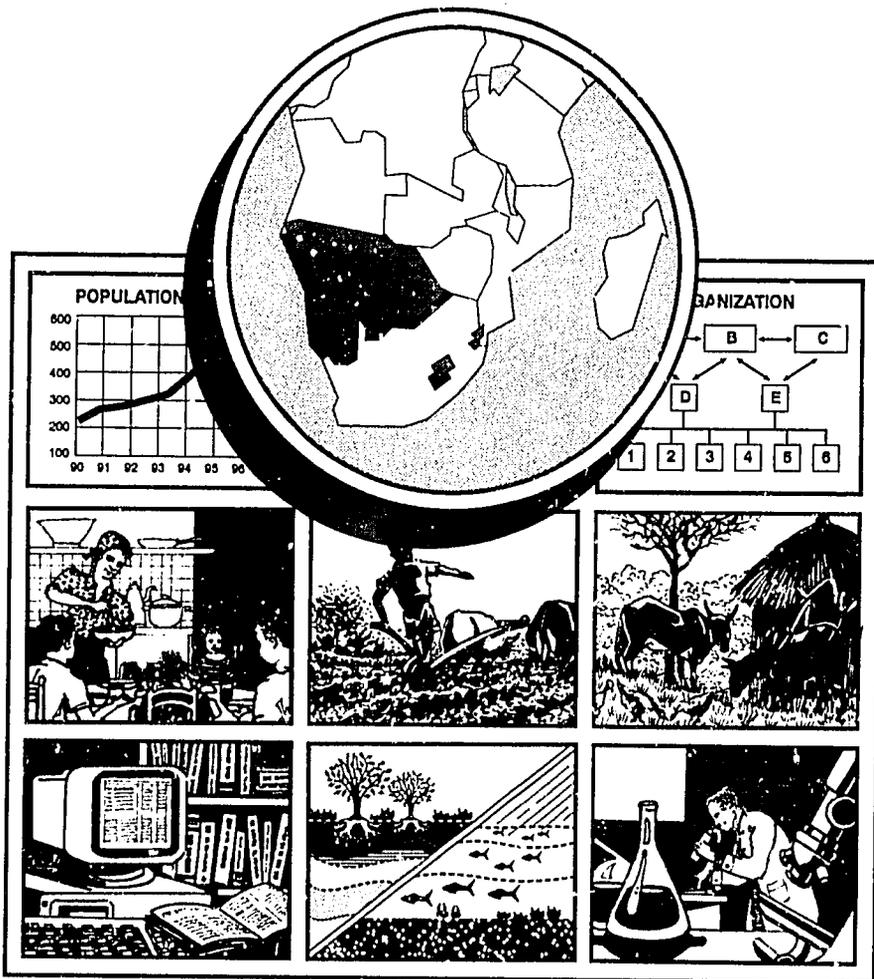




# National Agricultural Research in a Regional Context: The Small Countries of Southern Africa

Andrew E. Okello  
and  
Pablo B. Eyzaguirre



The mandate of the International Service for National Agricultural Research (ISNAR) is to assist developing countries in bringing about lasting improvements in the performance of their national agricultural research systems and organizations. It does this by promoting appropriate agricultural research policies, sustainable research institutions, and improved research management. ISNAR's services to national research are ultimately intended to benefit producers and consumers in developing countries and to safeguard the natural environment for future generations.

ISNAR offers developing countries three types of service, supported by research and training:

- For a limited number of countries, ISNAR establishes long-term, comprehensive partnerships to support the development of sustainable national agricultural research systems and institutions.
- For a wider range of countries, ISNAR gives support for strengthening specific policy and management components within the research system or constituent entities.
- For all developing countries, as well as the international development community and other interested parties, ISNAR disseminates knowledge and information about national agricultural research.

ISNAR was established in 1979 by the Consultative Group on International Agricultural Research (CGIAR), on the basis of recommendations from an international task force. It began operating at its headquarters in The Hague, The Netherlands, on September 1, 1980.

ISNAR is a nonprofit, autonomous institute, international in character and apolitical in its management, staffing, and operations. It is financially supported by a number of the members of the CGIAR, an informal group of donors that includes countries, development banks, international organizations, and foundations. Of the 18 centers in the CGIAR system of international centers, ISNAR is the only one that focuses specifically on institutional development within national agricultural research systems.

*STUDY PAPER # 7*

**National Agricultural Research  
in a Regional Context:  
The Small Countries of Southern Africa**

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Andrew E. Okello

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***isnar***

**International Service for National Agricultural Research  
1992**

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**AGROVOC Descriptors**

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management; organization of research; research; research policies; Southern Africa

**CABI Descriptors**

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agricultural research; management; organization of research; research; research policy; Southern Africa

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# *ISNAR Small-Country Project*

## **Introduction**

**I**n 1989, ISNAR began a global study of agricultural research systems in small, low-income developing countries with populations of fewer than five million people. Because of resource limitations and the inherent constraint of size that restrict the scale of the research effort in these countries, their national agricultural research systems (NARS) are small — often under 50 researchers. Nonetheless, these NARS have varied and complex tasks to perform in their respective countries.

The major goals of this study are to identify the strategic role of NARS in small countries and to determine how essential research tasks can be carried out in small research systems. Several

cases are to be examined in depth, and for these, the study will assess the research capacity and resources that are currently available or needed to conduct agricultural research. This is examined in light of their mandates under the agricultural development policy of their respective countries, as well as requirements for conserving the country's natural resource base.

The project is funded largely by the Italian Government with additional support from the Rockefeller Foundation, the Danish International Development Agency (DANIDA), and the CTA (Technical Centre for Agricultural and Rural Cooperation, ACP-EC Lomé Convention).

## **Objectives**

- To create and maintain a data base on 50 small countries, containing information on their agricultural research needs and national agricultural research systems.
- To devise means of measuring and classifying key factors related to agricultural research so that the NARS of small countries can be analyzed and compared. Such factors include agroecological zones, the scale of research systems (e.g., human and financial resources, sizes and types of institutes, types and quantity of local research programs), internal demand for technology, external sources of information on new technologies, and linkages to those sources.
- To identify suitable organizational models for NARS, as well as mechanisms and strategies for setting priorities and allocating resources to research.
- To evaluate national and regional research environments so as to help small countries exploit opportunities for acquiring new technologies from outside.
- To identify and assess mechanisms that enable NARS to manage their links with policy-makers, local producers, and external sources of knowledge and technology.
- To identify the skills needed by small-country research leaders to manage the alternative strategies open to them.

# Project Activities

## A Global Data Base on NARS in Small Countries

**F**ifty developing countries are included in a global data base on agricultural research needs and the state of the NARS. These countries have populations of less than five million (1980 census) and meet at least three of the following four criteria:

- The economically active agricultural population is 20 percent or more of the total economically active population.
- Per capita income is less than US\$2,000 (1980 US constant dollars).
- AgGDP per capita for the economically active agricultural population is less than US\$2,000.
- AgGDP is 20 percent or more of GDP.

For each country, this information will be used to assess the national demand for research as well as existing national research capacity. The data base should provide cross-country indicators of common constraints, options, and trends.

## Country Case Studies

**H**onduras, Jamaica, Sierra Leone, Togo, Lesotho, Mauritius, and Fiji have been selected for in-depth study. The studies cover institutional development, research organization and structure, external linkages, and information flows to the country.

## Regional Studies

**R**egional studies will be conducted in parts of West Africa, the Caribbean, and the South Pacific. The goal of the regional studies is to assess research capacity in regions where small countries predominate. The regional studies will also identify mechanisms and strategies by which national systems can increase their effectiveness and efficiency and gain access to the information and technology they need. The studies will consider the division of labor between NARS in a regional context as well as the role of regional research organizations and collaborative networks.

# Methods and Concepts

**T**he ISNAR project will develop methods for analyzing research needs and capacity in small countries. These will identify key issues and employ the following concepts:

- **Scale:** the inherent research capacity of a national system: the combination of a NARS's human and financial resources, knowledge base, and infrastructure.
- **Scope:** the institutional agenda of a NARS, the set of research topics and objectives to which it is committed. Scope has two dimen-

sions: the range of research programs and the level of sophistication of the research.

- **Technology Gradients and Information Flows:** the varying intensities and levels of complexity in technology generation among national systems and the network of information exchange. An analysis of structure and levels of technology generation and transfer in a region is crucial for guiding the flow of information to smaller research systems. The study of gradients and flows also examines the capacity NARS must have in

place to have access to the technology and information they need.

- **Linkages:** linkages to institutions and systems outside the NARS itself. The study will explore two key sets of linkages that are

essential for the national agricultural research system. The first includes linkages to policymakers and to farmer knowledge systems in the country. The second includes linkages to external sources of knowledge, technology, and resources.

## Managing Scientific Information

In collaboration with the CTA (Technical Centre for Agricultural and Rural Cooperation, ACP-EC Lomé Convention) and agricultural research information specialists from developing countries, a study is underway to explore the management of scientific information in small research systems with limited resources.

Access to scientific information that is relevant to the development of objectives and appropriate to the conditions of developing countries is crucial for agricultural research systems. It is particularly critical in small countries because the resources to do all the research that farmers need are not always available. The scope of

research in a country can be increased through effective information management. Information can also be used to supplement or replace some kinds of research, releasing scarce resources to be used for programs that must be conducted locally.

NARS in small countries are often limited in their ability to identify and receive the information they need to conduct adaptive and resource management research. This study will assess and propose mechanisms for identifying and obtaining scientific information for research programs in small countries. It will then focus on mechanisms of managing this information.

