivory Coast, the long period of French management of tree crop research is

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<sup>15</sup>INEAC—Institut National pour l'Étude Agronomique du Congo.

<sup>19</sup>Personal communication with Eric Tollens, Professor of Agricultural Economics, the University of Leuven, Leuven, Belgium, January 14, 1985.

coming to a close under the terms of a May 1984 "Convention" between the Ivory Coast and France. Since the Marc Delorme research station in the Ivory Coast has the foremost collection of coconut palm genetic material in the world, the transition from French to Ivorian management and the financing of the tree crop research in the Ivory Coast are of considerable interest to French-directed coconut research stations at Vanuatu and French Guiana and to the major producers of coconuts—Indonesia, Malaysia, India, Sri Lanka and the South Pacific archipelagos.

*Strengthening National Agricultural Research Services.* In the past five years, donors have turned their attention to strengthening Africa's national agricultural research services.<sup>20</sup> But the state of the art on strengthening such systems is in its infancy, and the data base is weak and open to question (Oram, 1985). Moreover, the International Service for National Agricultural Research (ISNAR) has not provided the expected leadership in this area during its first five years of activity.<sup>21</sup> Some donors are moving aggressively with national agricultural research projects, and African states could be saddled with "brick and mortar"-dominated projects that have been hastily designed as discrete projects, rather than as part of an inter-

active system of core investments in research, extension services and training in schools and faculties of agriculture.

A key issue in strengthening national research systems is the balance between commodity and farming systems research. Because scientific and technical advances will come from commodity research, farming systems teams, in my judgment, should be the handmaidens of commodity research teams.

#### **Agricultural Production Constraints**

After 25 years of independence, most African states and most donors do not have coherent and empirically grounded rainfed, irrigated and livestock production strategies.<sup>22</sup>

This gap is probably a function of some or all of the following factors:

- Many African states have given low priority to agriculture and have pursued a passive agricultural strategy, responding to the changing interests of donors.

- In the 1970s, many donors concentrated on direct action programs such as Integrated Rural Development programs. Agricultural production was only one of many components, with little perceived urgency to develop coherent production strategies.

- Because of numerous failures in rainfed, irrigation and livestock projects, donors have

<sup>20</sup>In Senegal alone, donors under World Bank leadership have committed \$105 million to strengthen Senegal's national agricultural research service in the period from 1982 to 1988.

<sup>21</sup>Unfortunately, ISNAR has taken on many of the qualities of an international consulting firm. It has not provided the intellectual leadership that is so critically lacking in debates on strengthening national agricultural research systems.

<sup>22</sup>Zimbabwe is a rare exception. See Zimbabwe (1982) and recent papers by Blackie (1984) and his colleagues at the University of Zimbabwe.

15 retreated from certain sectors, such as livestock, and are now attempting to formulate strategies that avoid past mistakes.

▣ Because of the lack of core funding, African university scholars often carry out ad hoc, short-term, externally financed studies, rather than longer-term studies of rainfed, irrigated or livestock production.

▣ Monitoring and evaluation studies have not delivered timely and rigorous feedback on constraints in implementing field projects.

▣ Researchers have often focused on the major components of an agricultural improvement strategy, such as supply response (Bond, 1983), land tenure, desertification and mechanization, while neglecting important institutional, managerial and financial management issues.

An intensive and ongoing research program on agricultural production constraints, to provide the knowledge base for better strategies, programs and projects, should be undertaken. The fact that between 1970 and 1985 the rate of population growth in Africa was double that of food production justifies such a program. Moreover, there is growing evidence that the farmer-led improvements in land productivity are inadequate to deal with rapid population growth rates of 3 to 4 percent.

For example, Lagemann's pioneering study in 1977 of three villages in high population density areas of eastern Nigeria found that, as population density increased, the length of fallow was reduced and yields declined. For example, cassava yields fell dramatically from 10.8 tons to 2.0 tons per hectare as the length of fallow was reduced from 5.3 to 1.4 years. According to the study, the length of fallow explained 60 percent of the variation in cassava yields. As the length of fallow was reduced, soil fertility decreased and soil erosion, acidity and weeds increased.

