

EPTD DISCUSSION PAPER NO. 37

**THE CHANGING ORGANIZATIONAL BASIS OF AFRICAN
AGRICULTURAL RESEARCH**

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P.O. Box 93375
2509 AJ The Hague, The Netherlands
(Also published by the International Service for National
Agricultural Research as ISNAR Paper No. 98-17)**

November 1998

EPTD Discussion Papers contain preliminary material and research results, and are circulated prior to a full peer review in order to stimulate discussion and critical comment. It is expected that most Discussion Papers will eventually be published in some other form, and that their content may also be revised.

ABSTRACT

National agricultural research systems in Africa increased markedly in size throughout the past three decades, but from an especially small base. In 1961, public systems in 33 of 48 African countries employed fewer than 25 full-time equivalent (fte) researchers, by 1991 there were only 8 such systems (and 23 countries employed more than 100 fte researchers, compared with only 4 countries in 1961). Despite this overall growth, and the efforts that began in the late 1980s to consolidate the conduct of agricultural research, most African agencies are still very small and fragmented by international standards, making it difficult to realize the scale and scope economies that seem increasingly evident in agricultural R&D conducted elsewhere. This study reports a range of institutional indicators for 341 agricultural research agencies located in 39 African countries. In 1991, 236 agencies (nearly 70 percent of our sample total) employed less than 20 fte researchers.

Most public research in Africa is still done by government agencies; they employed 87 percent of the total number of researchers in 1991. University research has grown the most rapidly, but still accounted for only 10 percent of the total number of African researchers in 1991. Partly in response to the small, fragmented, and comparatively isolated structure of agricultural R&D agencies, but partly from local political and, especially, donor pressure too, there has been a proliferation of research networks in recent years. We identified 86 networks, of which 72 involved Africans linked to Africans, a rather parochial strategy in an increasingly interdependent world. Regional approaches to the conduct and funding of agricultural R&D have been revived in more recent years, a feature of much of the region's research in earlier, colonial times, as we describe here. However, the political and economic realities of today bear little relationship to those of colonial times, and it remains unclear how these regional approaches will prosper and effect meaningful research given the organizational uncertainties that still abound.

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1. INTRODUCTION

The organizational framework within which agricultural R&D takes place encompasses such things as the overall governance and administrative structure of a national program of R&D, the size, scope, and structure of the agencies performing the research, and the management aspects related to the conduct of the research itself. How the funds for R&D are raised, allocated, and spent, who chooses the research to be done, and in what context it is carried out all have major incentive implications that affect the efficiency and effectiveness of a program of research.

There is a sense among many policymakers who deal with agricultural R&D issues that the old modes of doing research are no longer effective and are in need of radical restructuring. In some, especially developed, countries the organizational aspects concerning agricultural R&D are changing quickly, perhaps more so over the past few

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decades than in previous periods (see, for example, Alston, Pardey, and Smith 1999 and Roseboom and Rutten 1998). New modes of financing agricultural R&D are being implemented, new partnerships between the public and private sectors to perform R&D are emerging, and the balance of R&D efforts between different public agencies, as well as between public and private agencies, is changing too.

Yet each country or region has its own institutional and organizational histories and specific economic circumstances. What makes sense in one country may not apply elsewhere, or may require significant revamping to meet local conditions. While the broader elements of institutional reform may be applicable, the devil is often in the details. Developing some sense of these institutional details is valuable for thinking through the policy aspects of institutional reform and provides some basis for discerning the local applicability of experiences achieved elsewhere.

Agricultural R&D in Sub-Saharan Africa (referred to as Africa hereafter) has a distinctive colonial past that continues to shape agricultural R&D institutions throughout the region. The aim of this paper is to provide historical perspective on the contemporary institutional development surrounding agricultural research in Africa; to characterize and, where possible, quantify the more pervasive organizational and governance problems facing African agricultural research; and to discuss various suggested solutions or policy practices.

Developments, from the embryonic efforts early in the twentieth century, through to the post-colonial period, are discussed in the next section. Many of today's policymakers may have little understanding of this history, yet it provides an important

perspective for tackling some of today's issues that have links to the past. Key organizational issues worthy of serious policy attention are discussed in Section 3. They relate to the organizational structures used to conduct R&D (including aspects such as the size, fragmentation, and sectoral orientation of African research agencies), administrative and governance issues, and the coordination and conduct of supranational research. Section 4 synthesizes and concludes the paper.

2. HISTORICAL PERSPECTIVE

While farmers have experimented and innovated for centuries, and continue to do so, state-supported and organized agricultural research had its beginnings in Germany in the mid-nineteenth century. This institutional innovation was adopted quite rapidly throughout Europe and the rest of the now-developed world. By 1875, more than 90 agricultural research stations had been established throughout Europe, and by 1900 the number of stations had grown to more than 500, employing about 1,500 professional scientists (Grantham 1984). Within a comparatively short timeframe, European countries also transplanted these R&D institutions to their colonies. This often happened as an outgrowth of the work done by colonial botanical gardens as a precursor to agricultural research. These gardens played an important role in the introduction and spread of new crops throughout the colonies.

2.1 ORGANIZATIONAL ORIGINS²

Public agricultural research in Africa took root in the late-nineteenth century when Europeans first colonized the continent. Their agricultural interests in the region derived, in part, from the desire to secure adequate and low-cost supplies of raw materials from indigenous or introduced tropical crops, such as oil palm, cacao, coffee, tea, and cotton, for which no ready substitutes were available in Europe. By the turn of the century, a good number of botanical gardens, model farms, and a few experiment stations had been established in Africa (particularly by the British and to a lesser extent by the French) to screen and propagate tropical export crops. True and Crosby (1902) report that, around 1900, some 24 botanical gardens and experiment stations had been established across 18 contemporary states in Sub-Saharan Africa alone. The botanical gardens in British Africa were linked to and supported by Kew Gardens, London. During the nineteenth century, the heyday of economic botany, Kew Gardens played a particularly active role in the collection, maintenance, characterization, and transfer of plant genetic material throughout the British Empire.³ Following the model of Kew Gardens, the French government established a “Jardin Colonial” at Nogent-sur-Marne near Paris in 1899 which developed and supported a network of “jardins d’essais” throughout the French colonies. The

² Some material presented in this part of the paper can be found in an earlier, less-comprehensive form in Pardey, Roseboom, and Anderson (1991).

³ To quote Joseph Chamberlain in the House of Commons on August 1890, “Thousands of letters pass every year between the authorities at Kew and the Colonies, and they are able to place at the service of those Colonies not only the best advice and experience, but seeds and samples of economic plants capable of cultivation in the Colonies” (Masefield 1972, 24). See also Brockway (1979).

Belgians followed suit and also established two botanical gardens in the Congo at about that time.

In keeping with Germany's leading role in the institutional development of agricultural research in Europe during the second half of the nineteenth century, one of the first agricultural research stations in Africa was established by the Germans at Amani, Tanganyika (now part of Tanzania). Established initially as a botanical garden in 1890, it acquired laboratory facilities and a small research staff in 1902 and was reconstituted as a research station. In addition, several trial farms were established to study the cultivation of crops such as wheat, tobacco, tea, cocoa, and pepper. However, prior to 1914, only cocoa had been commercialized as a plantation crop (Fuggles-Couchman 1964). Anthony et al. (1979) claim that the Amani station was the most advanced agricultural research center in tropical Africa on the eve of World War I. However, Germany lost all its colonies during the war, and the station was closed in 1917 when the British took control of Tanganyika. It was reopened by the British in 1926 as the East African Agricultural Research Station.

These botanical gardens and early experiment stations laid the foundation for the emergence of a fledgling agricultural research infrastructure in Africa, so that by 1920, at least one research station or site had been established in virtually every country in the region (McKelvey 1965 and Spencer 1986). The successful introduction of a wide range of cash crops in Africa between 1850 and 1940, such as coffee, tea, oil palm, cotton, cocoa, groundnuts, rubber, sisal, cotton, maize, and rice, undoubtedly owes much to the search-and-screening work of these early research establishments. The commercialization

of these crops strengthened the demand for additional agricultural research throughout the colonies as a response to the production problems and other technological challenges confronting these emerging agricultural sectors.

2.2 BETWEEN THE WORLD WARS

The period 1920-40 saw further expansion of agricultural research and a greater degree of research specialization—and with that specialization, the emergence of commodity-specific research stations. Most botanical gardens were transformed into agricultural experiment stations and grew as a consequence, or—alternatively—became increasingly marginalized (especially in terms of agricultural research) if they opted to focus merely on the collection and conservation of plant material. As a result, the networks of botanical gardens lost a great deal of their earlier importance. Administrative responsibility for agricultural research during this inter-war period rested largely with the local colonial administrations, with only limited intervention by metropolitan governments such as those in London, Paris, Lisbon, and Brussels. However, in French West Africa (established in 1895 and comprising Benin, Burkina Faso, Côte d'Ivoire, Guinea, Mali, Mauritania, Niger, and Senegal) and French Equatorial Africa (established in 1910 and comprising Chad, the Central African Republic, Congo, and Gabon) a two-tiered research system of federal and local research agencies emerged during the 1920s and 1930s. Federal research agencies, administered by the respective federal governments, assumed a

coordinating role regarding the work performed by the local stations.⁴

Funding for agricultural research in Africa at this time generally came from local, in-country sources.⁵ In addition, some privately funded and performed agricultural research was also undertaken by plantation industries and marketing boards for crops such as oil palm in Zaire and coffee in Kenya. A notable example was the Empire Cotton Growing Corporation (ECGC), a nonprofit organization established under British Royal Charter in 1921 with support from the cotton spinning industry. The ECGC established a network of agencies performing cotton research throughout the British Empire, with African sites in the Sudan, Uganda, Kenya, Tanzania, and Malawi. Researchers regularly rotated among the colonial stations and the organization's headquarters in London. The French commodity research institutes, established in the 1940s and 1950s, were modeled after the ECGC.

A new and significant development at this time was the introduction of specialized professional training for scientific personnel destined for work in the colonies. Beginning in the early 1920s, the British Colonial Agricultural Service sponsored a two-year course in tropical agriculture for its new staff; one year at Cambridge, England, and the other in

⁴ Togo and Cameroon were originally German colonies placed under French governance after World War I by the League of Nations. They were never formally integrated in the federal structures.

⁵ Jeffries (1964) estimates that expenditures by the British government on agricultural research in its African colonies between 1920 and 1940 totaled only £500,000. Eisemon, Davis, and Rathgeber (1985, 194) note that "French official support of colonial research was insubstantial before the Second World War" while Headrick (1988, 229) states that "Only after World War II did France begin to invest in something other than infrastructures in its colonies."

Trinidad at the Imperial College of Tropical Agriculture, which was established there in 1921 (Masefield 1972). An “Ecole Supérieure de l’Agriculture Tropicale” had already been established in France in 1902. In 1921 this school and the neighboring “Jardin Colonial” were merged to become the “Institut National d’Agronomie Coloniale” (INAC). This was followed in 1928 by the establishment of a research and training institute that focused on animal health and production in the tropics, namely the “Institut d’Elevage et de Médecine Vétérinaire des Pays Tropicaux” (IEMVT) (Angladette 1982 and Angladette 1988).

It was not until after World War II, in response to widespread changes in the world’s political and economic situation, that metropolitan governments began to play a more active role in the conduct and administration of agricultural research in their colonies. This led to a major reorganization and expansion of agricultural research capacity in Africa between 1945 and 1960, particularly in the British and French colonies.

2.3 POST-WORLD WAR II PERIOD

During the 1930s, a number of prominent individuals and organizations in both France and Great Britain had already argued for a more active involvement in colonial research by the central government, but it was not until after World War II that major institutional changes were set in motion. In France, the “Association Colonies-Sciences,” established in 1925 to promote colonial research, proposed the establishment of an “Office des Recherches Scientifiques Relatives à la France d’Outre Mer” during its first congress in 1931 and reiterated this proposal at its second congress in 1937 (Eisemon, Davis, and

Rathgeber 1985).

In Great Britain, Lord Hailey strongly advocated that the British government provide a substantial increase in funding for research in Africa and that it take a more centrally coordinated, public-sector approach to the conduct of agricultural research throughout its African colonies. His advice was based on a large survey he conducted between 1935 and 1938 on the political, social, and economic state of affairs in Africa (Jeffries 1964). Acting upon these recommendations, the British government created a Colonial Research Fund with an initial annual budget of £0.5 million. The necessary legislation was enacted in July 1940 and several organizations, such as the Colonial Research Committee and the Committee for Colonial Agricultural, Animal Health and Forestry Research were established to initiate and coordinate colonial research. However, implementation of many of the plans made at this time was deferred until after World War II. In 1946, the annual budget of the Colonial Research Fund was raised to £1.0 million.

The move to a more centralized approach to funding and administering colonial research had important consequences for subsequent agricultural research activities throughout the British colonies in Africa. Immediately following the war, the British government sought to complement and extend the ongoing local research within its African colonies by reorganizing and expanding its agricultural research endeavors along regional lines. Between 1946 and 1952 the following regional agricultural research organizations were established: the East African Veterinary Research Organization, the East African Freshwater Fisheries Research Organization, the East African Agriculture and Forestry Research Organization, the East African Trypanosomiasis Research

Organization, the East African Marine Fisheries Research Organization, and the Tropical Pesticides Research Institute of East Africa. All these organizations were principally financed by the British government. In addition, the research department of the East African Tea Holdings at Kericho was incorporated into the newly established Tea Research Institute of East Africa in 1949. The funding for this institute came mainly from a tax on tea exports from the region. To monitor and coordinate all of the research carried out by the territorial and inter-territorial institutes of Kenya, Tanganyika, Uganda, and Zanzibar, the East African Agricultural and Forestry Research Council was created in 1947. Additional regional research organizations, such as the East African Bureau of Research in Hygiene and Tropical Medicine and the East African Institute of Social Research, were also established around 1950 (Jeffries 1964).