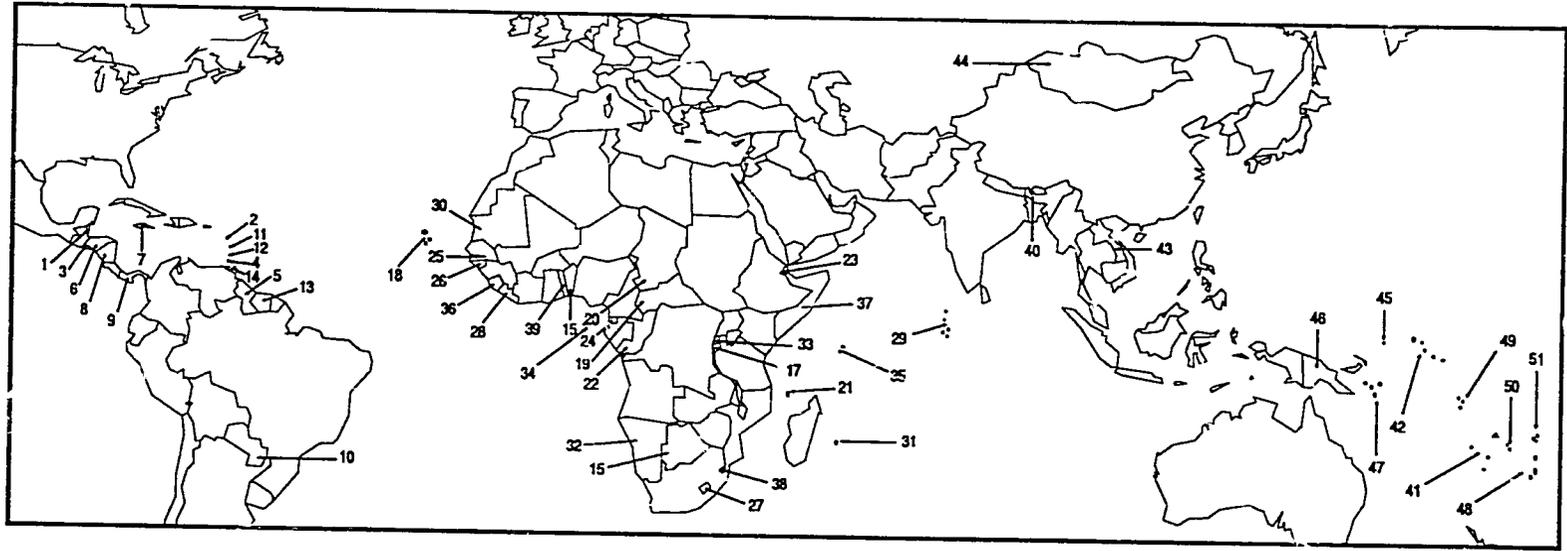
## Dissemination of Results

**Seminars/Workshops:** Workshops are the key to disseminating the results of this study. The first workshop, held in The Hague in January 1990, reviewed project methodology and began implementation of country and regional studies. When the main phase of the study is complete, a global workshop of research leaders from small developing countries will be held. At this workshop, the conclusions of the study will be validated and applied.

**Advisory Service and Training:** In collabora-

tion with national and regional agricultural research organizations, the methods developed in the study will be used for strategic planning and to produce improved management techniques for small research systems.

**Publications:** The data base, case studies, and issues papers will be published and made available to agricultural research managers, scientists, and development agencies concerned with agricultural growth and sustainability in developing countries.



### Small Countries (as Defined by this Project)

#### Latin America and Caribbean:

- 1 Belize
- 2 Dominica
- 3 El Salvador
- 4 Grenada
- 5 Guyana
- 6 Honduras
- 7 Jamaica
- 8 Nicaragua
- 9 Panama
- 10 Paraguay
- 11 St. Lucia
- 12 St. Vincent
- 13 Suriname
- 14 Trinidad and Tobago

#### Africa and the Indian Ocean:

- 15 Benin
- 16 Botswana
- 17 Burundi
- 18 Cape Verde
- 19 Central African Republic
- 20 Chad
- 21 Comoros
- 22 Congo
- 23 Djibouti
- 24 Equatorial Guinea
- 25 Gambia
- 26 Guinea-Bissau
- 27 Lesotho

- 28 Liberia
- 29 Maldives
- 30 Mauritania
- 31 Mauritius
- 32 Namibia
- 33 Rwanda
- 34 Sao Tome e Principe
- 35 Seychelles
- 36 Sierra Leone
- 37 Somalia
- 38 Swaziland
- 39 Togo

#### Asia and the Pacific:

- 40 Bhutan
- 41 Fiji
- 42 Kiribati
- 43 Laos
- 44 Mongolia
- 45 Nauru
- 46 Papua New Guinea
- 47 Solomon Islands
- 48 Tonga
- 49 Tuvalu
- 50 Vanuatu
- 51 Western Samoa

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## Abstract

A regional approach in which a national agricultural research system can benefit from activities that take place in neighboring countries is often advocated as a way for small countries to overcome their size constraints. This paper reviews the regional context for agricultural research in the small countries of Southern Africa (Botswana, Lesotho, Namibia, and Swaziland) from a national viewpoint. Given their limited resources, each of the the countries can benefit from increased collaboration on selected issues with other countries in the region. However, the areas of collaboration need to be selected and prioritized in relation to national needs. And levels of participation, in networks for example, need to be carefully defined to match national capacity. Participation and collaboration in regional efforts requires that the countries themselves have well-defined research policies and priorities, that their portfolios of national research activities are aligned to capitalize on potential spillovers from the region, that the strengths of a research system characterized by institutional diversity are recognized, and that the different parts of the system are directed towards common policy goals. An outward-looking strategy for these small countries that builds on knowledge and technologies borrowed from the region will require a redefinition of what constitutes *research* — away from experimentation alone towards a broader set of functions. This reorientation will require new, and perhaps different, skills and qualifications from researchers and different ways of organizing and managing research activities.

## Résumé

Une approche régionale par laquelle un système national de recherche agricole (SNRA) peut tirer parti des activités de ses voisins est souvent préconisée comme un moyen pour les petits pays de surmonter leurs contraintes de tailles. Cette étude examine le cadre régional de la recherche agricole des petits pays de l'Afrique australe (le Botswana, le Lesotho, la Namibie et le Swaziland) d'un point de vue national. Etant donné leurs ressources limitées, chacun de ces pays peut bénéficier d'une plus grande collaboration avec les autres pays de la région pour affronter un problème donné. Toutefois, il faut sélectionner et donner une priorité aux domaines de collaboration par rapport aux besoins nationaux. De surcroît, les niveaux de participation aux réseaux, par exemple, devraient être soigneusement définis afin de répondre à la capacité nationale. Une bonne participation et collaboration à l'effort régional présuppose que les pays aient clairement défini leurs politiques et priorités de recherche ; que leurs activités de recherche nationale soient alignées afin de tirer profit des possibles retombées des résultats provenant de la région ; que les points forts d'un système de recherche, caractérisé par une diversité institutionnelle, soient reconnus ; et que chaque partie du système tende vers une politique de développement générale. Une stratégie de recherche plus ouverte, développée à partir d'informations scientifiques et de technologies empruntées à la région, nécessitera une révision du concept de la "recherche" qui soit plus éloigné de l'experimentation et qui comprenne une série de fonctions plus générales. Cette réorientation exigera des qualifications et des compétences nouvelles, voire différentes de la part des chercheurs ainsi que différents moyens pour organiser et gérer les activités de recherche.

## Resumo

A cooperação regional onde um sistema nacional de investigação agrícola pode aproveitar das actividades realizadas nos países vizinhos é uma estratégia aconselhável para que os países pequenos possam superar o tamanho limitado das suas estruturas de pesquisa. Este estudo apresenta uma revisão do contexto regional que afecta a pesquisa agrícola nacional nos países pequenos de África Austral (Botswana, Lesoto, Namíbia, e Swazilândia). Em consideração dos seus recursos escassos e limitados, cada um dos países pode beneficiar de uma maior colaboração sobre temas específicos com outros países na região. Para que tal colaboração seja eficaz, as áreas de trabalho colaborativo devem ser seleccionados de acordo com as prioridades e necessidades nacionais; os níveis de participação nas "redes de investigação" por exemplo, devem ser identificados em função da capacidade nacional. A participação e a colaboração nas actividades regional requer que os países estabeleçam políticas e prioridades de pesquisa bem definidas e claras; é preciso alinhar os programas de pesquisa para aproveitar melhor os conhecimentos e tecnologias produzidos dentro da região; é preciso reconhecer as vantagens comparativas da diversidade nas instituições que contribuem à pesquisa agrícola nacional; mas é imprescindível que as diversas actividades de pesquisa sejam orientadas às políticas de desenvolvimento nacional. Os países pequenos podem aplicar uma visão mais aberta para aproveitar melhor as fontes de informação e tecnologia existentes, mas isto implica uma redefinição da pesquisa nacional para dar maior ênfase às funções além da experimentação. Esta nova orientação requer novas práticas e qualificações e novos conhecimentos dos pesquisadores, junto com novas maneiras de organizar e administrar a pesquisa agrícola nacional.

## Resumen

Un enfoque regional, en el cual un sistema nacional de investigación agrícola pueda beneficiarse de las actividades que se realizan en países vecinos, es una estrategia apropiada para los países pequeños que buscan superar el tamaño limitado de sus estructuras de investigación. Este documento revisa el contexto regional para el desarrollo de la investigación agrícola en los países pequeños de África austral (Eotswana, Lesoto, Namibia y Swazilandia). Debido a sus limitados recursos, cada uno de los países puede beneficiarse de una colaboración técnica más estrecha con otros países de la región en aspectos claves. Sin embargo, las áreas de colaboración deben ser elegidas de acuerdo a las prioridades y las necesidades nacionales. En el caso de las numerosas redes de investigación, los niveles de participación deben ser cuidadosamente definidos para concordar con la capacidad nacional. La participación y colaboración en iniciativas regionales requiere que los países mismos tengan políticas y prioridades de investigación bien definidas; que sus actividades de investigación a nivel nacional estén en posición de contribuir y aprovechar resultados, conocimientos y tecnología producidos dentro de la región; y que se reconozca las ventajas comparativas de la diversidad de instituciones que contribuyen a la investigación nacional. Para lograr tal cooperación entre sistemas nacionales es imprescindible que las diferentes actividades de investigación sean orientadas bajo una política común de investigación para el desarrollo. Los países pequeños pueden adoptar una visión más abierta y amplia para acceder y aprovechar mejor las fuentes de información y tecnología que existen al exterior. Esto implica una redefinición de la investigación nacional para dar mayor énfasis un grupo de funciones más amplio que la simple experimentación. Esta reorientación va a requerir nuevas, y quizás diferentes, habilidades y calificaciones de los investigadores y distintas maneras de organizar, manejar y dirigir las investigación agrícola nacional.