Although Lagemann found many examples of farmer innovations in response to growing population pressure<sup>3</sup>—intensification of production by using household refuse and animal manure, riverbottom irrigation and increased dependence on off-farm employment for income generation—the evidence is clear that, in the villages studied in eastern Nigeria, population pressure ran ahead of farmer innovations (Lagemann, 1977).

Sound crop and livestock production strategies for the complex and diverse agroecological systems in Africa cannot be prepared in Washington, Rome or Paris on the basis of secondary data and supervisory reports on projects that have failed. They must emerge from in-depth field studies of production con-

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<sup>3</sup>Ester Boserup's (1981) population-led model of agricultural development has historical support under conditions of low population growth rates (1 to 2 percent) and idle land. But with rates of population growth of 3 to 4 percent and the closing of the frontier, an urgent need arises for new technology that is produced through public investment in agricultural research.

straints over the next three to five years. These studies should examine both successes (cotton production campaigns in Mali, Cameroon and Zimbabwe; the Kenya Tea Development Authority) and failures (food production in the Casamance in Senegal; rainfed farming in the Dosso project in Niger).

The results of short-term research on production constraints should be used to prepare separate rainfed, irrigated and livestock production strategies for West Africa and for East and Southern Africa. Separate strategies are necessary because of the diversity of agrarian structures in the different regions in Africa. In West Africa, smallholders dominate the agrarian structure, while in Southern Africa (Swaziland, Zimbabwe, Malawi and Zambia), there is a dual structure of smallholders and estates/commercial farmers.

*Key Issues.* Several key issues should be examined in research programs on rainfed, irrigated and livestock production constraints. These include:

- Understanding the historical experience. The studies should use De Wilde's (1967) classic study as a starting point and identify key factors in successful and unsuccessful production projects over the past two decades.

- Profitability of technical packages. Micro-economic research is needed to compare yields, risk and profitability of existing farming and livestock systems with improved technical packages.

- Sequence of adoption—technical packages or components of packages? The common assumption of donors for the past 15 to 20 years in Africa is that farmers and livestock herders will adopt entire technical packages if they are profitable. But research by Byerlee and Polanco (1986) in Mexico and Goodell (1984) in the Philippines, and unpublished studies by Byerlee in West Africa suggest that adoption of new technology follows a clear stepwise pattern, with the components that give highest returns on capital being adopted earliest. Hence, as farmers gain experience, they will adopt more components over time. This issue should be explored in depth in the constraints studies.<sup>24</sup>

- Production-marketing linkages. The fragmentary data on successful food production projects (maize in Senegal, in the Kasai Oriental region of Zaire and among smallholders in Malawi and Zimbabwe) point out the strategic importance of reliable market outlets. The maize project in the Kasai region, for example, achieved its fifth-year production objec-

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<sup>24</sup>For a classic study of the diffusion of maize in Africa see Gerhart (1975). For a state of the art paper on the diffusion of agricultural innovations see Feder, et al. (1985).

lives in the second year. This success is attributed to the existence of a reliable market for maize in nearby areas and to maize varieties that CIMMYT breeders developed over a decade before the project started. Unfortunately, marketing issues often are not examined because of preoccupation with production constraints.

Spread of new crops. Studies of production constraints should examine promising new crops. For example, maize has replaced sorghum and millet, historically the dominant crops, in East and Southern Africa. Irish potatoes, with a potential of three crops a year in some areas, are increasing in popularity in the Central Highlands of Kenya and in Rwanda. Maize has replaced sorghum in the cotton rotation in Mali Sud, the Ivory Coast and northern Cameroon. Wheat, a minor crop in Zimbabwe until irrigation was introduced, is now produced throughout the winter months (April through September).