The shift toward regional coordination and rationalization of agricultural research in British West Africa was not as pronounced as that experienced in British East Africa. In West Africa, it was not so much a case of creating new research organizations but of restructuring existing agencies into regional institutes. The Cocoa Research Station of the Gold Coast (now Ghana) became the West African Cocoa Research Institute in 1944, the rice experiment station in Sierra Leone was transformed into the West African Rice Research Station in 1949 and, subsequently, into the West African Rice Research Institute in 1954, and the Oil Palm Research Station in Nigeria assumed interterritorial status in 1951 when it was renamed the West African Institute for Oil Palm Research. All three institutes were part of the West African Interterritorial Research Organization (WAIRO), an umbrella body for the regional research activities in British West Africa (comprising

British Cameroon, Ghana, Nigeria, and Sierra Leone).⁶

In British Central Africa (today's Malawi, Zambia, and Zimbabwe) the Agricultural Research Council of Central Africa was established in 1961 with substantial support from the British government. The mode of operation adopted by the Council was quite different from previous approaches to regional research elsewhere in Africa. Rather than establish regional institutes, project teams were formed with researchers from several different disciplines with their research focused on problems of economic significance for the region—an early example of a multidisciplinary, mission-oriented approach to research in Africa. The project teams and facilities were attached to existing national agricultural research agencies to minimize overhead costs and to foster interaction among the scientific staff (Cooper 1970). However, the Council was disbanded after only a few years' operation as a result of the dissolution of the Federation of Rhodesia and Nyasaland in 1963. Other forms of regional collaboration involved the Joint Fisheries Research Organization, which operated from 1954 to 1961, and the Tea Research Foundation of Central Africa, which was not established until 1966, following a long history of local research funded by the industry.

Publicly performed and largely publicly funded agricultural research throughout British Africa evolved in a largely dualistic fashion. On the one hand were the ministry-

⁶ Several other regional institutes were under the auspices of WAIRO. These included the West African Institute for Trypanosomiasis Research, established in 1947 and officially opened at Kaduna in Nigeria in 1951; the West African Stored Products Research Unit at Lagos, which began operations as the West African Pest Infestation Survey in 1948; the West African Fisheries Research Institute established in Sierra Leone in 1952; the West African Maize Rust Research Unit in Nigeria; and the West African Timber Borer Research Unit in Ghana.

based institutes, mainly managed and financed at the local level, and on the other hand were the regionally mandated institutes primarily directed and (especially in East and Central Africa) funded by the metropolitan government. The regional institutes in East Africa were discipline-based operations, providing specialist research services to all three countries. Thus the virologists, soil physicists, and other specialists working at the East African Agriculture and Forestry Research Organization (EAAFRO) complemented the more site-specific work of the breeders, agronomists, and entomologists in the local institutes. Similarly, the scientists at the East African Veterinary Research Organization (EAVRO) tended to work in-depth on a selected number of diseases or research problems rather than on issues of a more general veterinary nature. In contrast, the regional agencies formed throughout British West Africa had commodity rather than research-specialty orientations, and their work had a higher site-specific component than the corresponding agencies in East Africa.

In 1943 in France, following the recommendations for institutional change advocated prior to World War II, the Vichy government created the “Office de la Recherche Scientifique Coloniale” (ORSC). Besides ORSC, several specialized, tropical agricultural research institutes emerged during the 1940s and 1950s (Angladette 1982).⁷

⁷ By 1960, eight such institutes were operational and covered food crops (IRAT), livestock and veterinary medicine (IEMVT), fruit (IFAC), coffee and cacao (IFCC), rubber (IRCA), cotton (IRCT), oil crops (IRHO), and forestry and fisheries (CTFT). In 1970 these institutes were integrated into Groupe d’Etudes et des Recherches pour le Développement de l’Agronomie Tropical (GERDAT), which in 1984 was restructured and renamed ‘Centre de Cooperation Internationale en Recherche Agronomique pour le Développement’ (CIRAD). Besides these eight institutes, GERDAT initiated research programs on practical acridiology and operational ecology in 1975, while in 1984 and 1985, respectively, institutes conducting research on agricultural machinery (CEEMAT)

These institutes conducted more applied, commodity-oriented research, while ORSC and its successor ORSTOM did more basic, less commodity-specific research on topics such as climate, diseases, and soil fertility.⁸ ORSC, along with the other specialized institutes, was organized with a rather centralized, metropolitan-based structure. All the institutes had their headquarters in France and satellite stations in the various colonies, which contrasts with the more decentralized, regional approach taken by the British (Eisemon, Davis, and Rathgeber 1985).

The federal structure of agricultural research in French West Africa (AOF) was further strengthened after World War II with the establishment, in 1949, of the “Comité de Coordination et de Contrôle des Recherches Agronomiques et de la Production Agricole.” The committee was expected to develop research policy options, coordinate and evaluate federal and local research and extension, and oversee the budgets for these activities. The distinction between federal and local research stations, introduced in the 1920s and 1930s, was further developed as some local research stations were upgraded to federal status and some federal stations to federal research centers. In addition, some of the specialized commodity research centers operating at the federal level, with local stations often attached to them, were integrated into the metropolitan-based commodity institutes during the 1940s and 1950s. What evolved was a linked, three-tiered research system of local

and farming systems (DSA) were added to the group (CIRAD 1986).

⁸ ORSC was reestablished as “Organization de la Recherche Scientifique et Technique d’Outre-Mer” (ORSTOM) in 1953. Initially, ORSC/ORSTOM also undertook agronomic research activities, but these aspects of its research program were hived off to form IRAT in 1960.

research stations, federal research stations and centers, and metropolitan-based commodity institutes. The federal stations and centers, including those operating under the umbrella of the metropolitan-based commodity institutes, received budgetary support from AOF (including regionally managed check-off funding schemes and the like), whereas the local stations were financed by the territories in which they were located.

Surprisingly to some, the Belgians administered the largest tropical agricultural research institute in Africa prior to 1960. Building on a long tradition of agricultural research dating back to the early days of colonization in the Belgian Congo (today's Democratic Republic of Congo and formerly known as Zaire), Burundi, and Rwanda, the Belgians established the "Institut National pour l'Etude Agronomique du Congo Belge" (INEAC) in 1933.⁹ Although headquartered in Belgium, INEAC established a large central station at Yangambi and an extensive network of 36 research stations throughout the Congo, Burundi, and Rwanda. Research was undertaken on export crops such as oil palm, rubber, cotton, coffee, and cacao. Contrary to the prevailing pattern in other parts of Africa at the time, considerable attention was also given to research on staple food crops such as rice, maize, cassava, and groundnuts. Immediately prior to Congo's independence in 1960, INEAC employed some 260 researchers (Tollens 1987), more than 10 percent of the total number of agricultural researchers in Africa at that time.

⁹ For a description of research activities in the Belgian Congo before the establishment of INEAC see Drachoussof (1989).

2.4 POST-INDEPENDENCE DEVELOPMENTS

Colonial Research Legacies

With political independence in the late 1950s and early 1960s, most African countries inherited agricultural research structures that operated as part of a regional system. As the old colonial structures collapsed, many smaller countries found themselves effectively cut off from the network of research services to which they previously had direct access. Other countries were left with highly specialized research agencies that did not necessarily address local production problems. There were major incongruencies across countries regarding the existing research capacity. Moreover, research was largely oriented to meeting the demands of export agriculture and paid little attention to the production constraints faced by subsistence farmers. As a result, what followed was a lengthy and often disruptive process of nationalization and reorganization of the inherited institutions.

The extensive research infrastructure in the Belgian Congo deteriorated rapidly following independence in 1960. Political upheavals and civil strife led to the complete withdrawal of all Belgian agricultural researchers from the Congo and a cessation of all Belgian support. In the mid-1960s, a joint effort was mounted by Italy, West Germany, France, and Belgium to revive INEAC by providing some 30 to 40 expatriate researchers. However, after a few years the program lost ground and was discontinued (Webster n.d.). In the case of Burundi and Rwanda, the INEAC facilities located in these countries were transformed into national agricultural research agencies (ISABU and ISAR, respectively) after independence. Nonetheless, Belgian influence over agricultural research in Burundi

and Rwanda continued for many years after independence, and ISABU and ISAR continued to be staffed and funded largely by Belgium.

Throughout British Africa responsibility for the local as well as the regional research institutes was transferred to the newly formed governments at independence. British technical assistance generally lingered for a little time after independence, but then declined quite rapidly in importance and switched from unrestricted core to project-based funding. The regional research centers in former British West Africa were either dissolved or absorbed into national agencies. In former British East Africa, regional research structures such as EAAFRO and EAVRO continued to function well beyond independence, but not without some problems.¹⁰ Asymmetries in the incidence of research benefits and costs may account in large measure for the different fates of these regional organizations. The West African organizations relied more heavily on local funding, in part through commodity boards, and pursued commodity-focused research. This gave a local focus to the research and struck a balance between the costs of research and the benefits flowing from it. Moreover, Nigeria, Ghana, and Sierra Leone do not border each other, and this made communications difficult and affected the sense of a common cause. By contrast, the regional institutes in East Africa were not as dependent on local funding and performed research that was generally less commodity or site oriented.¹¹ A qualitative

¹⁰ Data taken from Pardey and Roseboom (1989) and Jamieson (1981) show that the regional organizations within East Africa accounted for about 20 percent of the total number of agricultural researchers working in Kenya, Tanzania, and Uganda at the time of independence.

¹¹ For example, approximately two-thirds of the total (i.e., agricultural plus non-agricultural) research expenditures by the metropolitan government in British Africa

assessment of this benefit-cost calculus suggests that there was consequently more incentive to maintain these regional organizations after independence in British East than in West Africa.

Nonetheless, aspirations for national control over the regional public agencies in general, rather than over these agricultural research organizations in particular, created friction regarding their funding, administration, and operation. Such friction resulted in the eventual collapse of the East Africa Community in 1978 and, in most instances, the integration of the remaining interterritorial research services into national structures. The disintegration of these regional research organizations eventually led to a substantial reduction in British financial support for agricultural research in these countries.

Regional agricultural research activities in British Central Africa had only just begun when the Federation of Rhodesia and Nyasaland collapsed in 1963. Consequently these regional research activities were either discontinued or taken over by national research entities.

This pattern of post-independence institutional development in former British Africa contrasts markedly with that in former French Africa. Rather than transferring responsibility for the colonial research institutes to the newly formed national governments, as occurred throughout British Africa, the French retained administrative responsibility, operating out of metropolitan France for many years following independence. A continuation of French ownership or long-term rights of access to the

during the period 1940-60 went to British East Africa. By contrast, the regional organizations in West Africa were financed mainly by funds derived from taxes levied on export crops (Jeffries 1964).

local research infrastructure throughout Africa formed part of the cooperative agreements that France signed with nearly all the French African territories that gained independence during the late 1950s and early 1960s. However, no agreements were reached with the incoming governments of Guinea and Mali, and France withdrew all its agricultural research staff and equipment from these two countries.

The division of labor between the federal and national agricultural research stations that had existed earlier throughout French West Africa and French Equatorial Africa dissolved with the collapse of these federations upon independence. However, the French commodity institutes, which continued to operate in many of the former colonies after independence, maintained the semblance of a regional division of research responsibilities until their activities were eventually nationalized.

It was not until the 1970s, when the 10-year contracts negotiated at independence were due for renewal, that the local research structures affiliated with the French commodity institutes were gradually assumed by the domestic governments and integrated into their newly established national agricultural research organizations. However, in many former French colonies French support with regard to agricultural research remained important. As a consequence, expatriate scientists continued to play an important role throughout countries in former French Africa than in former British Africa. In 1991, for example, about 21 percent of the researchers working in former French Africa were expatriates compared with only 7 percent in former British Africa.

General Developments

The years immediately following independence were often fairly turbulent for agricultural R&D organizations. Many countries were starting with comparatively little physical, human, and organizational capital in the agricultural sciences, or the research capital they did inherit was often directed to a narrow (often commercial, export-related) range of commodities. Substantial sections of the local agricultural economies were not served by these systems at that time.

The ensuing years saw a rapid build-up of (local) research staff and research facilities and a significant expansion in the number of research agencies. Unfortunately, the scarcity of local organizational and management skills in many of the newly independent states meant the funds flowing to R&D were not always spent as wisely as perhaps possible. Public research agencies often developed in a haphazard fashion under an expanding and diverse set of government ministries and agencies, leaving many countries with a somewhat fragmented set of research agencies, as we document below.

The expanding scope of the research agencies saw new initiatives in areas of food research that were hitherto neglected, like staple food crops such as cassava, sorghum, and millet, as well as the introduction of research in livestock, forestry, and fisheries. A desire to expand the geographical scope of the research into less-favored agroecological areas that also had received little or no direct attention in the past often resulted in an increased numbers of local research facilities. Besides expanding the commodity and geographical coverage, a number of new research themes emerged, some more a result of earmarking by donors, perhaps, than a response to any domestic demand. There was the

work on “atomic agriculture” in the 1960s, the farming systems research beginning in the 1970s, the agroforestry, natural resource management, and sustainability themes that have gained the attention of policy makers more recently, as well as “value-adding” types of R&D, often in the form of food processing, storage, and distribution research. Some of these themes (or aspects of them) have payoff potential in an African context, others are little more than buzzwords that act to draw attention and resources away from the more urgent production problems facing subsistence and commercial farmers in Africa.¹²

All of this change regarding agricultural R&D must be seen against the broader background of the institutional, social, and political changes that were occurring throughout Africa at this time. Certainly the continent has seen its share of political and social instability over the years and these factors have especially important organizational and other effects on agricultural R&D.

Political and Institutional Instability

Agricultural research is a long-term endeavor; it typically takes seven to 10 years, for example, to breed a new crop variety and many more years for that variety to find its way into most farmers’ fields. These long lags make agricultural R&D especially susceptible to the social and economic disorders that follow from political instability, civil unrest, or outright war. Over the past three decades, Africa has seen much more such instability than most other regions in the world. The more flagrant examples are countries

¹² For an elaboration of the perverse consequences these buzzwords can have, even in a highly developed R&D system such as the United States, see Alston and Pardey (1996).

such as Angola, Liberia, Mozambique, Nigeria, Rwanda, Sudan, Somalia, Uganda, and Zaire.¹³

There are other, less visible, forms of instability that can be equally devastating to the longer-term development of a viable organizational base for agricultural R&D. Throughout many countries in Africa, research institutes and departments frequently have been moved from one ministry to another or split, merged, or reconstituted under various guises, reflecting a continuing cycle of change in the mandates of the ministries which govern them. Unfortunately, more often than not, these changes have been motivated largely by political (and, in some cases, bureaucratic) concerns rather than a considered and meaningful response to the changing nature of the agricultural sciences or the economic context within which these public agencies operate. Since 1962, the Cocoa Research Institute of Ghana, for instance, has variously been administered by the National Research Council, the Ghana Academy of Sciences, the Council for Scientific and Industrial Research, the Ministry of Cocoa Affairs, the Ghana Cocoa Marketing Board, and the Ghana Cocoa Board (Eicher 1989). Similarly, the mandate of the Ministry of Agriculture in Kenya has undergone frequent changes, with consequent organizational impacts on the public R&D agencies they administer. In 1974 all crop and livestock research within the Ministry of Agriculture was merged into a new Scientific Research Division (SRD). Five years later (1979), SRD was split as a consequence of establishing a

¹³ Not only political instabilities but also economic policies that were detrimental to agriculture, such as overvalued exchange rates and heavy taxation, have hindered the development of the agricultural sector in Africa. See Pardey et al. (1998) for a more detailed analysis of this issue.

separate Ministry of Livestock Development. In 1983 the Ministry of Agriculture and the Ministry of Livestock Development were reunited, only to be divided again in 1986. Most recently, in 1988/89, the research divisions of both ministries were merged and transformed into an autonomous parastatal organization, the Kenyan Agricultural Research Institute (KARI) (Roseboom and Pardey 1993).