# Acronyms

ARD	Agricultural Research Division (Lesotho) Agricultural Research Division (Swaziland)
AVRDC	Asian Vegetable Research and Development Center
CARIS	Current Agricultural Research Information System
CGIAR	Consultative Group on International Agricultural Research
CIAT	Centro Internacional de Agricultura Tropical
CIMMYT	Centro Internacional de Mejoramiento de Maíz y Trigo
CONVERDS	Collaborative Vegetable Research and Development Network for Southern Africa
DAR	Department of Agricultural Research (Botswana) Department of Agricultural Research (Malawi) Division of Agricultural Research (Namibia) Department of Agriculture (Zambia)
DRSS	Department of Research and Specialist Services (Zimbabwe)
DRT	Department of Research and Training (Tanzania)
EEC	European Economic Community
FAO	Food and Agriculture Organization of the United Nations
GLIP	Grain Legume Improvement Program
IARC	international agricultural research center
ICIPE	International Center for Insect Physiology and Ecology
ICRAF	International Center for Research in Agroforestry
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IITA	International Institute of Tropical Agriculture
ILCA	International Livestock Centre for Africa
INTSORMIL	International Sorghum and Millet Collaborative Research Program (USAID)
ISNAR	International Service for National Agricultural Research
ITDL	Individual Title Deed Land (Swaziland)
LAPIS	Lesotho Agricultural Production and Institutional Support Project
LWMRP	Land and Water Management Research Project
LWP	Lesotho Woodlot Project
NARS	national agricultural research system(s)
NGO	nongovernmental organization
ODA	Overseas Development Administration (United Kingdom)
PTC	Preferential Trade Commission
SACCHAR	Southern African Centre for Cooperation in Agricultural Research
SALC	Southern African Development Community <i>formerly</i> Southern African Development Coordination Conference (SADCC)
SARCCUS	Southern African Regional Commission for the Conservation and Utilization of the Soil
SMIP	Sorghum and Millet Improvement Program
SNL	Swazi Nation Land
SRGB	SADC Regional Gene Bank
UNISWA	University of Swaziland
USAID	United States Agency for International Development

# Introduction

## Small Countries and the Regional Approach to Research

A regional approach is often advocated as a way for small countries to overcome their size constraints.<sup>1</sup> It is an approach in which a national agricultural research system (NARS) can benefit from activities in neighboring countries. It is defined as a national research strategy that promotes active participation in regional research programs and incorporates research conducted elsewhere in the region into national planning and priority-setting exercises. Some of the key mechanisms for promoting greater collaboration in research are regional research institutions, regional coordinating councils for planning and funding, and regional networks. These are found in West Africa, the Caribbean, and the South Pacific — all regions with a large number of small countries that face strict limits on the size and scope of their national research systems. This paper focuses on Southern Africa, where promising regional approaches are becoming institutionalized and could provide a way for small countries to get the agricultural technology and information they need without overextending national research programs and institutions.

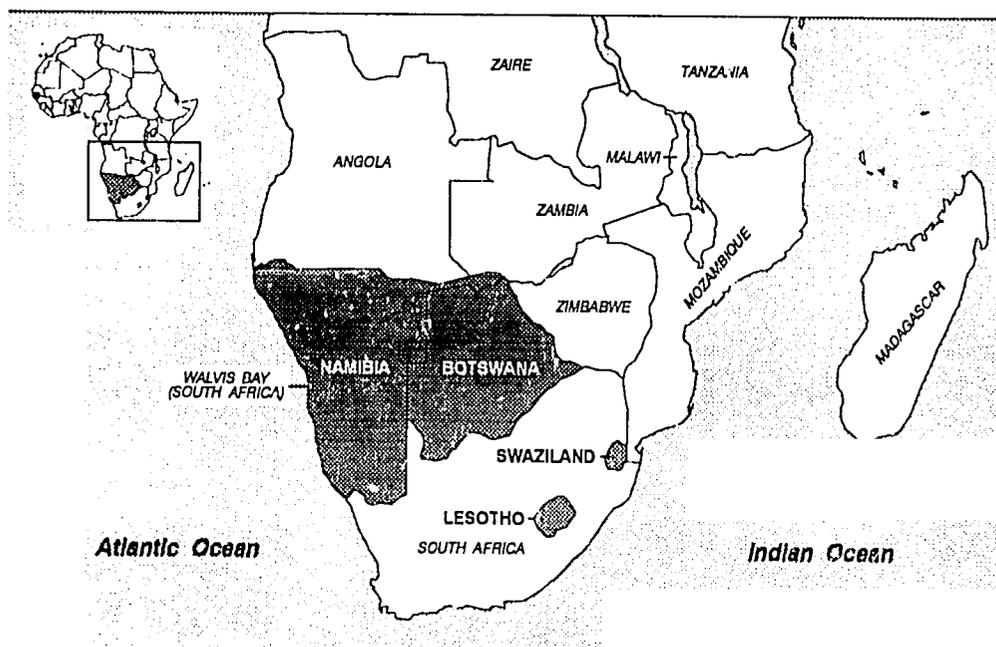
### *Defining the Small Countries of Southern Africa: Commonalities and Differences*

Applying the population and economic criteria used in ISNAR's small-country project (Eyzaguirre 1991), four countries, Botswana, Lesotho, Swaziland, and Namibia, were identified as "small countries" in Southern Africa (figure 1). There are marked differences between these four countries in terms of their natural resource base, agricultural sectors, and policies, but they face similar problems in the organization and development of their national agricultural research systems. The research systems that these countries are able to sustain, even in the best of circumstances, are likely to be small and somewhat different from those of larger countries.

The regional profiles (tables 1 and 2) illustrate some of the similarities and differences among these countries and between them and the region as a whole. Botswana and Namibia are among the larger countries in Africa in terms of national territory, while Swaziland and Lesotho are small in area. Only Swaziland has a significant commercial crop sector and only Namibia has an important fisheries sector. All four countries are marked by the importance of livestock production relative to crops. In terms of export earnings and value, livestock is clearly dominant in Botswana, Lesotho, and Namibia.

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1. A small country is defined by its economic size, which acts as a constraint to development. Most international organizations and development economists use population and the size of the economy (in our case, the focus is on the agricultural sector) as the major criteria for determining whether a country is *small* (see also Commonwealth Secretariat 1991; Forsyth 1990; Jalan 1992).



**Figure 1. Southern Africa**

**Table 1. Basic Country Data, Southern Africa**

Country	Year measured	Population (thousands)	Agric. Population (thousands)	GDP (millions 1985 dollars)	AgGDP (millions 1985 dollars)	AgGDP per capita in ag. (constant 1985 dollars)
Angola	(1985)	8,754	6,287 (71.8%)	4,845	2,243 (46.3%)	357
<b>Botswana</b>	<b>(1989)</b>	<b>1,257</b>	<b>801 (63.7%)</b>	<b>4,037</b>	<b>174 (4.3%)</b>	<b>217</b>
<b>Lesotho</b>	<b>(1988)</b>	<b>1,675</b>	<b>1,358 (81.1%)</b>	<b>2,261</b>	<b>421 (18.6%)</b>	<b>310</b>
Malawi	(1990)	8,754	6,574 (75.1%)	4,859	1,462 (30.1%)	222
Mozambique	(1990)	15,656	12,780 (81.6%)	13,888	8,312 (59.8%)	650
<b>Namibia</b>	<b>(1989)</b>	<b>1,724</b>	<b>618 (35.8%)</b>	<b>3,291</b>	<b>295 (9.0%)</b>	<b>478</b>
<b>Swaziland</b>	<b>(1986)</b>	<b>687</b>	<b>478 (69.6%)</b>	<b>1,572</b>	<b>334 (21.3%)</b>	<b>699</b>
Tanzania	(1988)	25,387	20,422 (80.4%)	12,336	6,256 (50.7%)	306
Zambia	(1990)	8,452	5,827 (68.9%)	5,620	789 (14.0%)	135
Zimbabwe	(1990)	9,709	6,617 (68.2%)	12,962	1,660 (12.8%)	251

Source: IBRD and FAO (selected years).

**Table 2. Basic Statistics on the Small Countries of Southern Africa, 1990**

Country	Total Population (000)	Total Land Area (000 ha)	Agricultural Land (000 ha)		Forest/Woodland
			Arable and Perm. Crop Land	Perm. Pasture	
Botswana	1,304	58,173	1,380	33,000	1,092
Lesotho	1,774	3,035	320	2,000	—
Namibia	1,781	82,429	662	38,000	18,150
Swaziland	788	1,736	164	1,180	1,180

Source: FAO (1990)

All four countries have crop sectors that are small in terms of hectares under cultivation and value of production; however, a large proportion of the population is employed by agriculture. Three of the four countries have small but highly productive commercial sectors that are sharply distinct from their large, resource-poor subsistence sectors. Looking at the agricultural land more closely, we see that the land planted to crops in these countries ranges from less than 13,800 km<sup>2</sup> to 1640 km<sup>2</sup>, which is small. For all four countries, the largest proportion of agricultural land is classified as permanent pasture, which is mostly fragile, with little water, and which is unable to sustain intensive or permanent use. These permanent pastures present more of a challenge to resource management than a problem to production.

There are two major issues in natural resource management facing the small countries of Southern Africa: how to manage a vast expanse of fragile and marginally exploited land and how to conserve a small agricultural resource base that is rapidly being depleted. This last also includes the problem of managing agricultural wastes. Botswana and Namibia are confronted primarily with the first — they both have vast expanses of fragile lands. Research is needed to help their policymakers with informed decisions on alternative uses such as wildlife versus livestock or agriculture versus conservation. Lesotho and Swaziland, with very small territories and strong pressures on

land resources, are confronted with major problems in both the conservation of soil and water resources and the processing of agricultural wastes from the sugar and pulp industries. Namibia is the only one of the four countries with major research interests in marine resources.