*Research on Rainfed Farming Constraints.* The study of rainfed farming constraints should be analyzed in a historical context, with emphasis on the interactions between population pressures, technical change, institutional innovation and the economic policy environment. The analysis of technical change should

focus on the stepwise process of pushing up crop yields, a little at a time, instead of on dramatic breakthroughs.<sup>25</sup> For an assessment of research on rainfed farming constraints, see Spencer (1985) and Eicher and Baker (1982).

*Research on Irrigation Constraints.* Except for Sudan and Madagascar, the amount of cultivated land under irrigation in countries in sub-Saharan Africa is probably less than 5 percent. This compares with around 30 percent in India. But irrigation is important in the river valleys of Zimbabwe, Somalia, Ethiopia and Mozambique and in parts of Mali, Senegal and northern Nigeria. Also, there are numerous indigenous irrigation techniques that have been finely honed to local ecological conditions.

The literature on irrigation is summarized by Eicher and Baker (1982) and recently updated for the Sahel by Moris, et al. (1984) and by Barnett (1984) in a survey of small-scale irrigation research. Blackie (1984) has also compiled a major compendium on African smallholder irrigation.

*Research on Livestock Constraints.* In 1974, the International Livestock Center for Africa (ILCA) was established, at which time a task force of four livestock specialists reported that livestock technology was available and that so-

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<sup>25</sup>I have used the term "breakthroughs" earlier to describe hybrid oil palm and maize varieties that were almost self-spreading innovations. This term should probably be discarded, however, because it raises unwarranted expectations about dramatic research results.

cial science research was needed to facilitate the transfer of this technology to nomadic and seminomadic herders to assist them in becoming sedentary farmers. In 1982, however, a Technical Advisory Committee (TAC) report noted that the 1974 task force observation of a backlog of on-shelf technology was incorrect and urged ILCA to add more technical staff to step up research on animal nutrition and breeding (TAC, 1982). Between 1965 and 1980, even in the absence of profitable innovations, it is estimated that donors channeled \$600 million into livestock projects in Africa. It is now clear that these projects were far ahead of the basic science and applied research base.

Research by economists on livestock is about 25 years behind research on crop production. There are many assertions and beliefs and a sparse supply of facts. A quantum increase is needed in research on livestock by technical scientists and by economists in the 1980s in order to catch up with the impressive knowledge base that has been generated by anthropologists over the past 60 years. Research by anthropologists and some economists reveals that pastoralists need to maintain large herds for the survival of the pastoral family under harsh ecological conditions. The behavior of herders, formerly alleged by researchers to be ultraconservative, is now

viewed as prudent. Cattle, researchers have come to agree, perform a number of social, ritual and economic functions, and the relative ranking of these functions varies widely according to ethnic group, country and ecological conditions.

The agenda for research on livestock should include:

- Increased research on animal nutrition, animal health and range management.
- Problem-solving research under field conditions.
- The technical, economic and social issues involved in mixed farming, including the economics of supplementary feeding during the dry season.
- Land tenure issues involved in the transition from nomadic to seminomadic and sedentary production systems.<sup>26</sup>

### Human Capital

This section focuses on human capital research priorities with emphasis on increasing Africa's scientific and managerial capacity for agricultural development. This research problem area is directly linked to strengthening national agricultural research services and to developing local analytical capability for policy analysis.

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<sup>26</sup>For a discussion of research in Kenya on the transition from seminomadic to the market economy, see Evangelou (1984).

By any yardstick—literacy rate, percentage of school-age population in secondary school and universities, or percentage of expatriates in scientific, managerial and academic staff positions—Africa is on the bottom of the human resource scale in the Third World.<sup>27</sup> What is the response of donors to this situation? The World Bank approved two education projects in Africa in fiscal 1984, representing 3.6 percent of its education portfolio, or \$25 million out of \$694 million of World Bank and International Development Association (IDA) funds (World Bank, 1984). In 1985, USAID was supporting undergraduate and higher degree programs in Africa in Cameroon, Uganda and Zimbabwe, and 250 African students were being supported in long-term training (B.S., M.S. and Ph.D.) in various agricultural disciplines (USAID, 1985). What explains this modest response by two major donors to Africa's crushing human resource problems? And the small number of World Bank loans to Africa relative to Asia? Are loans to education not profitable in Africa? To understand human capital research priorities, let us briefly trace the role of education in African development.