Idachaba (1998) provides some insights into the unstable political and governance regimes that have befallen agricultural research agencies throughout Nigeria over the past several decades, often as a consequence of frequent changes or restructuring of state and federal governments. The Federal Ministry of Science and Technology (FMST), for example, was first established in 1980, merged with the Ministry of Education in 1984, reestablished in 1985, abolished in 1992, and reconstituted again in 1994. The National Council for Science and Technology, which preceded the Federal Ministry of Science and Technology, had a similar turbulent history throughout the 1970s. In addition, the responsibility for agricultural research shifted during the 1970s in gradual steps from the Federal Ministry of Agriculture to the Federal Ministry of Science and Technology (and its predecessors), but was moved back to the Federal Ministry of Agriculture in 1992 (Roseboom et al. 1994). Idachaba also describes the frequent turnover of board members of the various agricultural research institutes, meaning that many of these boards have been ineffectual or even dysfunctional. A particularly flagrant and common occurrence is the replacement of an entire board at one time; such occurrences cause sudden and usually disruptive shifts in institutional policies and practices.

3. CONTEMPORARY ORGANIZATIONAL ASPECTS AND ISSUES

3.1 OVERALL ORGANIZATIONAL TRENDS¹⁴

In broad terms, the institutional basis of public agricultural research in Africa has changed little in the past 30 years. Most African agricultural researchers still work for government R&D agencies such as ministerial research departments or semi-autonomous agricultural research institutes. In 1991 these government agencies employed 86.5 percent of the full-time-equivalent (fte) researchers working in African agricultural R&D agencies; slightly less than the 90.7 percent so employed in 1961. The remaining 10-15 percent of the fte agricultural researchers worked for semipublic agencies and universities.

Semipublic R&D agencies are taken here to be those agencies not directly administered by government and with significant autonomous sources of funding, usually some compulsory cess or marketing-board profits.¹⁵ They usually provide R&D services for a particular and often significant export commodity. Examples include agencies doing research on coffee (Kenya), sugar (Mauritius and South Africa), tea (Kenya and Malawi), and tobacco (Zimbabwe). All the semipublic research institutes reported in our survey sample were in former British colonies, and nearly all were established during colonial times. Comparatively few semipublic agencies have been established since 1961.

¹⁴ This section draws heavily on Pardey, Roseboom, and Beintema (1997), which summarizes the institutional data obtained from a survey on agricultural research in Africa.

¹⁵ As a practical matter we required that an autonomously governed R&D agency receives at least 25 percent of its income from sources other than government and international donors before classifying it as semipublic.

Consequently, they employ a shrinking share of the region's full-time agricultural researchers; 4.3 percent in 1961 down to 3.5 percent in 1991.

In contrast with the government and semipublic R&D agencies, university-based agricultural research has expanded more rapidly. The total number of full-time researchers at universities grew on average by 7.1 percent per annum over the past three decades, and by 10 percent per annum if South Africa is excluded. Still, despite this rapid growth, universities maintain only a small share of the overall research effort given the very small base they started with. Initially throughout post-independence Africa, most university staff were fully engaged in educating graduates to staff newly emerging national bureaucracies, and most universities started to conduct research only gradually. Although the time devoted to research has grown over the years, most university faculties still allocate less than 20 percent of their time to this endeavor. Moreover, this research is usually more discipline-based rather than applied research aimed at solving specific production problems faced by farmers.

3.2 NATIONAL AGRICULTURAL RESEARCH STRUCTURES

Organizational Type

NARO model. The most common case of consolidation among African NARS has been the adoption of a single structure called a National Agricultural Research Organization (NARO). The motivation behind this development was, often, to lower the transactions costs of agricultural R&D across otherwise disparate agencies, and to streamline the allocation of limited resources, thereby improving the focus of the research—spatially and

otherwise. Unfortunately, developments have not always met goals, but this remains the dominant organizational model for publicly performed agricultural R&D throughout Africa and, indeed, many countries elsewhere in the world. In 1991, 28 of the 48 countries in Africa had adopted a NARO structure—by our definition having a comprehensive program of research by commodity and spatial focus, and employing at least 50 percent of a country’s fte agricultural researchers. A NARO typically undertakes crop and livestock research, but sometimes also veterinary, forestry, and fisheries, and others (appendix table B.1).

Other organizational models. Besides the single-agency, NARO model, two other organizational models exist among African NARS: the “two-agency model” and the “multi-agency model.” In the case of the two-agency model, public agricultural research has been consolidated into two separate agencies which, combined, account for at least 50 percent of a country’s total cadre of fte agricultural researchers. Typical of this are two separate agencies for crop and livestock research (as in Cameroon and Mozambique) or two separate agencies for distinct agroecological zones (as, until recently, in Côte d’Ivoire). The multi-agency model represents the case in which no single agency conducts a dominant share of the country’s total agricultural research.

In 1991, of the 20 non-NARO–structured NARS in Africa, four followed the two-agency model, and 16 the multi-agency model. Together they accounted for 179 of the 265 non-NARO agencies identified in our survey. The remaining 86 non-NARO agencies operated as distinct entities in countries with a NARO.

In addition to these 293 NARO and non-NARO agencies, we identified 105 faculties, university colleges, or schools of agriculture, forestry, and veterinary sciences throughout Africa. Almost half of these were found in just three countries—Nigeria, South Africa, and Sudan—11 countries lacked a faculty of agricultural, veterinary, or forestry sciences in 1991 (appendix table B.1).¹⁶

Table 1 provides some indications of the organizational differences between African agencies classified as NAROs and those that are not. These organizational modes give rise to quite distinct research agencies, which imply different types of policy and administrative problems. As one would expect, NAROs are typically much larger than non-NAROs. In fact NAROs employed, on average, 6.5 times more fte researchers than non-NAROs. In addition, they operate many more research stations and have more researchers at each station. On average, NAROs employed almost 70 fte scientists at their headquarters; in contrast, non-NAROs employed an average of 20 scientists at headquarters, which account for about 80 percent of the total number of scientists working for each agency. Thus, non-NAROs concentrated most of their staff at their primary facility, while NAROs typically had less than half their staff at headquarters.

While NAROs, by definition and design, have quite broad research agendas, non-NAROs typically do research on just one or two commodities or groups of commodities

¹⁶ Our tabulation of “agricultural” faculties does not cover all faculties in the natural and social sciences that do research of relevance to agriculture (e.g., biology, fisheries, environmental sciences, economics).

Table 1 Staffing characteristics of NARO versus non-NARO agencies

Organizational type	Average fte researchers	Of which at headquarters		Average number of stations	Researchers per station
		number	percentage		
NAROs	160.2	68.6	42.8	11.4	7.4
non-NAROs	24.8	20.0	80.9	1.6	1.8

Source: Compiled by authors from survey data.

Note: Based on a sample of 14 NAROs and 120 (government and semipublic) non-NAROs in 23 African countries. Data represent the situation in 1991. Only research stations that are staffed with researchers have been considered here.

(e.g., crop research).¹⁷ Table 2 summarizes the deployment of research staff working for non-NARO agencies, stratified according to each agency's respective commodity focus.

Agencies engaged in crop research are generally among the larger agencies, while those engaged in forestry research or research not targeted to a specific commodity are generally the smallest.

Table 2 Staffing characteristics of non-NARO agencies

Commodity focus	Average fte researchers	Of which at headquarters		Average number of stations	Researchers per station
		number	percentage		
Multi-sector	26.5	23.6	89.1	1.6	1.1
Crops	35.0	29.5	84.3	1.6	2.1
Livestock	21.0	18.3	87.0	1.2	1.3
Forestry	18.1	12.3	67.8	2.3	1.8
Fisheries	26.7	19.2	72.1	2.1	2.4
Other	16.4	12.2	74.5	1.3	1.8
<i>Average</i>	<i>24.8</i>	<i>20.0</i>	<i>80.9</i>	<i>1.6</i>	<i>1.8</i>

Source: Compiled by authors from survey data.

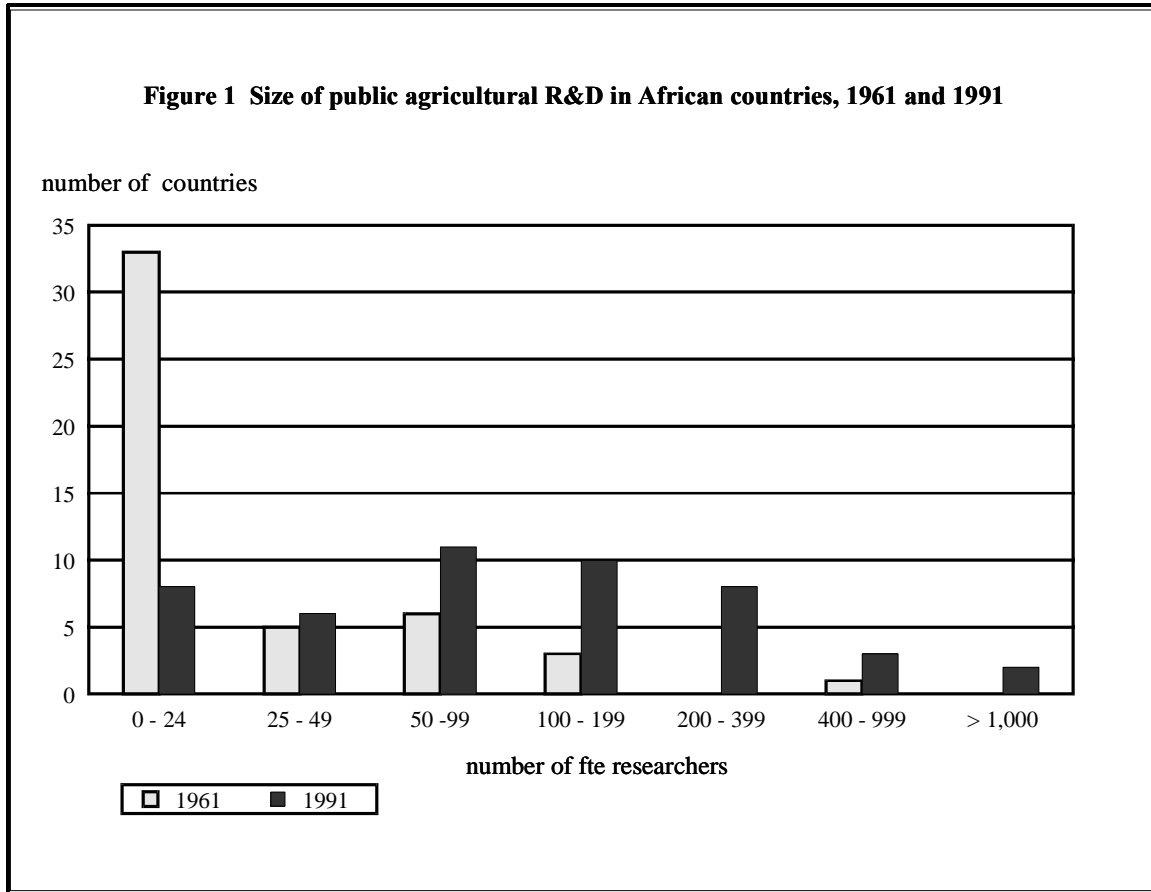
Note: See table 1.

¹⁷ Only 12 of the 120 agencies undertook R&D that spanned more than one commodity group.

Size

At political independence most national agricultural research systems were quite small: 33 of the 48 African countries employed less than 25 fte researchers in 1961 (Figure 1). Only four countries employed more than 100 researchers. Marked change has occurred since then, with considerable growth of the national research effort. Most of the expansion can be attributed to growth in mid-sized national agricultural research systems employing between 100 and 400 researchers. In 1961 there were only three mid-sized systems; by 1991 (the latest year for which we have comparable data) there were 18 such systems. By 1991, the number of small systems employing less than 25 fte researchers had shrunk to eight, while the number of large systems employing more than 400 fte researchers had grown to five (Sudan, Tanzania, Kenya, Nigeria, and South Africa).

The growth in the size of the agricultural effort throughout Africa has been quite uneven; smaller systems (with less than 25 fte researchers) grew much more rapidly (an average of 9.7 percent per annum between 1961 and 1991) than mid-sized (25-200 fte researchers) or larger (greater than 200 fte scientists) systems, which grew by 6.1 and 2.0 percent, respectively. The adjustment costs associated with growth, such as implementing new administrative and organizational structures, incorporating incoming staff into programs of research, and, naturally, expanding the physical facilities to house the additional researchers, have been disproportionately greater in the smaller systems in Africa. However, Pardey, Roseboom, and Beintema (1997) show that this rapid growth may largely be a thing of the past: the number of researchers among 21 African countries grew by only 2.8 percent per annum from 1981 to 1991, compared with 6.2 percent in the 1960s, and 4.8 percent in the 1970s.



Rather than simply looking at R&D size from a system (i.e., country) perspective, the new institutional data that underpin this paper make it possible to analyze the size distribution across research agencies. This is done for 1991 in table 3. It shows a wide disparity in size. The largest agency in our sample is KARI with 532 fte researchers, the smallest is the Sugar Technology Department of the University of Mauritius with 0.4 fte researchers. The size distribution of the 341 agricultural research agencies in table 3 is highly skewed toward smaller agencies, especially those with less than 10 fte researchers.

Table 3: Size distribution of agricultural R&D agencies, 1991

Number of researchers	Government		Semipublic	Universities	Total
	NAROs	non-NAROs			
	<i>(number of agencies)</i>				
Less than 5	0	34	2	73	109
5 - 10	1	29	2	31	63
10 - 20	2	38	3	21	64
20 - 50	4	50	4	5	63
50 - 100	3	22	1	0	26
100 - 200	7	3	0	0	10
200 - 400	4	1	0	0	5
Greater than 400	1	0	0	0	1
<i>Total</i>	<i>22</i>	<i>177</i>	<i>12</i>	<i>130</i>	<i>341</i>

Source: Compiled by authors from survey data.

Note: Based on a sample of 341 agricultural research agencies in 37 Sub-Saharan African countries.

About half the agricultural research agencies fall into this category; many being university departments and faculties (80 percent of the faculties employ less than 10 fte researchers).