These countries must deal with broad demands for agricultural research. And with severe limitations on the size of the research system that they can sustain, they are dependent upon making the best use of research that is done in countries with greater research capacities. These may be in the region or outside.

This paper considers the potential these countries have for using research done at the regional level to address the issues facing agriculture and natural resource management at the national level. It also considers how the small size of the national research systems in Botswana, Lesotho, Namibia, and Swaziland affects their participation in regional activities. The paper sets out to identify (a) the special problems of small-country NARS in Southern Africa, (b) the potential for them to benefit from regional cooperation, and (c) the functions and mechanisms that may enable the NARS in Botswana, Lesotho, Namibia, and Swaziland to apply a regional approach in planning their own research activities. In this way, regional technology and information sources could be used to strengthen and stretch national resources.

## Methodology

The methodology is based on the conceptualization of a research system in terms of scale and scope (Eyzaguirre 1991).

**Scale** refers to the available set of resources of a research system (human, financial, physical) institutionalized in such a way as to be brought to bear on a given scope. Terms linked to scale are

- resource availability;
- size;
- capacity;
- potential output.

**Scope** refers to the range and types of objectives and the corresponding research activities conducted by a research system. Terms that are linked to scope are

- objectives;
- coverage;
- focus;
- program orientation.

One of the characteristics of a small-country research system that emerges from this project is the high level of institutional diversity that exists, with many different institutional types and activities present in most countries. This strategy, involving "multiple sources of innovation" (Biggs 1990), is often not explicitly stated, but it allows the small country to broaden its scope or portfolio of research beyond what would be feasible in a single small organization. In Southern Africa, where there are only one or two small public research institutions per country, much of the research that takes place is done by development projects or nongovernment organizations (NGOs). This has important implications for the functions of public-sector agencies.

This paper includes, therefore, more than just an analysis of the central or core publicly funded research institutes — it also includes the activities of universities, nongovernmental organizations, private-sector organizations, donor projects, and parastatal bodies. This provides a more accurate representation of the total system and allows managers to better understand the de facto division of research efforts in each country, the potential division of labor based on comparative advantage, and the way that institutional comparative advantages work to ensure that all the technologies that the country needs are acquired, one way or another.

### *Segmenting the Scope of Research into a Portfolio*

Because the potential scope of research can be too broad for a small NARS to handle, one of the ways that the scope can be made manageable is by breaking it down into domains or into a national research portfolio. The classification of research domains groups the topics and commodities on which a NARS might work based on common features in its associated knowledge and technology system and in the policy environment (table 3). Thus, research on "global staples" is done by international agricultural research centers (IARCs), and the technologies and knowledge produced are in the public domain. Food security is the driving force behind the policies and investments that support research on global staples. Furthermore, the access that NARS have to maize and sorghum technologies, for example, is relatively straightforward through the well-organized networks and other mechanisms that are in place to disseminate these technologies. Other groups are characterized by different knowledge patterns, institutional environments, and policy implications. For example, there has traditionally been greater private-sector involvement in research on export crops, which can lead to

**Table 3. Categories of Research Topics and Subjects**

Global Staple	Traditional Export	Minor Food Crop	High-Input, Non-traditional Export	Livestock	Socioeconomics & Rural Engin.	Natural Resource Management
Bananas	Cashew nuts	Apples	Asparagus	<b>SMALL RUMINANTS:</b>	Farm production & management	Agroforestry
Beans	Cinnamon	Barley	Broccoli	Goats	Farm structures	Fisheries (fresh-water/marine)
Cassava	Cloves	Breadfruit	Brussels sprouts	Sheep	Farming systems research	Forestry
Cowpeas	Cocoa	Broad & mung beans	Cardamom	<b>LARGE ANIMALS:</b>	Marketing research	Pests, diseases, weed control and management
Groundnuts	Coconuts	Cabbage	Citrus	Cattle	Postharvest and storage	Plant genetic resources
Malze	Coffee	Carrots	Flowers/ornamentals	Horses	Machinery/tools/power irrigation	Range/pasture management
Potatoes	Cotton	Castor beans	Fruits	Camels	Rural engineering	Seed technology
Pulses	Oil palm	Chick peas	Ginger	Donkeys		Soil (fertility/erosion/conservation)
Rice	Rubber	Citrus fruits	Grapes	<b>POULTRY/SWINE:</b>		Irrigation/water management
Sorghum	Sisal	Date palms	Grapefruit	Chickens		
Soya	Sugar	Figs	High-value vegetables	Ducks		
Wheat	Tea	Fruits (local use)	Jojoba	Turkeys		
	Tobacco	Garlic	Kava	Swine		
		Lentils	Mangoes	Animal traction		
		Melons	Papaya	Dairy technology		
		Millet ( <i>Elystne</i> , <i>Digitaria</i> )	Passionfruit	Diseases and pests		
		Mustard (seed)	Peaches	Husbandry and management		
		Nectarines	Pineapples	Nutrition/fodder/forage		
		Oats	Plums	Zootechnology		
		Okra	Pyrethrum			
		Onions	Quinquina			
		Pandanus	Ramie (textile fiber)			
		Peas (garden-)	Sour sop			
		Pears	Strawberries			
		Peppers	Sunflowers			
		Pigeon peas	Vanilla			
		Plantain	Ylang-Ylang			
		Radishes				
		Safflower (oilseed)				
		Sesame				
		Soya				
		Sunflowers				
		Sweet potatoes				
		Swiss chard				
		Taro ( <i>Xanthosoma</i> , <i>Colocassia</i> )				
		Tomatoes				
		Triticale				
		Turnips				
		Vegetables (local use)				
		Yams ( <i>Dioscorea</i> )				

restricted and costly access. Research in socioeconomics and natural resources, in contrast, is usually closely associated with universities (Elliott 1992).

These patterns are important in determining technology gradients<sup>2</sup> for specific crops or groups of crops. They also form part of the analysis of potential benefits to be gained from participation in regional research activities. Understanding the pattern of technology flows allows a small country to position itself so that maximum benefits can be obtained at least cost, and scarce national resources can be allocated to projects and programs where the lack of existing knowledge justifies national investments.

The institutions responsible for agricultural research are identified for each country. The resources available to each institution are then aggregated in order to determine the scale of research in each of the research systems. Institutional research programs and activities are classified by domain so that the scope of research can be determined for each institution, and the current research portfolio determined for the research system as a whole. Technology flows, linkages with sources of technology and information, and the role of regional collaborative research and networks are then discussed in relation to their potential to contribute to the national research effort.

## Regional Framework for Agricultural Research in Southern Africa

A study of agricultural research in the small countries of Southern Africa must consider the regional environment in which these research systems operate. For many years, the political problems associated with the Republic of South Africa have forced the front-line countries in the region to work together and find joint solutions to their agricultural problems. The political urge to collaborate and the support of many development agencies and donors now mean that the region has probably the most developed mechanisms or framework for cooperation in agricultural research.

Successful regional collaboration in research is easier to achieve when the following factors are present:

1. the political will to collaborate between the NARS of the region;
2. common problems facing agricultural research and development in the region;
3. similar institutional structures for research and development;
4. common institutional cultures and language;
5. geographic proximity and good lines of communication;

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2. The term *technology gradient* refers to the different intensities in the generation and transfer of new agricultural technologies from one country to another within the same region (Eyzaguirre 1991).

6. institutional mechanisms at the regional level for establishing goals, coordinating tasks, and managing a common pool of resources.

All of these factors are present in Southern Africa, creating favorable conditions for institutionalizing regional approaches.

## Regional Institutions

The main vehicle for collaboration is the Southern African Development Community (SADC) (formerly the Southern African Development Coordination Conference (SADCC)), and in particular the Southern African Centre for Cooperation in Agricultural Research (SACCAR), which was established in 1985. SACCAR was set up by 10 countries<sup>3</sup> with the following objectives:

- to strengthen national agricultural research systems and capabilities;
- to promote the interchange and utilization of scientific information;
- to generate new technologies needed by farmers through regional collaborative projects and intercountry liaison;
- to promote and disseminate available agricultural technologies;
- to promote and implement studies of problems common to all member states and initiate cooperative research to overcome them;
- to provide regional support services and functions as necessary.

SACCAR is not a research institution itself — it serves as a forum for discussion, an information exchange facility, a source of fellowships for training and education, and a catalyst in the relationships between national agricultural research systems, international agricultural research centers, and donor agencies. Its main

mode of action is a series of regional research programs and projects, usually executed by external agencies in conjunction with the NARS themselves, and a number of support and facilitative services from its headquarters in Botswana. These include an information service, research databases, regular meetings and workshops, reports and publications, and a sponsored regional journal.

Three other major groups of institutions can be identified as important technology and information sources for the small countries in the region. The first of these groups consists of international agricultural research centers (IARCs). These include institutes of the Consultative Group on International Agricultural Research (CGIAR), in addition to other institutions that are similar in purpose and activities, such as the International Centre of Insect Physiology and Ecology (ICIPE) in Kenya and the Asian Vegetable Research and Development Center (AVRDC) in Taiwan.

Although none of these centers are located in Southern Africa, many of them are very active in the region, primarily with the regional projects and programs of SACCAR. The IARCs are represented through their offices, centers, or stations, which are spread throughout the region and act as gateways for access to germplasm, information, specialist assistance and advice, and other services.

From the small-country viewpoint, other potentially valuable sources of external technologies and expertise are the NARS in neighboring countries. The larger countries with their greater resources and research capacity are especially well

3. Angola, Botswana, Lesotho, Malawi, Mozambique, Namibia, Swaziland, Tanzania, Zambia, and Zimbabwe.

placed. They can provide technologies and knowledge appropriate to the agricultural and agroecological problems they share with their small neighbors. The regional programs and other SACCAR activities are intended to facilitate these direct NARS-to-NARS contacts.

The institutions that form the research system in the Republic of South Africa make up the third group of external sources of information. Direct contacts with the Republic of South Africa have

been shunned in the past, although some countries<sup>4</sup> have maintained their membership in the Southern African Regional Commission for the Conservation and Utilization of the Soil (SARCCUS) based in South Africa. The commission was set up in 1950 to promote closer technical cooperation among its member states in all matters pertaining to agriculture and the development of related natural resources. The commission's activities are similar to those of SACCAR, although it acts more as an entry point to expertise in South Africa.