*Historical Note.* In the early 1960s, donors responded to the critical manpower shortages

attendant on independence and invested heavily in human resource projects and programs in all subsectors, including primary, secondary, technical and university training. This is understandable in light of the low literacy rates and the fact that replacements for expatriates were urgently needed in the civil service. But the demand to Africanize the civil service imposed a narrow mission on African universities, leaving faculties and departments of agriculture on the periphery and in the hands of expatriates for several decades.

The need for university expansion in the 1960s was overwhelming when one considers that in 1961 the output of locally trained university graduates in Kenya, Tanzania and Uganda was 99 for the combined population of 23 million in the three countries. At the scientific level, the problem was even more acute. In 1964, there were only three African scientists working in research stations in Kenya, Uganda and Tanzania (Johnston, 1964).

The imperative for universities to help Africanize the civil service is obvious when one considers that the civil service in Senegal was dominated at independence by 1,500 French civil servants. The University of Dakar responded by producing graduates for the civil service and for the industrial and urban sectors. Today, it has 12,000 students and is con-

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<sup>27</sup>The absorptive capacity bottlenecks in agriculture have been cited in the literature over the past 25 years. See the classic studies by De Wilde, et al. (1967) and Lele (1975); audit reports (USAID, 1984, 1984a); and research priority studies (Devres, 1984, 1985).

sidered the paragon of liberal arts teaching in West Africa. However, Senegal postponed setting up a university-level faculty to teach agriculture for undergraduates until 1979, 19 years after independence, even though 70 percent of its people live in rural areas.

Frederick Harbison and Charles Meyers (1964) helped make the case that education was an investment, not a social service, and they urged African states to establish manpower planning units in Ministries of Education. But as Krueger and Ruttan (1983) have pointed out, manpower planning proved to be more of an art than a science, promised more than it delivered and fell into disfavor in little more than a decade. By 1970, most donors had retreated from primary- and university-level education.

*Present Situation.* Because of the massive shortage of scientists, teachers and managers, Africa is the continent of technical assistance par excellence. For example, the number of French in the Ivory Coast (1 per 160 Africans) is estimated to be around 50,000, or four times the number there during the colonial period (Zartman and Delgado, 1984, p. 13). Kenya, after 22 years of independence, is still relying on a large team of foreign economic advisors.<sup>28</sup> The University of Toronto economist, Gerald

Helleiner, with considerable experience in East Africa, observes that:

A succession of expatriates learn more and more about developmental decision-making while the Africans below them in the hierarchy become progressively more alienated and discontented. The experience and collective "memory" which is accumulated during the process of development is thus appropriated by foreigners who subsequently leave the country carrying these invaluable assets with them. [Helleiner, 1979, p. 240]

The shortage of African scientists, managers and academic staff in schools and faculties of agriculture is acute.<sup>29</sup> For example, in 1984, 26 percent of all professional staff in research, extension services and agricultural training schools and faculties of agriculture in the nine member countries of the Southern Africa Development Coordination Conference (SADCC) in Southern Africa were expatriates (Devres, 1984, p. 20).

When Zimbabwe became independent in 1980, it had 201 agricultural research officers and technicians and a highly productive research service geared to meet the needs of commercial farmers (Oram, 1985). By 1984,

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<sup>28</sup>The international team of advisors is provided by Harvard's Institute of International Development under a contract funded by several donors.

<sup>29</sup>See Blackie (1984a) and Lele (1984).

21 over 75 percent of the "European" scientists employed in the late 1970s had resigned or retired under the postindependence incentive scheme. Most of these officers have been replaced by young Zimbabweans fresh out of the university with B.Sc. degrees. In July 1984, 47 percent of the research staff had less than two years of experience (Chigaru, 1984). Because only a small percentage of officers can be released for advanced training at any one time, it will probably take a decade to upgrade Zimbabwe's research service through local and overseas graduate training.