Only 16 (4.7 percent) of the agencies in our sample employed more than 100 fte researchers; 12 of them were NAROs.

Fragmentation

The great disparity in size across research agencies raises an immediate question of whether this is because NARSs, while growing overall, are doing so by proliferating many smaller agencies. To measure this organizational aspect we developed a “fragmentation index,” which is an adaptation of the *Herfindahl* index commonly used to measure firm

concentration in the industrial organization literature. This index takes a maximum value of 1.0 if a single agency represents the total agricultural research capacity of a country. It takes on lower values when the total number of fte researchers is dispersed across an increasing number of agencies. More formally, the fragmentation index, FI , is written as:

$$FI_j = \sum_i \left(\frac{a_{ij}}{\sum_i a_{ij}} \right)^2$$

where a_{ij} is the share of fte researchers employed by agency i in country j and $\sum_i a_{ij}$ represents the sum of researchers employed by all agencies in country j .¹⁸

The relationship between the size and fragmentation of a research system and the changes in that relationship over time are evident in figures 2a-d. Here, system size (in terms of the number of fte researchers) has been plotted against the fragmentation index for each of the years 1961, 1971, 1981, and 1991. Clearly NARSs differ widely in these organizational aspects. By 1991, despite similarities in size (being large by African standards), Kenya and Tanzania had consolidated public agricultural research systems, while those in Nigeria and South Africa were comparatively fragmented. In further contrast are the research systems of Burkina Faso, Côte d'Ivoire, Ghana, Malawi, Mauritius, Namibia, Togo, Uganda, and Zimbabwe, which are small by African standards, and structurally fragmented. These are plotted in the lower left quadrant of figure 2d.

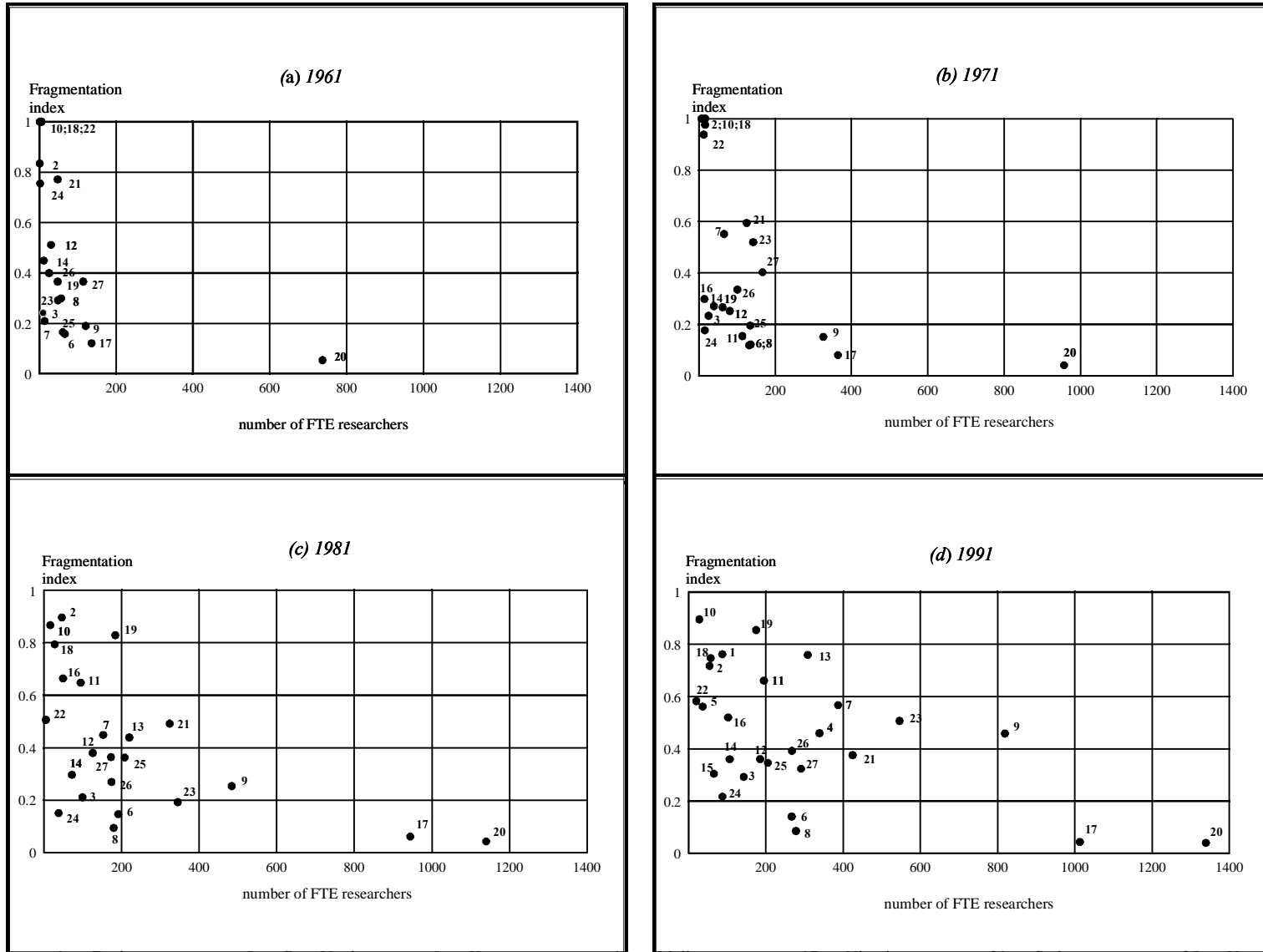
¹⁸ It was fragmentation in the conduct, not the administration and governance of R&D we sought to measure here. So, for the purposes of this index, agencies administered by a council have been treated separately, while the various research institutes, stations, or centers that form part of a national agricultural research organization were grouped into a single agency.

Note, however, that since 1991 the research systems in Côte d'Ivoire, Togo, and Uganda have been reorganized and, it seems, streamlined and consolidated.¹⁹

A time series of fragmentation indices provides a useful overview on the pattern of institutional change in an agricultural R&D system; sufficient data were available for several countries, shown in figure 3. These graphs reveal that the NARSs of Kenya and Tanzania experienced several cycles of consolidation and fragmentation, while those of Ethiopia and Senegal undertook an all-in-one consolidation process, adopting a single-agency NARO structure in 1964-65 and 1970-71, respectively. In contrast, the degree of

¹⁹ We were lacking sufficient quantitative information to construct fragmentation indexes for the NARS in Angola, Central African Republic, Chad, Congo, Gabon, Gambia, Mauritania, Mozambique, Reunion, Seychelles, Sierra Leone, and Zaire. However, our impression is that these countries all have rather fragmented systems.

Figure 2 Size and fragmentation of African NARSs, various years



Legend:

- | | | | |
|----------------|-----------------|---------------|-----------------|
| 1 Benin | 5 Cape Verde | 9 Kenya | 13 Mali |
| 2 Botswana | 6 Côte d'Ivoire | 10 Lesotho | 14 Mauritius |
| 3 Burkina Faso | 7 Ethiopia | 11 Madagascar | 15 Namibia |
| 4 Cameroon | 8 Ghana | 12 Malawi | 16 Niger |
| | | | 17 Nigeria |
| | | | 18 Rwanda |
| | | | 19 Senegal |
| | | | 20 South Africa |
| | | | 21 Sudan |
| | | | 22 Swaziland |
| | | | 23 Tanzania |
| | | | 24 Togo |
| | | | 25 Uganda |
| | | | 26 Zambia |
| | | | 27 Zimbabwe |

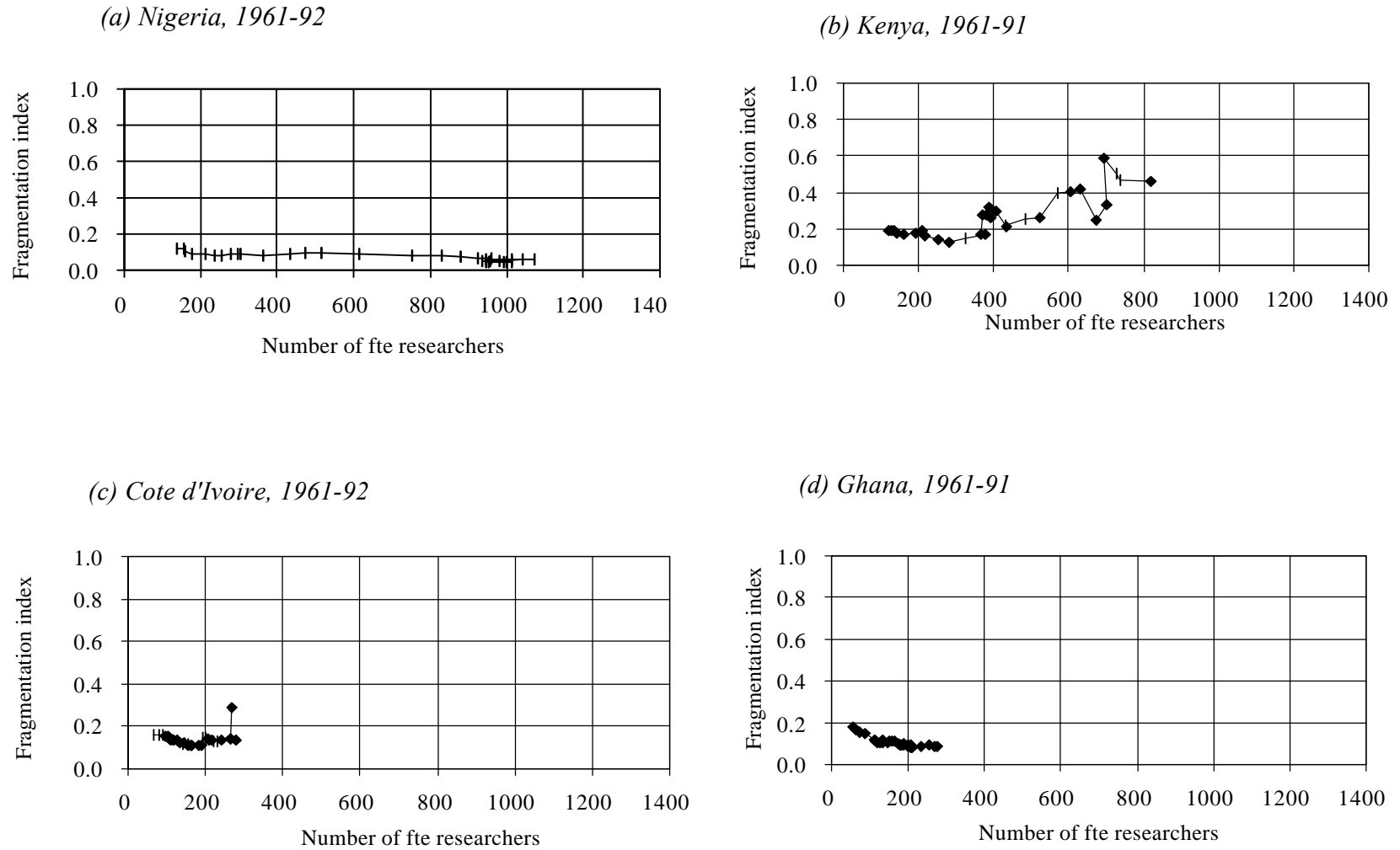
institutional fragmentation in the public research systems of Ghana and Nigeria changed little over time, despite substantial growth in overall size.²⁰ These data show that larger systems are usually more fragmented, although probably less so than in the past because of an overall trend toward consolidation of public agricultural R&D (via the NARO model and other approaches discussed above). Interestingly, with the exception of South Africa and perhaps Nigeria,²¹ there are no African countries where internal political boundaries

²⁰ The organizational change that lies beneath these summary statistics is well illustrated by the case of Kenya and Tanzania, respectively. In 1963 (at independence) Kenya inherited a fragmented, two-tiered research system, with two supranational agencies (i.e., EAAFRO and EAVRO) and several national institutes administered by various government agencies. The supranational structures continued operating as such until 1977, after which they were nationalized. In 1974, all the crop and livestock research scattered throughout the various divisions of the Department of Agriculture were merged into a Scientific Research Division (SRD). Veterinary research, however, remained under the Veterinary Services Department. In 1979, SRD was broken up as the Ministry of Agriculture was divided into an agricultural ministry and a livestock ministry. These two ministries were reunited in 1983, then divided again in 1986, with similar consequences for the respective agricultural R&D agencies. Then, in 1988, the research divisions of the Ministry of Agriculture and the Ministry of Livestock together with some research facilities that previously formed part of EAAFRO and EAVRO were merged into a single agency—the Kenyan Agricultural Research Institute (KARI).

Tanzania also inherited a fragmented agricultural research system upon gaining independence. Soon thereafter (specifically in 1968), all crop, livestock, forestry, and fisheries research under the Ministry of Agriculture was merged into a newly created Research and Training Division. Yet in 1971, forestry and fisheries research was transferred to the Ministry of Nature and Tourism, and in 1974 crop and livestock research was allocated to the Department of Agriculture and the Department of Livestock, respectively. In 1981, the research divisions of these two departments became two autonomous agencies (i.e., TARO and TALIRO), although some residual research activities remained under the direct authority of the two departments. In 1989-90, TARO and TALIRO were abolished and their research activities taken over by the new Directorate of Research and Training (DRT).

²¹ Internal geopolitical boundaries have played an important role in the fragmentation of the university component of the Nigerian NARS. Each state in Nigeria has essentially established its own faculty of agriculture (Roseboom et al. 1994). In South Africa, the Agricultural Development Institutes (one located in each of the seven agroecological zones and conducting applied research) have, as part of the new

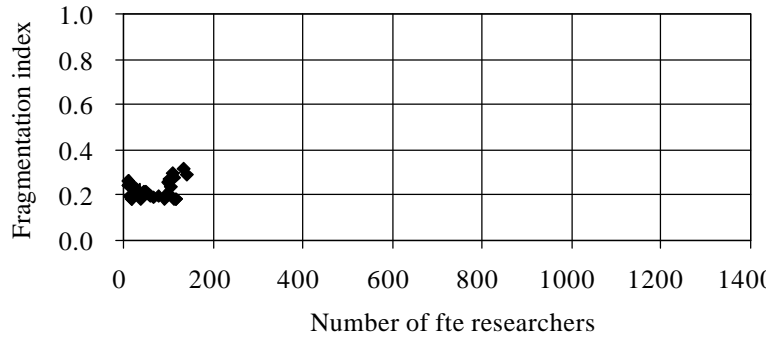
Figure 3 Fragmentation profiles for selected African NARSs, 1961-92



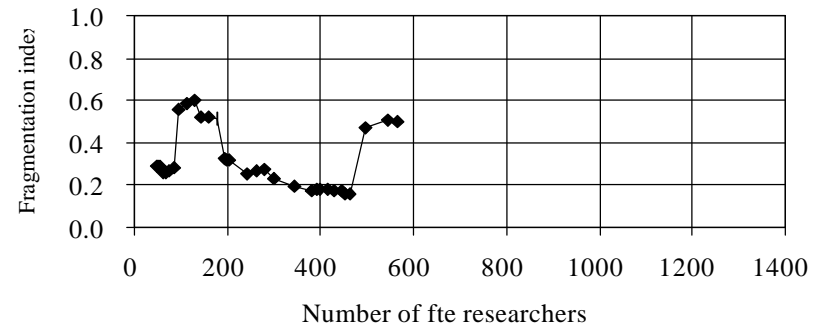
government structure in South Africa, now been placed under the provincial governments.