## Regional Research Programs

A complete analysis of the regional scope of research would include a detailed assessment of research programs in all the countries of the region, including South Africa. The focus of this paper is, however, on the four small countries in the region and their interaction with regional programs and structures. It is essential not to forget the important role of the larger countries in the region, especially as sources of technology and knowledge. The regional networks are intended to link participating countries with technologies and expertise from outside the region, especially in the initial phases. An additional and increasingly important function for the networks is to build scientific linkages between the NARS in the region, allowing small countries or countries with weaker research programs to depend on their neighbors for some technologies.

Most regional programs focus on crops or natural resource management (table 4). Regional programs are being formulated for livestock and farm implements (with the International Livestock Centre for Africa). There is a regional training program in research management that involves ISNAR, and a project sponsored by the Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) to strengthen the faculties of agriculture, forestry, and veterinary medicine in the region. The re-

gional gene bank project aims to preserve plant genetic resources and will take a lead in strengthening national capacities to identify, preserve, and record indigenous crop species. Small gene banks in national institutions will be established or strengthened where necessary.

The first generation of SACCAR regional research projects were planned and implemented almost exclusively by IARCs. In more recent times, regional projects have been planned jointly by IARCs and NARS. At the planning stages, national scientists have been involved through participation in feasibility studies and regional planning workshops. During the implementation phase, mechanisms such as steering committees, technical advisory panels, and annual research workshops are used to ensure that project activities are relevant to the needs of the region. In this way, national scientists have been able to influence the research agenda.

Most regional networks seek to involve NARS from each of the 10 SADC member countries in their management and implementation. This has resulted in substantial research activities in the chosen commodities and interactions throughout

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4. Angola, Ectswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, and Swaziland.

**Table 4. Regional Programs and Networks Associated with SADC**

Program or Network	Main Center	Date of Inception	Collaborators	Programs
SACCAR Land & Water Management Research Programme	Botswana	1987	ODA	Water Resources
SADC Soil & Water Conservation & Land Utilization Unit	Lesotho	—	—	Soil Conservation
Regional Sorghum & Millet Improvement Program	Zimbabwe	1984	ICRISAT INTSORMIL	Sorghum Millet
Grain Legume Improvement Program - Bean Project	Tanzania	1986	CIAT	Beans
Grain Legume Improvement Program - Groundnut Project	Malawi	1982	ICRISAT	Groundnuts
Grain Legume Improvement Program - Cowpea Project	Mozambique	1990	IITA	Cowpeas
Agricultural Research Management Training Project	Tanzania	1987	ISNAR	Research Management Training
Agroforestry Research Program	Kenya	1987	ICRAF	Agroforestry
SADC Regional Gene Bank for Fiant Genetic Resources (SRGB)	Zambia	1989	Nordic Gene Bank	Genetic Resources
Collaborative Vegetable Research Network in Southern Africa	Tanzania	1992	AVRDC	Vegetables
SADC Maize & Wheat Improvement Research Network	Zimbabwe	1988	CIMMYT	Maize Wheat

Source: SPAAR Information System.

the region. The way it works is that one country assumes the responsibility for specific sectors and subsectors. For example, Botswana is responsible for agricultural research coordination (and, hence, SACCAR), Zimbabwe is the focal point for food security, and Swaziland is the lead country for staffing and training. This approach is reflected less formally in the activities of the regional networks. Malawi has taken the lead in groundnut

research, Zimbabwe in maize, Botswana in beans, and Lesotho in cowpeas.

Although individual countries take the lead for research on specific crops, other countries also have a role to play in conducting research in addition to that done by the lead countries. This research is related partly to national priorities, but it is also a direct result of network activities that actively promote participation

through research as a condition for membership. The chance that a country will deliberately reduce its research on a crop and rely on its neighbors for new technologies is therefore slight, since it would then be excluded from the network on the grounds of nonparticipation, and technologies would be difficult to locate and bor-

row without the communicating mechanisms offered by the network. Networks, therefore, have the tendency to further stretch the already broad agenda of the smaller NARS, thereby compromising the network objective of encouraging research spillovers between countries.

## Overview of the Small-Country NARS

One premise of this approach to regional research is that it should develop from the needs and capacities of the national systems. Since Botswana, Lesotho, Namibia, and Swaziland will continue to have small research systems over the long term, it is important to look at their overall capacity.

One feature of small-country NARS is that many of the commonly used indicators of research capacity are confounded by the small economic size of the country. For example, the level of funding both per researcher and as a percentage of the agricultural gross domestic product in the small countries of Southern Africa compares favorably to that of many larger countries in Africa (Pardey, Roseboom and Anderson 1991). Similarly, the ratio

of researchers to agricultural land is not markedly disadvantageous in the small countries. However, the total number of researchers for all four small countries is less than half the number of agricultural researchers in the public sector of Tanzania, for example (see table 5). Individually, they have fewer researchers than might be found in a single station in a larger country, while still having to cover the full range of research topics. While a larger country may be able to sustain several public or parastatal research institutions, the small countries of Southern Africa cannot. Any increase in their capacity to conduct research will come from an increase in the number of actors in agricultural research and development outside the government sector (see tables 6 and 7). This includes the institutional and ad

**Table 5. Agricultural Land per Scientist in the Small Countries of Southern Africa, 1988-1990**

Country	Agric. Land (000 ha) <sup>a</sup>	Econ. Active Ag. Pop.	No. National Scientists <sup>b</sup>	Agric. Land /Scientist	Econ. Active Ag. Pop. /Scientist
<b>Small Countries</b>					
Botswana	34,380	271,000	36	955,000	7,528
Lesotho	2,320	653,000	25	92,800	26,120
Namibia	38,662	184,000	43	899,100	4,279
Swaziland	1,344	207,000	17	79,060	12,176
<b>Small Countries (BLNS) Total</b>					
	76,706	1,315,000	121	633,934	10,868
<b>Larger Countries:</b>					
Tanzania <sup>c</sup>	40,250	10,315,000	387	104,005	26,654

Note: 1988 data are from ISNAR's OFCOR case study.

Source: ISNAR Small-Country Project database.

a. Arable land + Permanent Crops + Pastures.

b. Core NARS institutions only.

c. 1990 data, based on Tanzania Research Master Plan.

**Table 6. Main Institutions Contributing to Research in the Small Countries of Southern Africa**

Country	Institution	Status	Main Role	Major Programs	Research Staff
Botswana	Department of Agricultural Research	Ministry of Agriculture	Research	Crops Livestock	39 (1990)
Lesotho	Agricultural Research Division	Ministry of Agriculture, Cooperatives and Marketing	Research	Crops Livestock	17 (1989)
	Forestry Division, Research Section		Research	Forestry	2 (1992)
Namibia	Division of Agricultural Research	Ministry of Agric., Water and Rural Development	Research	Crops Game Livestock	40 (1992)
Swaziland	Agricultural Research Division	Ministry of Agriculture and Cooperatives	Research	Crops Pastures	16 (1991)
	Forest Research Unit, Usuthu Pulp Company	Private Sector	Research	Forestry	4 (1991)
	Research Dept., Swaziland Sugar Association	Commodity Board	Research	Sugarcane	3 (1991)

hoc research activities that take place in a variety of private companies, donor projects, universities, and parastatals, most of which do not have research as a central part of their mandate. While it may not be realistic to merge these research activities

under a single institution, this type of development places greater responsibility on government research agencies to coordinate these activities and provide research policy guidance for the system as a whole.

**Table 7. Other Institutions Contributing to Research in the Small Countries of Southern Africa**

Country	Institutions	Status	Main Role	Major Programs
<b>Botswana</b>	• College of Agriculture, University of Botswana	University	Education	Basic/applied research (plants, animals, natural resources)
	• National Institute of Development Research and Documentation	University	Documentation & Research	Socioeconomics, environment, ecology
	• Botswana Livestock Development Corp.	Parastatal	Marketing & Production	Dairy and beef cattle, livestock man. systems
	• Rural Industries Innovation Center	NGO	Rural Industries	Tools & machinery, postharvest
	• Thusano Lefasheng	NGO	Rural Development	Indigenous plants
	• Botswana Development Corporation	Parastatal	Marketing & Production	Dairy & commercial crops (vegetables, fruits, cereals)
<b>Lesotho</b>	• Development and Conservation Projects outside the NARS (several)	Donor projects	Development & Conservation	Conservation: erosion control, forestry & agroforestry
<b>Namibia</b>	• Directorate of Forestry, Ministry of Agric., Water and Rural Development	Government	Services	Forestry
	• Namibia Economic Policy Research Unit	Government	Research	Economic policy
	• Desert Ecological Res. Unit of Namibia	Government	Research	Natural res. man. Plant genetic resources
	• Namibia Institute for Social & Economic Research, University of Namibia	University	Research	Socioeconomics
<b>Swaziland</b>	• Faculty of Agriculture, University of Swaziland	University	Education	Crops Livestock
	• Faculty of Science, University of Swaziland	University	Education	Natural resources
	• Social Science Res. Unit	University	Res./Educ.	Socioeconomics
	• Swazican Ltd	Private sect.	Production	Pineapple
	• Veterinary Diagnostic Lab., Ministry of Agric. & Cooperatives	Government	Diagnostic Services	Animal health
	• Economic Planning & Analysis Section, Ministry of Agric. & Cooperatives	Government	Planning Evaluation	Socioeconomics & Policy advice
	• Mhlume Sugar Company	Private sect.	Production	Sugarcane
	• Simunye Sugar Co.	Private sect.	Production	Sugarcane
	• Ubombo Ranch	Private sect.	Production	Sugarcane
	• Inyoni Yami Swaziland Irrigation Scheme	Donor Project	Production	Citrus Sugarcane

# Agricultural Research in Botswana

Botswana is an arid to semi-arid country where agriculture employs the majority of the people and mining provides most of the national income. Rural poverty is widespread and the country faces a great deal of pressure on its vast but fragile

lands. Livestock is the dominant industry within agriculture. In addition to food security in staple grains, there is also a policy to find new crops and activities to increase and diversify rural incomes and agricultural production.