Because of the shortage of African scientists and managers, the major donors continue to send large numbers of students overseas for postgraduate training in agriculture. (Moock, 1984). But the cost of overseas training is escalating and the relevancy of training in an applied field, such as agronomy, horticulture, range management and agricultural engineering, is questionable if the thesis research is not carried out in Africa on local problems. A surprisingly small percentage of African students studying agriculture in Europe and North America return to Africa for their Ph.D. thesis research.

*Research Needs.* African higher education is at a crossroads. After 25 years of independ-

ence, a conviction exists among many African policy makers that, although great strides have been made in the Africanization of the civil service, there has been a dramatic underinvestment in science and technology since independence (King, 1985). Today, there is ample evidence across the continent that technological capability is still predominantly in expatriate hands. When African ministers of education met in Harare, Zimbabwe, in 1982, they identified science and technology as the "priority of priorities" for the coming decades because "science and technology form the basis of industrialization." But what about science and technology for agricultural development?

Overseas training and technical assistance are temporary solutions at best for meeting Africa's manpower needs in the agricultural sector. The time has come to shift the center of gravity for training in agriculture from industrialized countries to M.Sc.-level training in agriculture in Africa (USAID, 1985). Recently, USAID announced an innovative plan to strengthen national agricultural services and faculties of agriculture in selected countries over the next 10 to 20 years (USAID, 1985). But these issues of strengthening indigenous research and teaching in agriculture should be examined by a consortium of donors

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in an in-depth Africa-wide study. The results of the study should enable donors to move ahead with investment programs to increase scientific and managerial capacity for agricultural development in Africa. The question of the cost of higher education in Africa will have to be addressed and data must be generated on the direct and indirect costs of training students at home compared with the costs (for example, foreign exchange) of training students overseas.<sup>30</sup>

In summary, the research agenda on human capital is central in the research portfolio for the agricultural sector. But as I have pointed out earlier, the resources invested in basic science, applied research, extension services and higher level training in agriculture are interactive investments. A detailed plan of work for research on human capital in agriculture should be developed in cooperation with researchers in these areas.

### **Rural Savings, Agricultural Credit and Capital Formation in Agriculture**

*An Overview.* Research on rural savings, credit and rural financial institutions is one of the most underdeveloped research areas in African agriculture (Eicher and Baker, 1982). The scarcity of research on savings and credit stems partially from the fact that, in contrast

to other continents, Africa's rural financial markets are dominated by informal lenders, including merchants, relatives and money lenders. Fragmentary data suggest that approximately half the loans from informal lenders are used for consumption purposes such as ceremonial obligations and school fees. Formal credit, as expected, is geared to high-potential agricultural areas, export crops and classes in rural society that have land, power and privilege. In some countries, government loans are viewed as a gift.

Although few studies of rural savings capacity in Africa have been carried out, the use of credit in promoting the adoption of technical packages is gaining attention as a research topic. The limited research on credit in sub-Saharan Africa has shown that credit programs can help small farmers, especially if credit is tied to profitable technical packages (usually export crops) and to marketing organizations that can deduct credit repayments from sales made by loan recipients. Credit programs for food production have frequently failed because of the lack of profitable and farmer-tested technical packages.

*Direction for Future Research.* What is the direction for future research on credit and rural financial markets? I am apprehensive about

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<sup>30</sup>The 1984 cost in the United States was \$35,000 to \$45,000 for a master's degree, and an additional \$80,000 for a Ph.D. degree.

**23** pursuing traditional research on agricultural credit (for example, size of loans, repayment rates) and formal and informal lenders because there are more basic questions to be addressed in Africa. I suggest research to determine the conditions under which rural communities have financed socially desirable rural infrastructures and smallholders have financed investments in irrigation projects. These issues have been neglected by researchers because of the assumption that donors should finance capital investments in agriculture and pay part or all of the recurrent costs (for example, salaries of extension agents) of rural projects.