Figure 3 (continued)

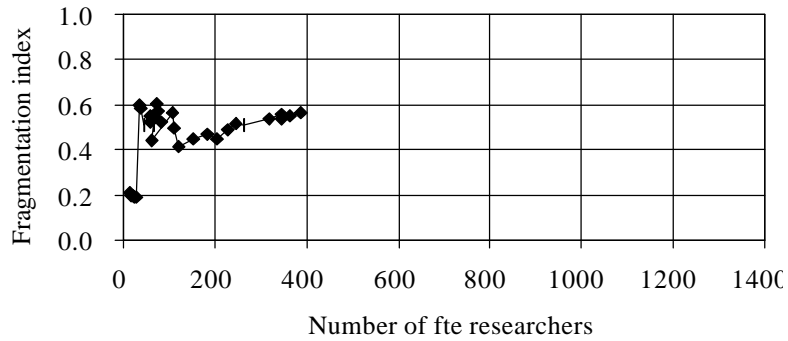
(e) Burkina Faso, 1961-1991



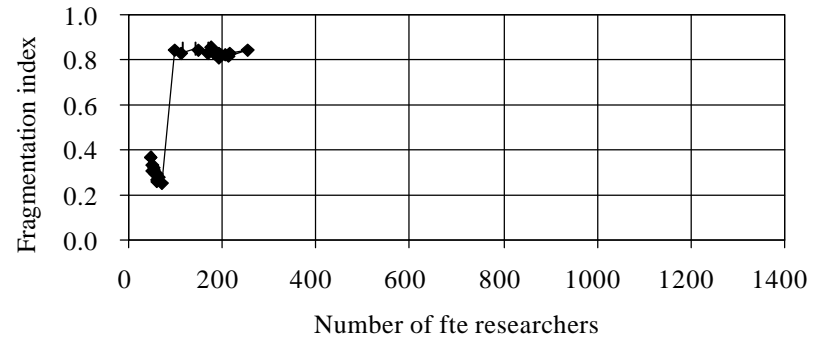
(f) Tanzania, 1961-92



(g) Ethiopia, 1961-91



(h) Senegal, 1961-92



have led to the development of separate state research agencies as, for example, in the United States and Australia. Nonetheless, internal political boundaries in Africa often have important consequences for the location of specific research stations in more centrally managed and nationally conceived research agencies. In Ethiopia, for example, national politics have pushed the Ethiopian Agricultural Research Organization (previously IAR) to reorganize along regional lines, including the relocation of researchers to their ethnic regions of origin. There are no rules-of-thumb for assessing the optimal organizational structure of a research agency, nor for the specific geographical configuration of its respective institutes. Certainly the trends in the agricultural sciences themselves would point to possibilities for reconfiguring and consolidating aspects of the research to take advantage of newly emerging scale and scope economies (Alston and Pardey 1996). Still, some agricultural R&D activities have significant site-specific aspects (conditioned heavily by agroecological considerations) that warrant local testing and adaptation work. This may call for rethinking and restructuring the agencies involved in public agricultural R&D to allow more research to be done or directed by centralized facilities, but integrated closely with more streamlined, local facilities. Of course, communication and transportation difficulties would mitigate against this “distributed network” model. In addition, a rationalization of national systems should also take account of the likely benefits from linking to, and directly supporting, collective, supranational research efforts.

Subsectoral Orientation

The allocation of research resources to specific research areas and subsectors, is

one of the more critical policy and management aspects directly influencing the ultimate effectiveness of a research system. Precisely how many resources are devoted to each line of research, how the funds are distributed, the feedback mechanisms between research performance (or lack thereof) and resource allocation processes, are all significant. Some agencies spread their limited resources too thinly so that few lines of R&D have the critical mass to effectively progress; others continue to invest in areas of research long after doing so is economically warranted. Furthermore, some invest in new areas of research because of political pressure or earmarking of funds by donors and others, when an economic assessment of the likely payoffs to that line of research would raise serious questions. At the same time, they may forego more promising research areas.

Investing in the specifics of an R&D program is often a strategic decision that requires hiring researchers with the right skills, developing research sites, purchasing specific equipment, and so forth. Ideally research decision makers could call on social scientists and others for relevant information to guide those priority decisions, and some African NARSs (e.g., Kenya and Zimbabwe) have made moves to gain better access to this type of information in recent years. A first analytical step is to assess the congruence between the share of research resources devoted to each commodity area, and the relative importance of each commodity in the value of total agricultural output. The idea here is that extreme departures from congruence (i.e., between research investment shares and corresponding agricultural production shares) may suggest an inappropriate pattern of research spending.

Table 4 presents the proportion of crop output in the total value of crop and livestock production (column 1), the share of crop scientists in the combined crop and

livestock researcher total (column 2), and the crop congruence ratio (column 3) formed as the ratio of column 2 to column 1. There are interesting and potentially important patterns in these data. Countries like Botswana, Namibia, and Lesotho have agricultural sectors more heavily based on livestock than on crop production, yet their research systems employ proportionally more crop than livestock scientists (as evidenced by crop congruence ratios greater than one). The reverse is true for countries like Rwanda, Nigeria, and Ghana where they have more crop-oriented production systems, but correspondingly greater shares of their scientists doing livestock research.

Strictly maintaining a congruence rule for resource allocation would imply spending twice as much on crop research than on livestock research if the value of crop production were twice that of livestock. Alston, Norton, and Pardey (1995) describe why a naive application of the congruence rule can be misleading. Nonetheless, the incongruent allocations of research resources evident in table 4 (i.e., congruence ratios that deviate from 1.0) raise the prospects of potentially significant improvements in the returns to investing in R&D from reallocating research resources. Certainly more formal research-evaluation techniques are needed (as described in Alston, Norton, and Pardey 1995) to assess these prospects, but that is beyond the scope of this paper.

Table 4 Congruence ratios for crop and livestock research

	Crop production share	Crop research share ^a	Congruence ratio crops
		<i>(percentage)</i>	
<i>Crop production share, less than 50 percent</i>			
Botswana	10	53	5.3
Namibia	14	20	1.5
Lesotho	34	60	1.8
Cape Verde	37	64	1.7
Sudan	45	52	1.2
Kenya	48	77	1.6
<i>Subtotal (weighted average)</i>	<i>43</i>	<i>66</i>	<i>1.5</i>
<i>Crop production share, between 50 percent to 85 percent</i>			
South Africa	51	55	1.1
Mali	53	55	1.0
Zambia	59	62	1.0
Ethiopia	62	78	1.3
Swaziland	63	83	1.3
Niger	63	81	1.3
Senegal	64	71	1.1
Madagascar	65	76	1.2
Zimbabwe	67	65	1.0
Burkina Faso	70	79	1.1
Tanzania	70	64	0.9
Mauritius	78	88	1.1
Togo	83	91	1.1
<i>Subtotal (weighted average)</i>	<i>60</i>	<i>65</i>	<i>1.1</i>
<i>Crop production share, greater than 85 percent</i>			
Rwanda	86	70	0.8
Nigeria	87	65	0.7
Ghana	88	74	0.8
Malawi	88	75	0.8
Côte d'Ivoire	92	87	0.9
<i>Subtotal (weighted average)</i>	<i>88</i>	<i>71</i>	<i>0.8</i>
<i>Total (weighted average)</i>	<i>68</i>	<i>67</i>	<i>1.0</i>

Source: FAO (1997) and survey data compiled by authors.

^a Represents share of crop researchers in total number of researchers.

3.3 GOVERNANCE OF NATIONAL AGRICULTURAL RESEARCH

Governance Structures

During the 1960s and early 1970s many African countries established an agency, often a council or committee, to develop and recommend science and technology policy options and to play a coordinating role among the various research performers.²²

UNESCO played an important catalytic role in this regard (UNESCO 1973 and 1985).

Many of these agencies formed the basis of the Ministries of Science (often in combination with higher education) that were established in later years.²³ The trend toward a centrally coordinated science and technology portfolio often caused friction among the Ministries of Science and Agriculture (the branch of government traditionally responsible for agricultural research). In some countries, the conduct, not merely the governance of agricultural research, was transferred to these new science ministries; in other cases dual structures developed with agricultural research performed by agencies within ministries of agriculture and within ministries of science. Jain (1990) observed that in some instances, moving agricultural research closer to science ministries changed the incentive structures for agricultural scientists and redirected their research in ways that diminished the rural-

²² Dates of establishment are: Benin: DRST (1976); Burkina Faso: CNRST (1976); Cameroon: CRSA (1962); Central African Republic: CNRST (1972); Chad: CNRST (before 1972); Congo: CNRST (1963); Côte d'Ivoire: MERS (1971); Ethiopia: NSTRACCT (before 1972); Gabon: CNRS (before 1972); Ghana: NRC (1958); Guinea: INRDG (1958); Kenya: NCST (1977); Madagascar: CNRST (before 1972); Mali: CSRS (1962); Mauritania: CNPS (1973); Niger: CNRST (1968); Nigeria: NCST (1970); Senegal: CIRST (1966); Sudan: NCR (1970); Tanzania: NSRC (1972); Togo: INRS (1965); Zaire: ONRD (1967); and Zambia: NCSR (1967) (UNESCO 1973 and 1985).

²³ Forje (1989) reports that, by the late 1980s, 29 of the 48 African countries had a formal Science and Technology policymaking entity. However, about a third of these entities were deemed institutionally weak or nonoperational.

development orientation of the R&D.

In 1991/92, the principal agencies doing agricultural R&D in 10 African countries were administered by the Ministry of Science (table 5); all but two of these countries (Ghana and Kenya) were Francophone countries.²⁴ In a further five countries, the Ministry of Science was directly responsible for some secondary components of each country's agricultural research system, and in three countries (Guinea, Nigeria, and Senegal) the primary agricultural research agencies were recently placed under the administrative control of the agricultural ministries, when previously they were the province of a science ministry.

²⁴ One reason for the primary role of the Ministry of Science in most former French colonies is that at the time they were established (about 1970) the national governments (including the Ministry of Agriculture) still had little control over the agricultural research agencies in their countries. The first task of the newly established Ministries of Science was to open negotiations with France about the future of the (agricultural) research activities managed by France. A Ministry of Science was considered better positioned to conduct such negotiations than the Ministry of Agriculture, not least because the negotiations involved more than agricultural research (Rocheteau et al. 1988). In addition, the agricultural research stations managed by French staff largely operated outside the bureaucratic structure of the Ministry of Agriculture. It was therefore more difficult for the Ministry of Agriculture to claim administrative leadership vis-à-vis the Ministry of Science as agricultural research was increasingly brought under national control.

Table 5 Public administration of agricultural research, early 1990s

	Ministry of Agriculture		Ministry of Science		Other ministries,	Universities,
	primary	secondary	primary	secondary	secondary	secondary
Angola	x	x				x
Benin	x					x
Botswana	x	x				x
Burkina Faso		x	x		x	x
Burundi	x	x				x
Cameroon		x	x		x	x
Cape Verde	x	x			x	
Central Afr. Rep.	x				x	x
Chad	x				x	x
Comoros	x					
Congo		x	x		x	x
Côte d'Ivoire			x			x
Djibouti		x	x			
Eq. Guinea	x					x
Ethiopia	x	x		x	x	x
Gabon		x	x		x	x
Gambia	x	x			x	
Ghana		x	x			x
Guinea	x			x		
Guinea-Bissau	x					
Kenya		x	x	x		x
Lesotho	x	x				x
Liberia	x	x				x
Madagascar		x	x			x
Malawi	x	x			x	x
Mali		x				x
Mauritania	x	x			x	x
Mauritius	x	x				x
Mozambique	x	x			x	x
Namibia	x	x			x	x
Niger	x	x				x
Nigeria	x				x	x
Reunion	x					
Rwanda	x			x		x
Sao Tome & Pr.	x					
Senegal	x				x	x
Seychelles	x	x			x	x
Sierra Leone	x	x				x

Table 5 (continued)

	Ministry of Agriculture		Ministry of Science		Other ministries,	Universities,
	primary	secondary	primary	secondary	secondary	secondary
Somalia	x				x	x
South Africa	x			x	x	x
Sudan	x	x				x
Swaziland	x	x				x
Tanzania	x	x			x	x
Togo	x	x				x
Uganda	x	x				x
Zaire		x	x	x	x	x
Zambia	x	x		x	x	x
Zimbabwe	x	x			x	x

Source: Compiled by authors from survey data and various other sources.

Note: In each country we have identified the (department within a) ministry that has primary responsibility for agricultural research. All other ministries or departments in ministries overseeing agricultural research agencies are labeled as having secondary responsibility. A coordination mechanism can have “complete” or “partial” coverage of the public and academic agricultural research entities in the country.

In 22 African countries, ministries other than the Ministry of Agriculture or the Ministry of Science (mainly ministries of livestock, forestry, fisheries, and environment) were administratively responsible for one or more secondary agricultural research agencies (excluding universities). In 19 African countries a single ministry oversaw all public agricultural research (other than that conducted by universities); in 18 countries it was the Ministry of Agriculture and in one country (Côte d’Ivoire) it was the Ministry of Science. In the remaining 29 countries, the responsibility for agricultural research was shared among various ministries.

Integration and Coordination

After independence virtually all African countries eventually sought to consolidate and integrate their various agricultural research activities into more manageable structures. As documented in section 3.2, the model adopted by most African countries in recent years is that of a NARO. By adopting this single-agency model, many coordination problems that previously existed were internalized (but not necessarily resolved) by the new organization. Since the 1970s, the organizational structure of many NAROs has moved away from a traditional crop and discipline orientation toward a problem and agroecological focus. This new orientation reflects the more “holistic” approach to agriculture that gained favor in the 1970s, as exemplified by the pursuit of farming systems research and the introduction of multidisciplinary research teams. Despite these developments, a commodity orientation is still predominant in most NAROs.