## Institutional Framework

The main institution responsible for agricultural research in Botswana is the Department of Agricultural Research (DAR) of the Ministry of Agriculture. There are some smaller organizations, mainly nongovernment, involved in natural resource management activities, including research on nontraditional crops, but their work is oriented more towards development than research (see tables 5 and 6). They include the Forestry Association of Botswana (forestry and forest products), Thusano Lefatsheng (nontraditional crops, often referred to as *veld products*), and the Rural Industries Innovation Center (agricultural engineering, rural energy).

The University of Botswana's National Institute of Development Research and Documentation is also engaged in research on rural development issues of relevance to

agriculture, including land tenure systems, range/livestock management, rural sociology, rural energy, and general rural development. The Botswana College of Agriculture is still in its infancy but plans to initiate research activities including collaborative research ventures with DAR.

DAR has some collaborative research activities with some of these organizations, especially in machinery development and food technology. But there is a need to foster more collaboration between all the institutions involved in agricultural research. The department has two main research divisions: the Division of Arable Crops Research and the Division of Animal Production and Range Research (for livestock, range, and pastures). Each division is headed by a chief agricultural research officer who reports to the deputy director of agricultural research.

## Scope of Research

Most agricultural research is conducted by DAR; other organizations participate in specific projects of particular or local interest. DAR is responsible for crop, livestock, and range research. Animal diseases are excluded, however. The Division

of Arable Crops Research is organized into six program areas: cereals, oilseeds, grain legumes, horticulture, soil and water management (including agricultural engineering and irrigation), and production systems. The Division of Animal Produc-

tion and Range Research also has six program areas: beef cattle, dairy cattle, small ruminants, feeds, range and pastures, and livestock production systems.

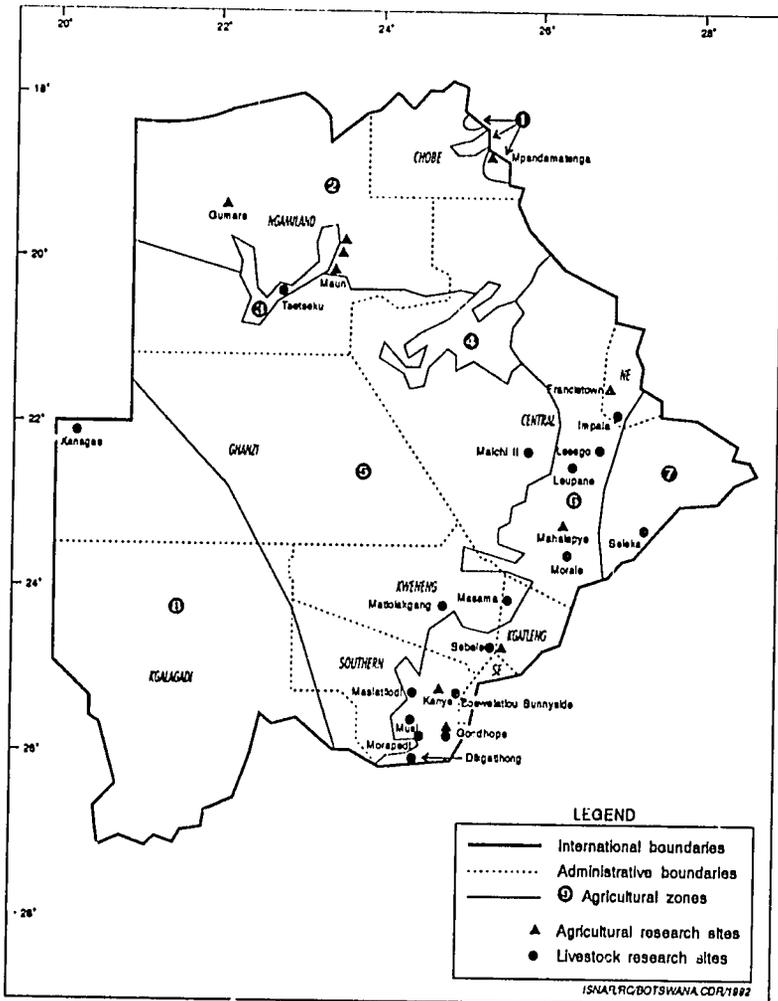
crops from the larger research programs in the region.

**Minor Food Crops**

**Global Staples**

The cereal, oilseed, and grain legume programs fall within the category of global staples. Many of the staff in these programs have been trained through collaborative efforts with IARCs and donors. The research programs and technology testing is carried out in close collaboration with international centers, and there is a great deal of technology available for these

The work of the horticulture program involves minor food crops and access to technology where information is more difficult, particularly in an arid country such as Botswana. AVRDC is now established in the region and may prove a useful source of technology and information. Little technology and information from more developed NARS and the private sector has yet been accessed in these areas.



**Figure 2. Agricultural and livestock research sites in Botswana, 1990**

## **Livestock**

Research on livestock has been DAR's traditional focus and it continues to attract a good deal of attention (Setshwaelo 1988). Current research is focused on the improvement of livestock quality and on the protection of grazing lands. Research is carried out on beef and dairy cattle, sheep, goats, and range/pasture improvement. Since livestock production is

a dominant feature of agriculture in the country and livestock ownership serves many different purposes, NARS managers are faced with a major challenge to identify research programs and technologies that can integrate livestock into the national goal of food security. Research strategies to deal with the environmental side effects of large cattle numbers (overgrazing and erosion) are an increasing area of importance.

## **Issues for Botswana**

DAR has slightly over 60 researchers, including expatriates and project personnel, making it one of the larger public research organizations in the four small countries discussed here. However, even at this size, the complexity of the problems it faces in natural resource management, crop, and livestock production are well beyond the scale of a small organization. One question is: how far should DAR extend its meager *scale* to cover the wide *scope* demanded by its mandate?

One solution might be for DAR to give greater importance to research policy coordination and guidance. While remaining the central and guiding component of the NARS, DAR may need to forge more complementary linkages with other institutions and mobilize their resources to do much of the work in areas of national priority. Long-term knowledge-based work on the environment could be placed in a university setting, while with greater supervision, NGOs and development projects may be useful partners for testing and introducing new commodities and finding new uses for indigenous plants.

Research on natural resource management seems very modest when compared to crop and livestock research. Some work on soil fertility, water management, and rangeland management has been done by DAR as part of its commodity program.

The university has also worked in this area, along with some NGOs, but with few linkages to DAR. There has also been some work on the conservation of indigenous plant genetic resources by DAR, the university, and Thusano Lefatsheng — DAR, for example, is building up a local seed bank to assist its breeding programs.

A key issue in natural resource management is to find sustainable uses for the large expanses of lands classified as permanent pasture but which are, in fact, open grazing and wildlife areas (table 2).

A clearer definition of who has the responsibility for specific aspects of research on natural resources is also needed. While the domains for crop and livestock research are clear, activities such as conservation of genetic and water resources cut across a range of other research domains and are being neglected.

The interaction and association between land-use practices and resource deterioration needs to be studied more carefully. As yet, the relative importance of the various factors involved in the deterioration of resources is not fully understood. Some examples are the effects of fencing policies on disease control and range use, alternative livestock or wildlife uses, and whether land is best used for conservation, afforestation, or production.

# Agricultural Research in Lesotho

The agricultural sector in Lesotho is basically a traditional smallholder production system. A certain amount of arable land is allocated through a traditional land tenure system administered by the chiefs and based on the principles of equity and subsistence and the needs of individual families. *Equity* is addressed by the principle that land is owned by the people as a whole, with its administration in the hands of chiefs on behalf of the king. This system entitles all Basotho

households to have access to land for the purposes of housing, cultivation, and/or business undertakings in urban areas. Grazing land remains communal. Any land that is not utilized for a specific period of time (three years on average) is taken away for reallocation to landless households. The government would like to create an efficient commercial farm sector that could compete in international markets and provide cheap food for the urban market.

## Institutional Framework

The Agricultural Research Division (ARD) and the Research Section of the Forestry Division of the Ministry of Agriculture, Cooperatives and Marketing are responsible for agricultural research in Lesotho. The University of Lesotho also has potential for carrying out limited research, but at present, this is mostly conducted as part of the training curriculum. Research activities also take place in development projects. A comprehensive survey of the agricultural research in the projects has for the first time documented the role that these projects play in agricultural research in the country (Namane 1992). ARD has one main station (Maseru

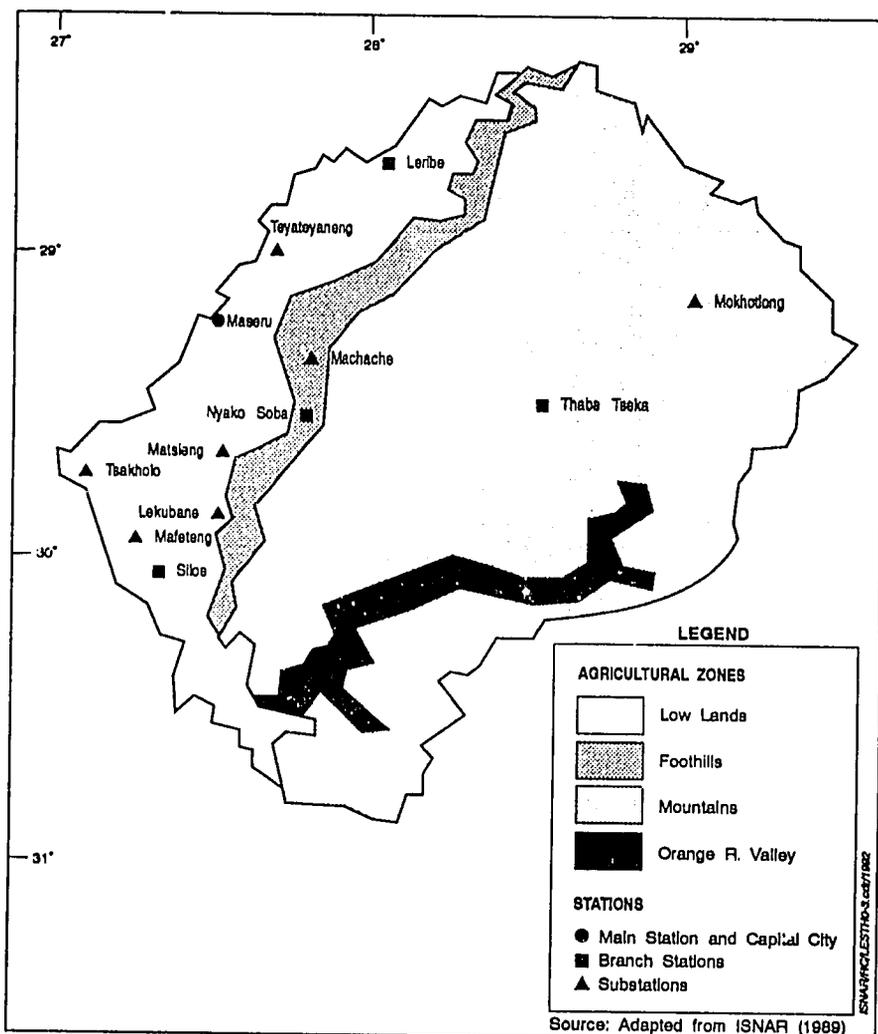
Research Station), four branch stations, of which one is still in the planning stage, and seven substations (figure 3).