Research on private and public capital formation in African agriculture is long overdue. Historical evidence throughout the world indicates that capital formation in agriculture is a slow, accretionary process, formed primarily by surplus family labor during slack periods of the year and by farm profits. Similarly, the historical record shows that communities can be mobilized to finance extension service agents, schools, roads and wells, if agricultural growth is occurring and if there are appropriate rural institutions that are locally managed.

A five- to ten-year comparative study of capital formation in six to eight countries

should carefully document how local communities have developed the following:

- Physical capital in agriculture by using surplus seasonal labor to increase land productivity through drainage, dams and ponds.<sup>31</sup>
- Biological capital—for example, expansion in size and quality of livestock herds.
- Rural infrastructure by mobilizing surplus seasonal labor, for example, to build schools and clinics.
- Private rural savings institutions—for example, rural savings clubs in Zimbabwe.

The study should also examine how the rural tax base can be expanded to finance schools, clinics and rural water supply schemes. In summary, the assumption that foreign aid must finance the bulk of investment in agriculture and rural infrastructure in Africa runs counter to the historical record. Moreover, the readiness of donors to pay recurrent costs should be re-examined in the light of experience. In the short run, the payment of recurrent costs by donors helps "move money." But in the long run, the payment of recurrent costs promotes "a delusional system of shadow government agencies, offices, titles, and perquisites that can never be financed by

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<sup>31</sup>Capital formation in agriculture cannot be concentrated in time or space. Because of the biological nature of increasing the size and improving the quality of livestock herds or improving land through clearing rocks, building fences and draining land, the basic process of capital formation should be viewed as incremental.

domestic resources after foreign aid is phased out" (Eicher, 1985).

### **The Political Economy of Food Security and Agricultural Policy**

The purpose of this section is to attempt to build a bridge between the microstudies that historically are the bread and butter of agricultural economists and the macrostudies that often are carried out quite independently by macroeconomists. Over the years, I have observed that farm management economists and, more recently, farming systems economists are usually more concerned with building bridges with technical scientists than with marketing economists and macroeconomists. Moreover, I have observed that some macroeconomists carry out their supply response studies and commodity projections as mechanical exercises with little attention to the underlying institutional, technical and managerial constraints. To help correct these tendencies, I propose a research agenda that attempts to link the interests and needs of both groups of economists.

Two years ago, the authors of the influential *Food Policy Analysis* reported that the starting point for food policy analysis "is usually a food balance sheet, which most countries now publish on an annual basis" (Timmer, Falcon and

Pearson, 1983, p. 22). However, I am not aware of any African country that publishes an annual food balance sheet. Because food production data are an essential input into food balance sheets, a few examples of the lack of reliable production estimates are in order. Lele and Candler (1984) report that the basic data sets (USDA and FAO) for East African agriculture are at wide variance and stress the need to interpret these figures with caution. Since Nigeria has the largest cadre of skilled manpower on the continent, its experience in building a statistical base is instructive. Wolfgang Stolper described his experience in helping prepare Nigeria's First Development Plan (1962-68) as *Planning Without Facts* (1969). But 25 years after independence, Nigeria's statistical system is still woefully inadequate. Observers report, for example, that estimates of the area under crops issued by different agencies, including the Federal Office of Statistics, differ by a factor of three to five.

The sobering point is that, even if crop and livestock production data are improved, national nutrition and consumption surveys, both essential inputs into food policy analysis, are scarce in Africa.