There are few African countries wherein a NARO is the sole provider of agricultural research services. In particular, forestry, fisheries, and veterinary research activities as well as the research conducted by universities are undertaken outside the NARO. Efforts to coordinate agricultural R&D across various agencies, even in those countries that have adopted a single-agency or NARO model, remain an ongoing policy problem. Nonetheless, only seven of the 28 African countries that have adopted the NARO model have put in place mechanisms that attempt to coordinate across the various agencies engaged in agricultural research (see appendix table B.1).

Cross-institutional coordination may even be more of an issue in multi-agency systems. Coordination mechanisms are evident in the bigger and more complex NARS,

such as Nigeria and South Africa.²⁵ But only six of the 20 NARSs with a two-agency or multi-agency structure have sought to develop such institutional structures.

The links between public agricultural research agencies and universities are particularly weak in most African countries. Consequently, research at the universities tends to focus on academic interests rather than the development of technologies for local agricultural sectors. The differing cultures and incentive structures, combined with disparate ministerial oversight also add to the problem of effective coordination and collaboration between universities and public agricultural research agencies (Michelsen et al. 1997).

²⁵ In Nigeria, a National Advisory Committee for Agricultural Research (NACAR) was established in 1991 with the launching of the National Agricultural Research Plan funded by the World Bank. The committee has a broad mandate, covering both agricultural research institutes and agricultural universities and faculties. The committee, consisting of representatives of the Ministry of Agriculture, the Ministry of Education, the chair of the Committee of Deans of Nigerian Universities/Faculties of Agriculture, the chair of the Committee of Directors of Research Institutes, a representative of the chairs of the governing boards of research institutes, and representatives of the private sector, is to advise the Federal Ministry of Agriculture on all matters concerning agricultural research. The committee is expected to play a vital role in improving overall focus of research and its relation to agricultural policies and priorities, as well as linking research with policy makers. It is also expected to review research programs, and the performances of different institutes through its five technical subcommittees on crops, forestry and tree crops, livestock, fisheries, and extension and training (Shaib, Aliyu, and Bakshi 1997).

In South Africa, the Agricultural Research Council (ARC) was established in 1992. It assumed the administrative responsibility for a group of 12 specialized agricultural research institutes that thus far had operated directly under the Ministry of Agriculture. Although ARC represents a major component of the South African NARS, major components of the NARS do not fall under the responsibility of ARC, such as the forestry and fisheries research institutes, provincial agricultural research and development institutes, and relevant university faculties. A chairperson and a maximum of 12 other members, appointed by the Minister of Agriculture, form the Council that controls and manages the ARC. The composition of the Council reflects various interests such as farmers, marketing boards, universities, and the agricultural input and processing industries. The daily management of the ARC is delegated to ARC's president and a small managing team. Together with the directors of the institutes they form the Broad Management of ARC.

Research Planning

Throughout the 1980s and 1990s widespread moves were made toward more formal research planning in Africa. Hambly and Setshwaelo (1997) identified 28 countries that had ostensibly developed comprehensive, multi-year plans for their national agricultural research systems, or parts thereof. These plans often sought to prescribe future research priorities in terms of commodity, spatial, and, in some instances, even problem focus as a basis for projecting resource requirements, staffing levels, facilities developments, and so on. A further 13 countries developed research policy documents that typically set out broad operational guidelines for the NARSs; only seven countries had apparently developed neither a research plan nor a policy document.

Many, but not all, of these planning exercises were done as part of a process required to secure external (often World Bank) funding. The efficacy of many of these plans is open to question. Many were developed with a heavy and usually costly involvement of external consultants, and the data and priority setting analyses used were usually rudimentary and often questionable. Local stakeholders, including local finance ministries and agricultural-sector policymakers, farmer and consumer groups, and agribusinesses, often played fairly perfunctory, advisory roles during the development of these plans. Perhaps more important, these groups were rarely part of the followup mechanisms designed to carry out the plans and monitor and modify their execution as changing circumstances usually warranted. In short, the improved priority-setting and resource-allocation mechanisms the plans sought to identify were rarely institutionalized.

3.4 GOVERNANCE OF SUPRANATIONAL AGRICULTURAL RESEARCH

By global standards, many national agricultural research agencies in Africa are comparatively small, poorly financed, and have limited numbers of highly qualified staff to conceive, lead, and conduct their programs of research. Yet agriculture continues to loom large in the economies of many countries in the region and the problems faced by farmers and others involved in agriculture are substantial and exceed the capacity of many national systems to address meaningfully. This has led to a resurgence in interest in regional approaches to agricultural R&D in Africa and a proliferation of agencies and forums on this topic in recent years.

Regionally financed, conceived, and conducted agricultural R&D is not new to Africa. Section 2 above describes the many regional approaches to public agricultural R&D that developed in parallel with the colonization of the continent during the earlier part of the twentieth century. However, the coincidence of interests leading to various regional approaches to funding, conducting, and disseminating R&D dissipated (sometimes rapidly, sometimes more slowly) with the demise of colonial structures during the 1960s.

Recent efforts to revive a regional approach to agricultural R&D in Africa began in earnest in the latter half of the 1980s and continue to command a good deal of attention, if not resources. These recent regional initiatives were preceded by international agricultural R&D efforts under the guise of the CGIAR, which increasingly focused its attention on Africa during the 1970s as an outgrowth of its success, and that of its precursor agencies, in South Asia and elsewhere beginning in the mid-1960s. Our review and discussion of these developments is divided into three, sometimes intertwined, parts: regionally

conducted research, regional coordination and funding, and international R&D.

Regional Research Activities

Few research agencies actually conceive and conduct their research regionally or, relatedly, are collectively funded by various national agencies in Africa to carry out such research. Those agencies that do exist rely largely on donor funding for their operations. Nonetheless, the number of “research networks” designed to foster cross-country collaboration in agricultural R&D has risen rapidly in recent years. Appendix table C.1 lists these networks in a way that identifies their links to various donor and implementing agencies.²⁶

We identified a total of 86 networks, 72 of which operate exclusively in Africa; the remaining 14 networks have a global coverage that includes Africa. Most of the regional networks were established during the late 1980s and early 1990s, and most are heavily reliant on donor support for their operation.²⁷ Many networks (about 30 of the African networks) are managed by CG centers, although sub-regional entities such as ASARECA, CORAF, and SACCAR are increasingly assuming management responsibility for these networks. If this trend continues, the CG’s role regarding these regional networks is increasingly likely to be limited to the provision of technical (i.e., scientific) expertise. More than one-third (26) of the 72 networks operating exclusively in Africa deal with

²⁶ Anderson (1991), Merlet et al. (1995), and de Lattre-Gasquet and Merlet (1996) provide some useful additional perspectives on research networking in Africa.

²⁷ USAID and IDRC have been particularly active in the support of networks throughout Africa. IDRC has a long history of support for networks linked to ILRI and ICRAF, and USAID was instrumental in establishing SAFGRAD in the late 1970s.

crops research, nine focus on livestock, five each on forestry and soils, three each address farming systems, postharvest processing and storage, and socioeconomic issues, and 18 networks deal with various other topics.

These networks vary markedly in the specifics of their operations, the resources at their disposal, their stated objectives, and their effectiveness. Some seek to facilitate general information exchange, others try to keep scientists better informed about progress on specific lines of research, and others actually try to foster (and, sometimes, help manage) regionally conceived programs of research. Such research programs are conducted within existing national agencies and sometimes jointly with CG centers.²⁸

Various donors, in particular USAID and IDRC, have encouraged the development of this latter type of network (known as “collaborative research networks”) quite extensively throughout Africa since the early 1980s. However, few of these networks bring additional funds for the conduct of national research. Most of the network funds are earmarked for coordination costs and to subsidize attendance at network meetings. Any research that is conducted under the auspices of these networks, is often performed and mostly financed by the participating national agencies. Thus national agencies contribute very substantially to these regional networks in terms of staff time and the operating expenses associated with local testing trials.

Many of these networks are perceived (at least by many researchers) as creations

²⁸ SPAAR distinguishes three network categories: (a) information exchange networks; (b) scientific consultation networks; and (c) collaborative research networks. Plucknett, Smith, and Ozgediz (1993) added a fourth category, namely that of a material exchange network that tests crop germplasm or finished varieties in different environments. Many older CG-managed networks fit in this category.

of “external forces,” which often means donor agencies or various regional and national political forums. Moreover, they often take on more formal structures than may be desirable, involving the establishment of secretariats or other coordinating mechanisms that involve significant organizational overhead and that foster too many meetings and too much paperwork with too little impact on the science that actually gets done.²⁹ Further, a surfeit of Africa-specific networks may be too insular (and ultimately self-defeating) in that it serves to isolate African researchers from the rapid scientific developments taking shape elsewhere in the world.

Other mechanisms for stimulating collaboration in African science, pooling research resources, minimizing unnecessary duplication, and so on are possible. Scientific exchanges, visiting scientist programs, sabbaticals, and the like are all potentially effective ways to foster a two-way flow of scientists between African countries and with research agencies in other parts of the world. Subsidizing attendance at meetings of international professional associations and maintaining access to journals and other professional publications are other, often neglected, possibilities. Perhaps the most innovative and ultimately most productive approach is to stimulate the access of African scientists to Internet technologies. Local Internet service providers are beginning to make their presence felt throughout substantial parts of Africa (many are commercial operations,

²⁹ We “gestimate” that the direct costs of the regional networks are something in the order of U.S.\$20-40 million per annum (taking due account that several networks listed in appendix table C are effectively inactive—often because they lack financial support—active networks typically have an annual budget in the \$0.5-1.0 million range). Coordination costs are not negligible. Many networks have a full-time regional coordinator (usually under contract to a CG center at an international salary) and there are national coordinators (usually paid out of national, not network, funds), which together form a technical steering committee with its attendant meeting and communication costs.

some are publicly supported, and others, such as USAID's Leland Initiative, are supported by donor dollars) (Barlow 1998). Internet accessibility could improve dramatically, and costs will undoubtedly fall. These mechanisms place the choice and incentive for participation in collaborative endeavors closer to the scientists doing the research.³⁰ These mechanisms are frequently used in other regions of the world, and may, in the longer run at least, be more effective than many current networking initiatives in Africa. They may also serve to stimulate the infusion of scientific ideas (and even scientists) from developed and other developing countries into Africa and, similarly, the participation of African scientists in relevant research taking place outside the region.

Regional Coordination and Funding

Besides the rapid growth in the number of regional networks throughout Africa, the number of organizations designed ostensibly to coordinate research from a regional perspective has grown as well.

Attempts to promote and coordinate regional approaches to agricultural research in the post-independence era had their organizational origins in the second half of the 1970s. In 1976, the Permanent Interstate Committee for Drought Control in the Sahel

³⁰ Some may argue that this allows too much discretion for the scientist in the choice of collaborative efforts to get involved in, leaving too little discretion for research managers and others to direct a program of work. This view may involve a misconception of the basic problem, which could stem from a lack of clearly defined research priorities for the national agency for whom the scientist works, the choice of scientists to hire, and the incentive mechanisms (in terms of salary, promotion prospects, etc.) faced by scientists. Earmarking resources for particular types of cross-country collaboration may do little to address these more fundamental problems.

(CILSS) established the “Institut du Sahel” (INSAH) in Bamako, Mali.³¹ This was followed by the establishment of the Southern African Centre for Cooperation in Agricultural Research (SACCAR) in Gaborone, Botswana in 1984 under the auspices of the Southern African Development Coordination Conference (SADCC).³² CILSS and SADCC are essentially political bodies whose operations are partly funded by the member countries, but with significant donor support as well. Certainly most of the operations of INSAH and SACCAR are funded from external sources.

More recent efforts involve the Special Program for African Agricultural Research (SPAAR), which was established by a group of donors in 1985 and has its secretariat at the World Bank. SPAAR aims to “promote effective donor coordination to meet the challenge of increasing agricultural production through agricultural research throughout Africa” (SPAAR 1997). Initially SPAAR was developed as a means to help coordinate donor support to African agricultural R&D, but membership of SPAAR was enlarged to include broader participation by other interested parties in 1994. Specifically, the African

³¹ Representing the following nine countries: Burkina Faso, Cape Verde, Chad, Gambia, Guinea-Bissau, Mali, Mauritania, Niger, and Senegal. INSAH’s objective is to foster food security in a balanced ecological environment by coordinating, harmonizing, and promoting scientific and technical research and training and by disseminating scientific and technical information on issues related to drought control, desertification management and population.

³² SADCC member countries are: Angola, Botswana, Lesotho, Malawi, Mauritius, Mozambique, Namibia, South Africa, Swaziland, Tanzania, Zambia, and Zimbabwe. SACCAR’s mandate is to (a) promote cooperation in agricultural research among the NARS of member states; (b) facilitate the exchange of information among national research systems; (c) promote the development of human resources necessary to man the agricultural systems; and (d) promote coordination of SADCC agricultural research activities. -Initially SACCAR’s mandate only covered food crops, but was expanded to include also commercial export crops in 1987 (Anandajayasekeram and Ndunguru 1995).

NARSs were invited to participate more directly in the forums and activities of the program. Some more prominent activities undertaken or promoted by SPAAR over the past decade include the following (SPAAR 1997):

- Efforts to create a project database of donor-funded agricultural research projects;
- The development of a “Framework for Action” for each of four subregions in Africa, involving a process of consultation throughout the region and the publication of a set of four reports (Spurling et al. 1992; Weijenberg et al. 1993; Weijenberg et al. 1995; and Taylor et al. 1996);
- A “Sustainable Funding Initiative,” launched in 1996, with the intent of helping African agricultural research institutions to identify, test, and establish innovative ways to fund agricultural research that improves the longer-term funding prospects for African agricultural R&D; and
- The establishment of regional modes of cooperation throughout the region.

SPAAR has assisted in and promoted the establishment of several regional entities to help coordinate agricultural R&D on a regional basis. These forums have included the Conference of African Agricultural Research Managers (CORAF) in 1987,³³ the Association for Strengthening Agricultural Research in Eastern and Central Africa

³³ CORAF’s members include mainly French speaking African countries in West and Central Africa, specifically, Benin, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Congo, Côte d’Ivoire, Gabon, Gambia, Guinea, Guinea-Bissau, Madagascar, Mali, Mauritania, Niger, Rwanda, Senegal, Sierra Leone, Togo, and Zaire. The membership of Ghana and Nigeria is unclear. They apparently have associate status. CORAF is closely associated with three France-based organizations (CIRAD, ORSTOM, and INRA) and receives financial support from France and the EU. CORAF’s objective is to “promote cooperation and information exchange between member institutions; to train researchers, technicians, and research managers and improve their access to scientific and technical information; to stimulate the development of a new type of partnership with regional organizations, international centers, Northern research institutions and funding agencies; to define common research objectives and implement projects, notable through a system of networks; to organize research teams with a regional vocation.”