Lesotho's NARS is undergoing major reorganization to integrate research with training. It is likely that the ARD, the Faculty of Agriculture, and the Lesotho Agricultural College will be brought together into a single research and training institution, which will broaden the mandate and scope of the NARS; it will also raise a number of project and management issues to be solved so that research remains oriented to the needs of the clients.

## Scope of Research

National policy in Lesotho aims at self-sufficiency in basic grains, along with increased production of fruits and vegetables. The highest priority is placed on the development of agricultural production that conserves the natural resource base

of this mountainous country. Of the various crops grown, basic food grains (pulses and cereals) and livestock receive the most attention because of their direct contribution to domestic consumption (Peshoane 1988). Second priority is



**Figure 3. Agricultural research station network and agroecological zones in Lesotho**

placed on vegetables for domestic consumption, then on export crops, such as asparagus. However, current ARD research programs are neither organized nor funded to reflect these priorities (ISNAR 1989).

### **Global Staples**

NARS research on beans, cowpeas, maize, sorghum, and groundnuts is limited to testing and adaptive research. This ap-

pears to be a rational strategy since technologies for these commodities are already abundant in the region. Available data indicate that the NARS is well linked to the regional networks covering these commodities (ISNAR 1989). However, there is some concern that the number and scale of regional networks in which ARD participates is leading to a diffusion of its efforts.

## **Livestock**

Livestock research includes small ruminants, poultry, and swine, but not cattle. Sheep and goat products, such as wool and mohair, are among the major sources of export income. Most of this research is conducted by ARD, although a number of development projects are also involved on an intermittent basis. This research entails introducing and testing a breed (usually swine or poultry) directly on farmers' land. Development projects lack facilities for livestock research, apart from a pony breeding project.

## **Minor Food Crops and High-Value Nontraditional Export Crops**

Research on minor food crops covers a wide range of commodities, but activities are limited to testing new varieties and evaluating agronomic practices such as plant density, fertilizer levels, and planting time. No breeding work is involved. Several species of brassica, Swiss chard, carrots, garden peas, etc., are under investigation.

Policy objectives point to a need for more research and development on minor food and high-value crops to diversify the agricultural export base and to reduce the level of imports. Some of the commodities in this category (e.g., asparagus) repre-

sent special niches that can be exploited only in very specific ways, with external research inputs. The research that may be needed to identify these new niches and nontraditional crops is location specific. Research managers may consider extending the scope of their programs via cooperative arrangements with private companies and development projects that might allow the ARD to cover this area.

## **Natural Resource Management**

The top priority in agricultural policy is to conserve and manage soil and water resources. However, ARD's efforts in natural resource management are largely confined to pest management; the current Range Management Program and an earlier farming systems research project represent attempts to boost research efforts in this area.

Little formal research on forestry was conducted in Lesotho until the late 1970s when the Lesotho Woodlot Project recognized the need for local investigations. Out of this project, the Ministry of Agriculture created a Forestry Division with a Research Section. The section's research is focused on silviculture, forest inventory work, seed supply, and some sociological research. It employs two professional staff and three diploma-level foresters.

## **Issues for Lesotho**

With approximately 20 full-time researchers in agriculture, there are many areas of research that fall outside the scope of the national research institutions. Monitoring the research activities of the many development projects and NGOs will become increasingly important and will include assuming more responsibility for quarantine and for collating information on the introduction of technology into the country. For very small NARS, these nonexperimental functions may be unavoidable, and they may, in fact, be a

positive feature in so far as they enable the NARS to guide the work of projects.

Currently, government has assigned responsibility for most conservation work to rural development projects that have external support.<sup>5</sup> Research responsibilities

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5. The Conservation Division has the overall responsibility for conservation work and in theory should also have the responsibility for the projects. The division has no research capacity, and it is not clear if it is responsible for research on natural resources.

are thus divided among several departments and projects. This raises an important policy issue because research on the management of natural resources tends to be country and/or location specific and closely linked to policy. In fact, a major output of research on natural resources is information for policymakers so that they can plan the best uses of land, water, and biological resources. Assigning responsibility for research in this field to temporary institutional structures such as projects seems undesirable, and much of the useful information from these projects is either not used or is lost. A small public-sector organization such as the ARD may not be in a position to execute much research in natural resource management, but it could perform coordination and monitoring functions.

Soil erosion is a problem common to the whole Southern African region, and it is a particular problem in a mountainous country like Lesotho where erosion control is of paramount importance for agricultural development. Research on soil conservation is complex and may require long-term planning and large expenditures in order to come up with solutions. However, ARD should be able to focus on identifying local problems and to use methodologies and technologies being developed globally or regionally. SACCAR's regional program has nominated Lesotho as the lead country in the region for soil and water conservation, and with this responsibility, ARD has a unique opportunity to bring regional and international resources to bear on Lesotho's most important problem: soil erosion.

## Agricultural Research in Namibia

Namibian agriculture is characterized by a dual production system. On one hand, there is well-supported commercial agriculture, based on large landholdings within exclusively settler-owned farms and ranches. There is also a subsistence subsector, involving a much larger number of smaller holdings. Since the country gained independence in 1990, develop-

ment policy has been focused more on the needs of the small farmers and herders who make up the bulk of Namibia's agricultural population. Furthermore, with independence, Namibia became a member of SADC and acquired many international linkages in agricultural research and development that have changed the national scope of research.

### Institutional Framework

The principal research institution in Namibia is the Division of Agricultural Research in the Ministry of Agriculture and Rural Development. Its mandate covers both crops and livestock. In 1990, there were at least 28 research facilities in Namibia under the ministry, including

one crop research station, six livestock breeding stations, 10 experimental farms, one testing center, five production farms with crop research or demonstration capabilities, one demonstration farm, one agricultural college, and four other colleges with either livestock breeding or

crop research stations. Many of the experimental and production farms now under the government's research and develop-

ment services were heavily subsidized settler farms abandoned by their owners at independence.<sup>6</sup>

## Scope of Research

The scope of research is undergoing a major transition from providing technical services to commercial farms and ranches to focusing on the small-scale subsistence farmers who make up the overwhelming majority of Namibia's rural population. Research policy and programs have undergone a major reorientation to address the problems of the subsistence sector.

In a recent assessment of its short- and long-term research priorities, the Agricultural Research Division concluded that the primary limitation to animal and crop production in the country lay in the application of existing knowledge, rather than in the generation of new knowledge; research is expected to focus on the adaptation and testing of existing technologies.

Livestock research continues to be much more important than crops; however, the integrated systems approaches being implemented will necessarily lead to a greater emphasis on crops. Because of the dry conditions that prevail in the country, crop research is mostly confined to the development of irrigated farming and efficient irrigation techniques based on local knowledge. Most farms experiment with different methods of using the meager water supply for vegetable production.

### *Global Staples*

Maize, sorghum, and beans are the principal focus of Namibia's crop research programs. Given that these crops are also the focus of much work by the IARCs and some of the larger countries in the region, Namibia's recent admission into SADC will facilitate its access to the low-cost, easily accessible technologies and the information that these international and regional

networks provide. ICRISAT is supporting trials on peas, lentils, and groundnuts and, with the United Nations Food and Agriculture Organization (FAO), is testing several cowpea cultivars. FAO also supports cassava and sorghum research. Namibia's NARS has tested 10 maize varieties from the Zimbabwe maize improvement program, 25 varieties of beans from Ethiopia in FAO-supported bean trials, and two groundnut varieties from Malawi. During the 1991 season, Namibia imported composite and hybrid maize varieties from Kenya for trial under local conditions.

### *Livestock*

Almost all the research in Namibia has been concentrated on livestock, which is reflected in the large number of livestock breeding stations and experimental farms that focus on beef cattle, goats, and sheep. Breeding is the major activity and is aimed at enhancing desired traits, such as uniform wool color in sheep and goats, and to adapt exotic breeds to the harsh Namibian environment. Less research has been done on pasture improvement. Under the new policy to support small farmers, this is an area that warrants additional support. The effects of livestock on vegetation and erosion is of great concern throughout the region; however, very little research has been done on herd

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6. Fisheries comprise the most important activity in Namibia's food and agricultural sector, and fisheries research is the most important sector within the research system. However, at the time of this writing, data on the size and composition of Namibia's fisheries research activities were not available. For the purposes of this paper, we have chosen to proceed with the comparison and will leave fisheries research to future analyses of the NARS in Namibia.



conditions and frequent drought in the region mean that the development of crop agriculture will face challenges in water use and management. Ways will need to be sought to improve both the harvesting and the efficient use of water. Competition for scarce natural resources will need to

be balanced with conservation of the fragile environment. Land redistribution remains an unresolved political issue which also has implications for the way the research system will need to approach technology development.