With respect to the issue of local analytical capacity, experience has shown that economic policy research is just as location-specific as

25 maize breeding. Although donors have been readily available since independence to finance the overseas training of African planners and provide advisors to African governments, it is almost impossible today to gain consistent donor support to build the M.Sc. capability in economics and agricultural economics in African universities. More attention needs to be given to developing the economic capability within individual African states.<sup>32</sup>

Macroeconomic studies of food and agriculture are of high priority in the 1980s. Currently, studies are being carried out by four major groups: the World Bank (directed by Uma Lele); the EEC (directed by Michael Lipton); the International Food Policy Research Institute (IFPRI) (coordinated by Christopher Delgado); and Michigan State University (carried out by the Department of Agricultural Economics in cooperation with African researchers).<sup>33</sup>

Food security is a popular research topic among agricultural economists in the 1980s.<sup>34</sup> Food security research agendas will be different in food deficit countries in Africa than in food self-sufficient countries in Asia. Moreover, research on efficient methods of absorbing food aid in Africa is a high priority topic.<sup>35</sup>

The big gap in the food security research agenda is in consumption and nutrition stud-

ies. Although urban consumption surveys were a popular research topic in the 1960s,<sup>36</sup> the field has been dormant for 15 years. One of the most comprehensive surveys was carried out in Sierra Leone in 1974/75 by Dunstan Spencer and his colleagues at Njala University College, University of Sierra Leone.<sup>37</sup> Consumption research is high on the priority list because it can answer two basic questions. First, have the changes in consumption (for example, of wheat and rice) in recent years been a response to a change in tastes or to relative prices? If the latter, they are reversible and subject to change through price policy. If the former, as is assumed by some in Southern Africa, then it may prove difficult to "turn back the clock" to sorghum and millet. Second, how do consumption patterns vary by income group? The answer to this question would enable the analyst to move beyond information on "average diets" to knowledge about diets of the malnourished.

## SUMMARY

The historical record since 1960 shows that agricultural change is an evolutionary, step-wise process. In the long run, most African countries have the physical capacity to feed themselves, given appropriate policies and in-

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<sup>32</sup>The need for policy reform in Africa is outlined by Gusten (1984), by various World Bank, USAID and European Economic Community (EEC) reports (Commission of the European Communities, 1984), and most recently by the Nordic Delegation (1984). The latter is surprising because Nordic countries have generally been preoccupied with project aid and have pursued a passive role in policy debates in Africa. But agricultural stagnation in the major Nordic recipient countries of Ethiopia, Tanzania and Mozambique may explain why the Nordic group is pressing for agricultural policy reform.

<sup>33</sup>The countries covered in the studies are: World Bank—Cameroon, Kenya, Malawi, Nigeria, Senegal and

Tanzania; EEC—Kenya, Mali, Rwanda, Tanzania, Zaire and Zambia; IFPRI—Burkina Faso, the Ivory Coast and Senegal; Michigan State University—Mali, Rwanda, Senegal, Somalia and Zimbabwe.

<sup>34</sup>For an excellent synthesis of the state of the art, see Reutlinger (1985).

<sup>35</sup>For a discussion of food security research priorities in Africa, see Eicher and Staatz (1985) and the World Bank (1985).

<sup>36</sup>For a survey and assessment of these studies, see Eicher and Baker (1982).

vestments in the prime movers of agricultural development: human capital, biological and physical capital formation, strengthened rural institutions and agricultural research to produce a continuous stream of new technology.

This paper has focused on the research needed to transform African agriculture over the next 10 to 20 years. Although the 1985 famine brought forth a vast outpouring of food and emergency relief, many African states cannot absorb present aid flows because project aid is not well coordinated and because there is a lack of local managerial, financial and technical skills to absorb it. In many countries the stock of available farmer-tested food and export crop technologies is meager. Moreover, in many complex sectors—livestock, irrigation and rainfed farming in semi-arid areas—the lack of technology, not the lack of farmer motivation, is the major brake on expanded food, livestock and export crop production.

The research agenda on agricultural development in Africa looks very different from inside and outside the continent. As someone from outside Africa, I have, over the years, presented an external view, but at times I find myself shifting to what I perceive to be internal research priorities. For example, instead of presenting the typical external view that more research is needed on agricultural credit, I have

recommended a research project to examine how indigenous private and public capital formation can be accelerated. Further, my proposed research agenda emphasizes the need to study the economics of investment in basic science, national agricultural research systems and human capital.

In the final analysis, I believe that this research agenda, reflecting both internal and external views, can make a significant contribution to the transformation of African agriculture over the next 10 to 20 years.