(ASARECA) in 1994 (operational since 1996),³⁴ and the Forum for Agricultural Research in Africa (FARA) in 1997. FARA, which consists of representatives of CORAF, ASARECA, and SACCAR, represents the African NARSs at the Global Forum on Agricultural Research, which was established in 1996 in conjunction with the CGIAR.

A potentially important role assigned to CORAF, ASARECA, and SACCAR is the overall coordination and governance of the various research networks in the region. Hitherto, the day-to-day management of most regional networks was carried out by a coordinator (often based at a CG center), with funds earmarked for the purpose by one or more donors. Local participation was effected by representation on both the governance and technical steering committees of the networks. CORAF, ASARECA, and SACCAR are working to assume much of these governance and coordination roles while the day-to-day management of a network will be the responsibility of one of the network participants. Currently this is often an international center, but the intention is that these functions will increasingly be performed by national agencies.

Whether the proliferation of initiatives and agencies to coordinate the funding and, in some instances, the conduct of African agricultural research has had any substantive impact or has merely served to increase bureaucratic overheads, is an open question. There is no evidence that SPAAR and related efforts have stemmed the slowing of bilateral support for African agricultural R&D since the mid 1980s—although multilateral

³⁴ ASARECA's member countries are Burundi, Djibouti, Eritrea, Ethiopia, Kenya, Madagascar, Rwanda, Somalia, Sudan, Tanzania, Uganda, and Zaire. ASARECA's objective is to strengthen the national agricultural research organizations in the member countries and enhance agricultural productivity in the region through the collaboration in agricultural research.

support from agencies such as the World Bank has been maintained. (See Pardey et al. 1998). International bureaucracies are likely to find it harder than domestic governments to tackle these resource-allocation issues. Designing mechanisms that deal effectively with the funding and performance of R&D in an international context is especially difficult. It is doubly so when the consequences of that research spill across national borders. There may be few if any compelling reasons for countries—and even bilateral donor organizations, who reflect the various priorities of their own governments—to subjugate, perhaps, some national interests for regional ones. Moreover, it may not be obvious where these areas of mutual benefit lie, and consultation in the absence of analysis may be insufficient to identify them. Pardey et al. (1998) discuss some of these difficulties as they relate to funding agricultural R&D in Africa. To date, efforts to analyze the spillover potentials for agricultural R&D from a regional perspective, assess their likely economic consequences, and feed this information into these regional policy forums have been largely nonexistent.

International Research

The Consultative Group on International Agricultural Research (CGIAR, or CG for short) was founded in 1971. There are currently 16 CG centers, which collectively spend around US\$320 million per annum. Four of these centers (ICRAF, IITA, ILRI, and WARDA) are headquartered in Africa and focus largely on problems confronting African agriculture, although ILRI has recently expanded its research to encompass global issues facing the livestock sector (table 6). The remaining 12 CG institutes are located throughout the world, but many maintain regional offices in Africa, or in some cases (like

ICRISAT's Niamey facility), significant research facilities. Most undertake research in the region, much of it in conjunction with local, public research agencies.

The CGIAR estimated that in 1995 about US\$140 million (\$104 million in 1985 international dollars), or 43 percent, of the group's core expenditures were targeted toward Africa.³⁵ This is a much higher proportion than the share of 12 percent that African countries have in total agricultural research spending by developing countries. Thus, for every \$100 spent by national agricultural research agencies in Africa in 1991, the CG spent about \$10.20 (1985 international dollars). For the Asia and Pacific region the comparative CG figure was \$1.30, for Latin America and the Caribbean it was \$3.60, and for West Asia and North Africa it was \$2.70 (1985 international dollars).

³⁵ Estimating the share of the CG's research effort directed toward Africa is not without problems. Most CG research has a global orientation and aims to be broadly applicable. Consequently the benefits from the research can spill broadly across various agroecologies that do not necessarily coincide with national or regional boundaries. Pardey et al. (1996), for example, estimated that the United States substantially benefitted from international agricultural research targeted toward developing country problems.

Table 6 International agricultural research centers

	Headquarters	Mandate	1995 budget (million U.S. dollars)
<i>CGIAR institutes</i>			
IRRI, International Rice Research Institute	Los Baños, Philippines	Rice Rice-based ecosystems	38.1
CIMMYT, Centro Internacional de Mejoramiento de Maiz y Trigo	El Batán, Mexico	Wheat, maize	31.7
CIAT, Centro Internacional de Agricultura Tropical	Cali, Colombia	Phaseolus bean, cassava Rice Tropical pastures	31.5
IITA, International Institute of Tropical Agriculture	Ibadan, Nigeria	Farming systems Rice, maize, cassava, cocoyams, soybeans	31.4
ICRISAT, International Crops Research Institute for the Semi-Arid Tropics	Hyderabad, India	Farming systems Sorghum, millet, pigeonpeas, chickpeas, groundnuts	30.1
CIP, Centro Internacional de la Papa	Lima, Peru	Potato, sweet potato, other root crops	23.2
IPGRI, International Plant Genetic Resources Institute ^a	Rome, Italy	Promote activities to further collection, conservation, evolution, and utilization of germplasm	17.9
WARDA, West Africa Rice Development Association ^b	Bouaké, Côte d'Ivoire	Rice	9.7
ICARDA, International Center for Agricultural Research in the Dry Areas	Aleppo, Syria	Farming Systems Barley, lentils, faba beans Wheat, kabali chickpeas	19.2
ISNAR, International Service for National Agricultural Research	The Hague, The Netherlands	Strengthen national agricultural research systems	11.3
IFPRI, International Food Policy Research Institute	Washington, D.C., United States	Identify and analyze national and international strategies and policies for reducing hunger and malnutrition	13.8
ICRAF, International Centre for Research in Agro-forestry	Nairobi, Kenya	Agroforestry, multi- purpose trees	16.9
IIMI, International Irrigation Management Institute	Colombo, Sri Lanka	Irrigation management	10.2
ICLARM, International Centre for Livestock Aquatic Research Management	Manila, Philippines	Sustainable aquatic resource management	7.8
CIFOR, Center for International Forestry Research	Bogor, Indonesia	Sustainable forestry management	9.0
ILRI, International Livestock Research Institute ^c	Nairobi, Kenya & Addis Ababa, Ethiopia	Livestock production and animal health	24.3
<i>CGIAR total</i>			326.2

Table 6 (continued)

	Headquarters	Mandate	1995 budget
<i>Other international centers</i>			<i>(million U.S. dollars)</i>
CIRAD, Centre de Coopération Internationale en Recherche Agronomique pour le Développement	France	Food and export crops, livestock, forestry, fisheries, and agricultural mechanization	202.3
ORSTOM, Office de la Recherche Scientifique et technique Outre-Mer	France	Agriculture in fragile tropical areas, ecosystems, environment, health, and society	87.8
ICIZE, International Center of Insect Physiology and Ecology	Kenya	insects	9.2 ^d
IFDC, International Fertilizer Development Center	United States ^e	fertilizer use	9.4

Source: Baum (1986), TAC/CGIAR (1987) and various annual reports.

Note: The CGIAR directed 43 percent of its 1995 budget toward Africa, somewhat lower than the corresponding share found for CIRAD and ORSTOM (47 and 51 percent, respectively). ICIZE spent its total budget in Africa in 1994.

^a IPGRI was first established in 1974 as the International Board of Plant Genetic Resources (IBPGR). The Board was funded as a CG center but operated under the administration of FAO and was located at FAO headquarters in Rome, Italy. In 1993 IBPGR changed its name to IPGRI, and was established as a self-administering CG center in its own headquarters building in Rome. An International Network for the Improvement of Banana and Plantain (INIBAP) was established in Montpellier, France in 1984. In 1993 INIBAP became a CG center but in 1994 it was placed under the administration of IPGRI but continues to maintain its own board.

^b Relocated from Monrovia, Liberia in 1989.

^c ILRI became operational in January 1995 through a merger of the International Laboratory for Research and Animal Diseases (ILRAD) and the International Livestock Center for Africa (ILCA). ILRAD was established in 1973 as a CG center headquartered in Nairobi, Kenya. Its research focused on livestock diseases (world) and tickbone disease and typhomiasis (sub-Saharan Africa). ILCA was established in 1974 as a CG center headquartered in Addis Ababa, Ethiopia and did research on animal feed and production systems for cattle, sheep and goats for sub-Saharan Africa.

^d Data for 1994.

^e Regional office in Togo.

Research relevant to African agriculture is conducted by other important international agricultural research institutes outside the CGIAR system. Most notable of these are the International Centre of Insect Physiology and Ecology (ICIPE) in Kenya, the International Fertilizer Development Center (IFDC)—which has a regional office in Togo—and two French organizations, CIRAD and ORSTOM. CIRAD, established in 1984 from a merger of several tropical agricultural research institutes, works mainly on tropical export crops such as cotton, oil palm, coffee, cacao, and rubber, but also performs some research on food crops, animal health and production, forestry, and fisheries. Few other international research organizations work on commercial export crops. ORSTOM was established in 1958 and has a broad research mandate, of which about 40 percent is agriculturally related. It does mainly basic research in areas such as soil fertility, pests and diseases, and climates.

In addition to their staff and facilities in France, CIRAD and ORSTOM traditionally operated and supported an extensive network of facilities and outposted staff throughout the (former) French colonies. In more recent years, however, many overseas research facilities of CIRAD and ORSTOM have been devolved to domestic governments. Despite the loss of direct control over these research facilities, a great deal of scientific collaboration has continued, and French scientists have continued to be outposted to these African facilities but in much smaller numbers than in the past. CIRAD and ORSTOM spent a total of FF 2,106 million (US\$ 422 million) in 1995, of which FF 702 million (US\$ 141 million) was directed toward tropical agricultural research for Africa; about the same amount as reported by the CG institutes (US\$ 140 million).

4. SYNOPSIS

Some aspects of the organizational structures for African agricultural R&D have changed quite markedly—especially over the past several decades. Other aspects have changed little. Most of the region’s agricultural R&D is still performed by government agencies (86.5 percent of the fte researchers in 1991). The share conducted by universities has grown markedly, but from a very small base so that by 1991 they collectively accounted for 10 percent of the African total. Research performed by semipublic entities is still a small share of the total (3.5 percent), often involving research on commercial export crops or subsectors with vertically integrated production-processing-marketing chains.

In this paper we identified the comparatively small size and institutional fragmentation of national agricultural research undertakings as a persistent problem throughout Africa. While the size of the national effort has grown, many research agencies working within these national systems are still quite small. From a sample of 341 agencies from 37 countries, almost half still employed less than 10 fte researchers in 1991, and nearly one-third employed less than five researchers. Most universities fell at the small end of the size spectrum; their staff typically spent a small fraction (less than 20 percent) of their time doing research.

Because of the site-specific nature of much agricultural R&D it may make sense to conduct the research from multiple locations. These biophysical factors are compounded by political pressures to locate different agencies in different ministries and different electorates. Collectively, these aspects can cause fragmentation of public R&D at both the

operational and organizational levels, and the loss of potential size, scale, and scope economies that come from consolidating the conduct of R&D within fewer facilities. At the operational level we noted an initial increase in fragmentation of agricultural research capacity during the 1960s, followed by a trend toward consolidation into fewer R&D agencies during the 1970s and 1980s. However, the moves toward consolidating research within a so-called national agricultural research organization (NARO), while widespread, were not universal nor comprehensive.

Other aspects of this fragmentation problem are relevant too. Different research agencies are often administered by different ministries, making it difficult to coordinate research efforts across these agencies. A good deal of organizational reform, with respect to the conduct and administration of public agricultural research, remains to be done before national research efforts in Africa realize the potential economies of size and scope that agencies elsewhere in the world appear to be reaping.

Regional approaches to agricultural R&D have been revived throughout Africa in recent years, motivated perhaps in part by the perceptions of national policymakers that smallness remains a constraint to successful research, and perhaps by donor perceptions that consolidating national research programs along regional lines would also streamline their own lending and granting practices. In colonial times, regionally conceived and conducted research was quite common. However, as we described in this paper, the operational, organizational, and funding details of this regional research were different for Anglophone compared with Francophone Africa, and different again within parts of these regions. Nonetheless, the existence of a political jurisdiction spanning national interests was a key feature of the pressures for, and successes of, these regional research initiatives.

The modern manifestation of “regionalism in African R&D” has been a proliferation of “research networks” and various regional and international forums designed to coordinate aspects of R&D. We noted and questioned the preponderance of research networks geared mainly (often exclusively) for African researchers. This runs against the grain of the globalization of science. Linking African scientists with scientists elsewhere may turn out to be more productive than the current focus on intra-regional collaboration. The regional “governance” and coordination bodies are numerous and growing. No doubt there is benefit in avoiding unnecessary duplication of research and conducting collaborative research in ways that tap the comparative advantages of the respective collaborators. Whether these sorts of decisions can be meaningfully made in regional forums, especially in the absence of structured information about the economic consequences (particularly as to the size and the distribution of the costs and benefits from R&D) is debatable.

Regional aspects of funding R&D are also under discussion. Again, identifying the distinct regional and national interests in regional approaches to funding R&D is a difficult but necessary step, ideally with the requisite policy analysis to inform the political processes that are afoot. The ultimate test is whether national governments are willing to use some of their own resources to fund research done elsewhere as opposed to locally, if such research can be shown to have greater impact in their farmers’ fields and consumers’ purses. Providing the requisite information to inform those national decisions, and designing systems that make best use of the limited R&D dollars available is also difficult but doable, yet woefully little of this serious analysis has been done to date for Africa.