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<sup>27</sup>The overall results are reported in Byerlee, et al. (1983), and the results of the food consumption surveys are reported by Strauss (1984).

## 27 ACRONYMS

<b>CGIAR</b>	Consultative Group on International Agricultural Research		
<b>CILSS</b>	Comité Permanent Inter-États de Lutte Contre la Secheresse au Sahel (Permanent Inter-State Committee for Drought Control in the Sahel)	<b>ISNAR</b>	Institute for Agronomic Study in the Congo)
<b>CIMMYT</b>	Centro Internacional de Mejoramiento de Maiz y Trigo (International Center for Maize and Wheat Improvement)	<b>ODA</b>	Official Development Assistance
<b>EEC</b>	European Economic Community	<b>OECD</b>	Organization for Economic Cooperation and Development
<b>FAO</b>	Food and Agriculture Organization (United Nations)	<b>SADCC</b>	Southern Africa Development Co-ordination Conference
<b>IARCs</b>	International Agricultural Research Centers	<b>TAC</b>	Technical Advisory Committee [CGIAR]
<b>ICRISAT</b>	International Crops Research Institute for Semi-Arid Tropics	<b>USAID</b>	United States Agency for International Development
<b>IDA</b>	International Development Association	<b>USDA</b>	United States Department of Agriculture
<b>IFPRI</b>	International Food Policy Research Institute	<b>WARDA</b>	West Africa Rice Development Association
<b>IITA</b>	International Institute of Tropical Agriculture		
<b>ILCA</b>	International Livestock Center for Africa		
<b>ILRAD</b>	International Laboratory for Research on Animal Diseases		
<b>INEAC</b>	Institut National pour l'Étude Agronomique du Congo (National		

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## 35 ABOUT THE HUNGER PROJECT

Established in 1977, The Hunger Project's purpose is to establish a global context of individual will and commitment for ending hunger on our planet by the end of the century. As of December 1985, more than 4,000,000 individuals living in 152 countries had publicly declared their commitment to the end of hunger by enrolling themselves in The Hunger Project.

The Hunger Project is currently active in 25 countries: Australia, Austria, Belgium, Belize, Brazil, the British Isles, Canada, Denmark, Finland, France, India, Ireland, Israel, Jamaica, Japan, Mexico, the Netherlands, Norway, Pakistan, Peru, Sweden, Switzerland, the United States, West Germany and Zambia. The Hunger Project's International Office is located in New York City.

The Hunger Project informs and educates people throughout the world about the persistence of hunger and starvation in a way that supports them in participating effectively in its solution.

The Hunger Project's educational programs include the Ending Hunger Briefing and an Ending Hunger In-Service for teachers. The Ending Hunger Briefing was created by a team of experts in the field of development; both the Briefing and the In-Service present a comprehensive overview of the facts of world hunger and ways to end it. The Briefing has been presented to more than 300,000 individuals in North America, Central America and Western Europe.

The Hunger Project also publishes educational materials about the persistence of hunger and the work that has already been done to eradicate it.

The Hunger Project's book, *Ending Hunger: An idea whose time has come*, examines five of the vital issues that have dominated the international debate on hunger: population, food, foreign aid, national security and the international economic system. Published by Praeger, it brings together, for the first time in one volume, the full range of expert thinking, perspectives and approaches to ending hunger.

The Hunger Project newspaper, *A Shift in the Wind*, is the world's largest-circulation publication on the subject of hunger. Each issue is distributed to approximately 2 million households throughout the world.

*The Hunger Project Papers* are occasional papers which present technical/professional analyses of subjects related to ending hunger. Both *The Hunger Project Papers* and *A Shift in the Wind* are circulated to more than 25,000 key opinion and policy makers, including educators and development experts, business and political leaders, and members of the media.

*World Development Forum*, a twice-monthly newsletter of facts, trends and opinion in international development, is distributed to more than 15,000 key policy makers and opinion leaders in many countries of the world.

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