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Appendix A

Acronyms and abbreviations

ACCT	Agence de Cooperation Culturelle et Technique
ACIAR	Australian Centre for International Agricultural Research
AOF	French West Africa
ARC	Agricultural Research Council <i>or</i> Agricultural Research Corporation
ARD	Agricultural Research Division
ASARECA	Association for Strengthening Agricultural Research in Eastern and Central Africa
AUPELF	Association des Universités Partiellement ou Entièrement de Langue Française
AVRDC	Asian Vegetable Research and Development Center
BUROTROP	Bureau for the Development of Research on Tropical Perennial Oil Crops
CEEMAT	Centre D'Enseignement et d'Expérimentation du Machinisme Agricole
CEFADER	Centre Fédéral d'Appui au Développement Rural
CGIAR	Consultative Group on International Agricultural Research
CIAT	Centro Internacional de Agricultura Tropical
CIDA	Canadian International Development Agency
CIFOR	Center for International Forestry Research
CILSS	Comité Inter-Etat pour la Lutte contre la Sècheresse au Sahel
CIMMYT	Centro Internacional de Mejoramiento de Maiz y Trigo
CIP	Centro Internacional de la Papa
CIRAD	Centre for International Research in Agricultural Development
CIRST	Conseil Interministériel de la Recherche Scientifique et Technique
CNPS	Commission Nationale de la Politique Scientifique
CNRS	Conseil National de la Recherche Scientifique
CNRST	Conseil National de la Recherche Scientifique et Technique <i>or</i> Conseil National pour la Recherche Scientifique et Technique
CORAF	Conférence des responsables de Recherche agronomique en Afrique de l'Ouest et du Centre
CRSA	Conseil de la Recherche Scientifique et Appliquée
CSIR	Council for Scientific and Industrial Research
CSRS	Conseil Supérieur de la Recherche Scientifique
CTFT	Centre Technique Forestier Tropical de Point Noire
DANIDA	Danish International Development Agency
DAR	Department of Agricultural Research
DDT	Direção do Desenvolvimento Tecnico
DEPA	Departamento da Pesquisa Agricola
DGRST	Directorat Général de la Recherche Scientifique et Technique
DNRA	Direction National de la Recherche Agronomique
DRSS	Department of Research and Specialist Services
DRST	Directorat de la Recherche Scientifique et Technique
DRT	Department of Research and Training
DSA	Département des Systèmes Agraires
DRT	Directorate of Research and Training
EAAFRO	East African Agricultural and Forestry Research Organization
EARO	Ethiopian Agricultural Research Organisation
EAVRO	East African Veterinary Research Organization
ECGC	Empire Cotton Growing Corporation
ESTC	Ethiopian Science and Technology Commission
FAO	Food and Agriculture Organization of the United Nations
FARA	Forum for Agricultural Research in Africa
FARC	Food and Agricultural Research Council

FOFIFA	Foibem-Pirena Mombra ny Fikarohana Ampiharina Amin'ny Fampanandrosoana ny eny Ambanivohitra
GERDAT	Groupe d'Études et de Recherches pour le Développement de l'Agronomie Tropicale
GTZ	German Agency for Technical Cooperation
IAR	Institute of Agricultural Research
IBPGR	International Board of Plant Genetic Resources
IBSRAM	International Board for Soil Research and Management
ICARDA	International Center for Agricultural Research in Dry Areas
ICIPE	International Center of Insect Physiology and Ecology
ICLARM	International Center for Livestock Aquatic Research Management
ICRAF	International Center for Research on Agro-Forestry
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IDRC	International Development Research Center
IER	Institut d'Économie Rurale
IEMVT	Institut d'Élevage et de Médecine Vétérinaire des Pays Tropicaux
IFAC	Institut Français pour les Agrumes Coloniaux
IFAD	International Fund for Agricultural Development
IFCC	Institut Français de Recherche du Café et du Cacao et Autres Plantes Stimulantes
IFDC	International Fertilizer Development Center
IFPRI	International Food Policy Research Institute
IIMI	International Irrigation Management Institute
IITA	International Institute for Tropical Agriculture
ILCA	International Livestock Center for Africa
ILRAD	International Laboratory for Research and Animal Disease
ILRI	International Livestock Research Institute
INAC	Institut d'Agronomie Coloniale
INEAC	Institut National pour l'Étude Agronomique au Congo
INERA	Institut National pour l'Étude et la Recherche Agronomique
INIBAP	International Network for the Improvement of Bananas and Plantains
INIDA	Instituto Nacional de Investigación e Desenvolvimento Agrária
INRA	Institut National de la Recherche Agronomique
INRAB	Institut National de la Recherche Agronomique du Bénin
INRAN	Institut National de la Recherche Agronomique du Niger
INRDG	Institut National de Recherche et de Documentation de Guinée
INRS	Institut National de la Recherche Scientifique
INSAH	Institut du Sahel
IPGRI	International Plant Genetic Resources Institute
IRAG	Institut de Recherche Agronomique de Guinée
IRAT	Institut de Recherche Agronomique Tropicale et des Cultures Vivrières
IRCA	Institut de Recherche sur le Caoutchouc en Afrique
IRCT	Institut de Recherche du Cotton et des Textiles Exotiques
IRHO	Institut de Recherches pour les Huiles et Oléagineux
IRRI	International Rice Research Institute
ISABU	Institut des Sciences Agronomiques du Burundi
ISAR	Institut des Sciences Agronomiques du Rwanda
ISNAR	International Service for National Agricultural Research
ISRA	Institut Sénégalais de Recherches Agricoles
KARI	Kenya Agricultural Research Institute
MERS	Ministère de la Recherche Scientifique
MRST	Ministère de la Recherche Scientifique et Technique
MSIRI	Mauritius Sugar Industry Research Institute
NACAR	National Advisory Committee for Agricultural Research

NARCC	National Agricultural Research Coordinating Council
NARI	National Agricultural Research Institute
NARO	National Agricultural Research Organization
NARS	National Agricultural Research System
NCR	National Council for Research
NCSR	National Council for Scientific Research
NCST	National Council for Science and Technology <i>or</i> Nigerian Council for Science and Technology
NRC	National Research Council
NSRC	National Scientific Research Council
NSTRAC	National Scientific and Technical Research Advisory Council
ONRD	Office National de la Recherche et du Développement
ORSC	Office de la Recherche Scientifique Coloniale
ORSTOM	Office de la Recherche Scientifique et Technique d'Outre-Mer
R&D	research and development
RB	Research Branch
SADCC	Southern Africa Development Coordinating Conference
SACCAR	Southern African Centre for Cooperation in Agricultural Research
SAFGRAD	Semi-Arid Food Grain Research and Development Project
SIA	Servicio de Investigaciones Agropecuarias
SRD	Scientific Research Division
SPAAR	Special Program on African Agricultural Research
TARO	Tanzania Agricultural Research Organization
TALIRO	Tanzania Livestock Research Organization
UNDP	United Nations Development Program
USAID	United States Agency for International Development
WAIRO	West African Inter-territorial Research Organization
WARDA	West Africa Rice Development Association

Appendix Table C.1 Agricultural research networks in Sub-Saharan Africa, early 1990s

Management Entity	Network		
	Name	Acronym	Orientation
<i>Regional networks (72)</i>			
AVRDC	- Regional Collaborative Network for Vegetable Research and Development in the Southern Africa ^a	CONVERDS	Vegetables
ASARECA	(See CIAT, CIMMYT, IITA, CIP, INIBAP, IPGRI, and ICRAF for networks in Eastern and Central Africa that will gradually coming under the governance of ASARECA.) - East and Central Africa Policy Analysis Network (ECAPA) (together with Michigan University)		Social economics
BUROTOP	- Coconut and Other Tree Crops Network		Tree crops
CIAT	- Eastern Africa Bean Research Network (together with CIDA) ^a - Southern Africa Bean Research Network ^b	EABRN SABRN	Beans Beans
CIMMYT	- Maize and Wheat Improvement Research Network for the SADC region ^b - Eastern and Southern African Farming Systems Research Network (together with USAID) - East and Central Africa Maize and Wheat Network ^a		Wheat Farming systems Maize, wheat
CIP	- Programme pour l'Amélioration de la Pomme de Terre et de la Patate Douce en Afrique Centrale et de l'Est ^a	PRAPACE	Potatoes
CIRAD	- Pathologie Respiratoire des Petits Ruminants (Network for Research on Respiratory Pathology of Small Ruminants) - Réseau Oasis (Oasis network)	PPR OASIS	Animal health ?
CORAF	- Cassava Network - Groundnut Network - Réseau de Recherche sur la Résistance à la Sécheresse - Maize Network - Rice Network - Cotton Network - Vegetables Network		Cassava Groundnut Drought resistance Maize Rice Cotton Vegetables
FAO	- African Network on Applied Meat Technology Research in Traditional Methods of Meat Processing and Preservation - African Research Network on Rural Poultry Development		Meat Poultry
GTZ	- West Africa Network on Animal Traction	WAATA	Animal traction
IBSRAM	- Network on Land Development for Sustainable Agriculture in Africa - Network on Management of Acid Soils in Humid Africa	AFRICALAND - Land development AFRICALAND - Management of acid soils	Soils Soils
ICIPE	- African Regional Pest Management Research and Development Network	PESTNET	Pest management

Appendix Table C.1 (continued)

Management Entity	Network		
	Name	Acronym	Orientation
<i>Regional networks continued</i>			
ICRAF	- Agroforestry Network for Africa - Eastern and Central Africa ^a	AFRENA-ECA	Agroforestry
	- Agroforestry Network for Africa - Humid Lowlands of West Africa	AFRENA-HULWA	Agroforestry
	- Agroforestry Network for Africa - Semi-Arid Lowlands of West Africa	AFRENA-SALWA	Agroforestry
	- Agroforestry Network for Africa - Southern Africa (together with CIDA) ^b	AFRENA-SA	Agroforestry
	- African Highland Initiative ^a		?
	- Africa Link ^a		?
ICRISAT	- Cooperative Cereals Research Network	CCRN	Cereals
	- West Africa Collaborative Groundnut Research Network (see also SAFGRAD)		Groundnut
IDRC	- Agrogeology Network (East Africa)		Agroecology
	- East Africa pesticide network		Pesticides
	- Environmental Economics Network for Eastern and Southern Africa	EENESA	Environmental economics
	- Network Coordinator Agro-forestry Research (Southern Africa) - Phase III		Agroforestry
	- Network on Sorghum Milling/Dehulling		Sorghum processing
	- Oilcrops Network for Eastern and Southern Africa and South Asia		Oilcrops
	- Oilseed Processing Network (together with ATI)		Oilseeds processing
	- Research Network on Land Tenure and Semi-Arid Lands (East Africa)		Land tenure
	- Southern African Agricultural Information Network	SAAINET	Agricultural info
	- Vegetable Oil / Protein System Improvement Network	PTA	Vegetable oils
IFDC	- West African Fertilizer Management and Evaluation Network (together with IDRC and UNDP)	WAFMEN	Fertilizers
IITA	- Alley Farming Network for Tropical Africa (together with IDRC and CIDA)	AFNETA	Farming systems
	- Central and West African Root Crops Collaborative Research Network	CEWARRN	Root crops
	- East Africa Root Crops Research Network (together with IDRC and USAID)	EARRN	Root crops
	- Southern Africa Root Crops Research Network (together with IDRC and USAID)	SARRN	Root crops
	- Soil and Plant Analytical Laboratories Network for Africa	SPALNA	Soil and plant science
ILRI	- Animal-Agriculture Research Network ^a	AARNET	Animal
	- African Feed Resources Network (AFRNET) (together with IDRC)		Feed resources
	- African Research Network for Agricultural By-Products (together with IDRC)	ARNAB	?
	- African Small Ruminant Collaborative Research Network (together with IFAD)	SRNET	Livestock
	- African Trypanotolerant Livestock Network	ATLN	Livestock
	- Animal Traction Research Network	CARNET	Animal traction
	- Cattle Research Network (formerly Cattle Milk and Meat Network)		Cattle

Appendix Table C.1 (continued)

Management Entity	Network		
	Name	Acronym	Orientation
<i>Regional networks continued</i>			
	- Pasture Network for Eastern and Southern Africa (together with IDRC)	PANESA	Pastures
INIBAP	- Banana Research Network Eastern and Southern Africa ^a	BARNESA	Banana
INSAH	- Sahelian Information Network	SIN	Agricultural information
	- Regional Collaborative Research Program in Food Security		Food security
IPGRI	- East African Plant Genetic Resources Network ^a		Plant genetic resources
ORSTOM	- Reseau Erosion (Erosion Network)	EROS	Erosion
	- Reseau Humus (Humus Network)	RHUM	Humus
	- Strategies Alimentaires (Food Strategies Network)	STRA	Food science
SACCAR	(See networks under AVRDC, CIMMYT, and ICRAF)		Agronomy
SAFGRAD	- Eastern and Central Africa Regional Sorghum and Millet Collaborative Research Network (together with ICRISAT and USAID)	ECARSAM	Sorghum, millet
	- West African Farming Systems Research Network (together with IFAD)	WAFSRN/RESPAO	Farming Systems
	- West and Central Africa Cowpea Collaborative Research Network (together with IITA and USAID)	RENACO	Cowpea
	- West and Central Africa Maize Collaborative Research Network (together with IITA and USAID)	WECAMAN	Maize
	- West and Central Africa Sorghum Research Network (together with ICRISAT and USAID)	WCASRN	Sorghum
UNDP	- Agronomic Network for East and Southern Africa (together with World Bank)		Agrominerals
	- Geological Network for Agrominerals in East and Southern Africa (together with World Bank)		
WARDA	- Mangrove Swamp Rice Network (together with USAID)		Rice
Winrock International	- African Rural Social Sciences Research Network	ARSSRN	Social sciences
<i>International networks (14)</i>			
ACIAR	- ACIAR Forestry Research and Information Network		Forestry
USAID	- Arid and Acid Soils Network		Soils
IRRI	- Asian Rice Farming Systems Network	ARFSN	Rice
ORSTOM	- CIS Economie Mondiale Tiers-Monde Developpement (Network on Third World Development and World Economy)	GEMDEV	Social economics
ORSTOM	- Climat Zones Arides (Arid Zones Climate Network)	CZA	Climate
USAID	- International Benchmark Soils Network for Agro-technology Transfer	IBSNAT	Soils
CIMMYT	- International Maize Improvement Network		Maize
INIBAP	- International Network for the Improvement of Bananas and Plantains	INIBAP	Bananas and plantains
IRRI	- International Network on Soil Fertility and Sustainable Rice Farming	INSURF	Soils, rice

Appendix Table C.1 (continued)

Management Entity	Network		
	Name	Acronym	Orientation
<i>International networks continued</i>			
IRRI	- International Network on the Genetic Enhancement of Rice	INGER	Genetic improvement, rice
ACCT	- Reseau International de Traitement des Donnees Sols (International Network for Soils Data Processing)	RIDTS	Soils
AUPELF	- Reseau sur la Conservation Post-Recolte des Denrees Alimentaires (Network for Post-Harvest Storage of Food Crops)	GRENIER	Post-harvest storage
IDRC	- Soil Fertility Network		Soils
Winrock International	- Sugar Cane Energy Network		Sugarcane

Source: Plucknett, Smith, and Ozgediz (1990) and SPAAR (1996).

^a Management of these networks is expected to be transferred to ASARECA.

^b Management of these networks is expected to be transferred to SACCAR.