## Agricultural Research in Swaziland

As in Namibia, the agricultural sector in Swaziland is marked by a dual economy with subsistence-based production on Swazi Nation Land (SNL) and commercial production on Individual Title Deed Land (ITDL). On SNL, the main crops are maize, beans, sorghum, vegetables, cotton, and tobacco. Livestock, particularly cattle, sheep, and goats, are widely raised and

have a high value in traditional Swazi communities. On ITDL, there is large-scale export production of sugarcane, pineapples, citrus, and wood pulp. The two subsectors are served by separate groups of research organizations. The public sector focuses on SNL farmers, while the private sector looks after the ITDL commercial growers.

### Institutional Framework

Agricultural research in Swaziland is conducted by organizations in both the public and private sectors (see tables 5 and 6). The major actors in the public sector are the Agricultural Research Division (ARD) of the Ministry of Agriculture and the University of Swaziland. Private-sector research covers the sugarcane, pineapple, and forestry industries.

ARD has its main research station at Malkerns; it is supported by two substations (Big Bend and Nhlango) and three

experimental plots (Luve, Hebron, and Mangangco). The University of Swaziland has research facilities at its Luyengo campus located near Malkerns. The Usuthu Pulp Company has a research unit located in the heart of the forestry plantation area, again close to Malkerns. The pineapple industry and the sugar estates have agronomists conducting adaptive research in their technical divisions. The estates also support the Swaziland Sugar Association, which conducts research on common issues facing the industry.

### Scope of Research

The scope of research refers to the activities undertaken by the ARD, the Faculty of Agriculture, and various private and

parastatal organizations. Data collected by Swaziland's CARIS Center in 1989 (SACCAR 1990b) showed that out of a total

of 115 research projects recorded for that year, 46 were Ministry of Agriculture projects, 32 were covered by the University, and 37 others were carried out by other organizations. Projects in crop science and production dominated ARD's research (76%) and that of the private sector (78%), but these areas were far less significant at the university (25%) where there was a broader spectrum of activities, with livestock (22%) being almost as important as crops.

### ***Global Staples***

ARD conducts adaptive research programs in maize, beans, cowpeas, groundnuts, and sorghum. It relies on linkages with regional research networks and good collaboration with international agricultural research centers to gain access to the results of more applied or basic research.

### ***Traditional Export Crops***

Sugarcane research is handled by the private sector. In Swaziland, this research involves local testing and adaptation to develop appropriate agronomic practices as well as effective pest and disease control. All work on breeding and postharvest technology is carried out abroad, and the estates maintain very close links with private- and public-sector institutions in South Africa. Cotton is an important

smallholder crop, and research on it is the responsibility of the ARD. This research is supported by the Swaziland Cotton Board, which raises funds for research through a levy on producers.

### ***Livestock***

Given the importance and role of cattle in traditional Swazi culture, it is surprising how little research is conducted on livestock. Research on beef cattle, a relatively recent development, is undertaken at the university's Faculty of Agriculture, while the Ministry of Agriculture's main efforts have been directed at animal health and pastures.

### ***Natural Resource Management***

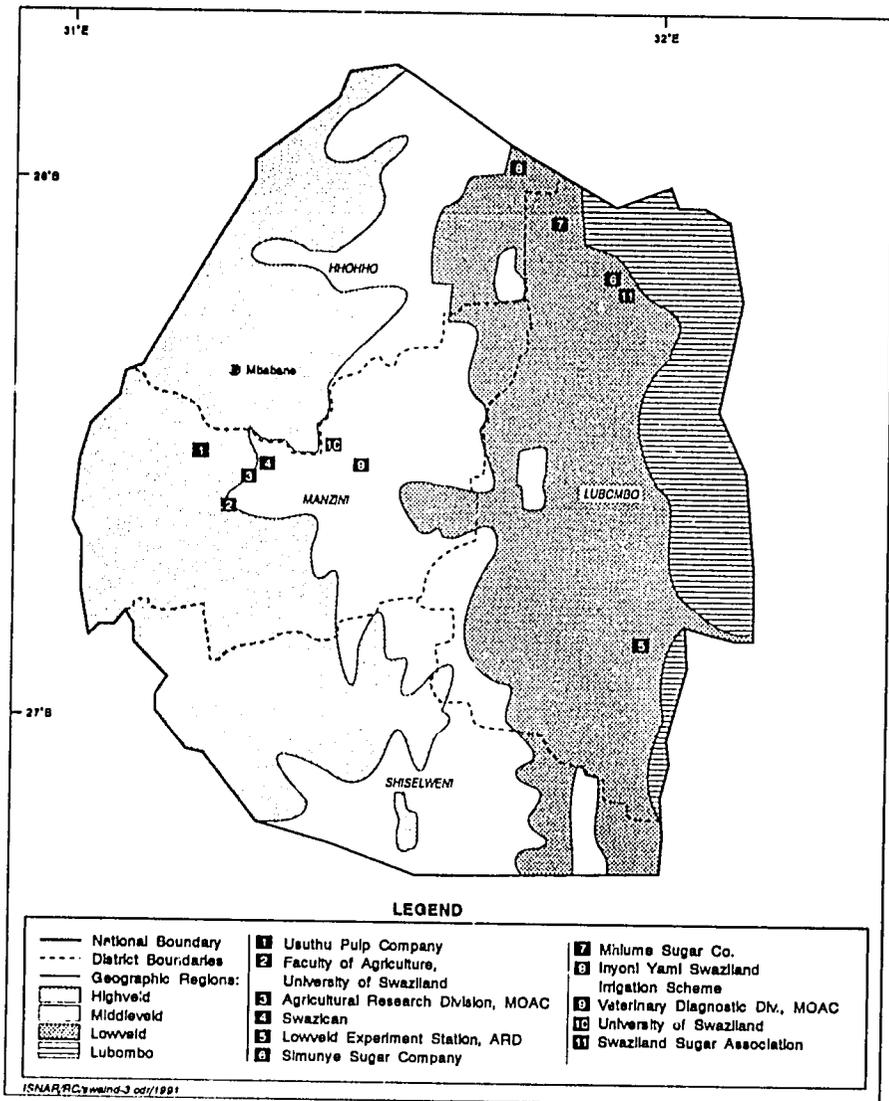
Forestry research is conducted by the private sector, with improved production of timber and wood pulp the major objectives. Most of this research is adaptive and highly location specific. More basic or applied research, requiring sophisticated laboratory analysis, for example, is contracted with research institutes in South Africa or Europe. Land degradation and erosion are serious problems in Swaziland and are the direct result of overgrazing. The university's Faculty of Science has undertaken a project to collect basic information on the soils of the country as well as information regarding soil erosion.

## **Issues for Swaziland**

There is a clear definition of research roles and responsibilities between the public and private sectors. Small subsistence farmers are the main focus for the ARD, while the private sector concentrates on larger-scale commercial growers. However, despite the fact that the ministry is represented on the research advisory committees of the private companies and producers' associations by its chief research officer, there is little coordination or integration of private-sector efforts

with those in the public sector. Creating conditions for joint efforts between public, private, and university research programs could have many benefits in increasing the efficiency and coverage of the system.

Although the university is active in research on socioeconomic and postharvest issues, most staff have very little time set aside for research. In general, collaboration between ministry and university personnel is very ad hoc in nature and the



**Figure 5. Agricultural research station network and agroecological zones in Swaziland**

research system could make better use of the human resources that are potentially available at the university.

Researchers in the ministry are well connected to SACCAR research networks and regional programs, and they actively participate in crop variety screening and testing programs, study tours, and meetings. However, IARC and SACCAR network re-

sponsibilities could overload the few researchers in the ministry and restrict the time and effort that is available for projects of purely national interest or importance. Staff in the university's Faculty of Agriculture on the other hand, operate almost totally outside these networks but could benefit from better contacts, either directly with the networks or with researchers in the ministry.

# Policy Issues for Small Countries in the Region

## Regional Collaboration — The SACCAR Model

The objective of this paper is to look at ways to maximize the use of resources in the small NARS of Southern Africa, both through regional cooperation and by identifying and managing linkages with external sources of knowledge and technology. These functions and objectives have been assigned to SACCAR, which was created to strengthen agricultural research and training in the region. SACCAR promotes collaboration between NARS by encouraging the transfer of knowledge and technologies between countries in the region and by facilitating the flow of global information and technology into the region. Furthermore, it helps to direct the flow of resources from donors, IARCs, and other international organizations to the research programs of member countries.

SACCAR represents an important counterweight for the small NARS in their relationships with larger NARS and other external agencies — a role that is even reflected in SACCAR's overall objectives (Abe and Marcotte 1989). For small countries, SACCAR does the following:

- provides a forum in which small NARS can participate as equal partners with their larger counterparts;
- works with the NARS to generate improved technologies for high-priority commodities and factors of production. This includes assistance to NARS in the planning, execution, monitoring, and evaluation of their research; training in research management for national scientists; and the development of spe-

cializations in key areas that enable the whole region to benefit from national outputs in training and research;

- provides long-term mechanisms for collaborative research and training, linking individual NARS to other NARS in the region as well as to international research agencies and donors. This implies the establishment of coordinated regional research programs as well as a mechanism for formulating joint national priorities. Such mechanisms strengthen the bargaining capacity of small countries with their external partners and improve the coordination of external assistance so that smaller countries are not bypassed;
- provides training for national scientists that allows them to participate actively in the global research system and build up the regional scientific community;
- disseminates information through publications, provides a monitoring (early-warning) service in strategic areas relating to food security, and assists NARS in strengthening their own ability to organize and manage information resources.

SACCAR's board determines the regional scope of its research. It is composed of NARS managers from the 10 countries of the region, plus three university deans and the directors of some extension services. It meets once or twice a year, primarily to review SACCAR's research activities, and attempts to match the re-

gional research agenda to national priorities. The board has the responsibility for approving programs in addition to seeking external sources of funds for supporting its programs.

SACCAR's regional research activities are organized into programs, usually covering broadly related commodities, factors, or constraints. The Grain Legume Improvement Program, for example, covers groundnuts and a number of types of beans. Programs may have subunits or projects tailored to a particular activity or commodity (the Groundnut Improvement Project is part of the Grain Legume Improvement Program, for example).

The planning and design of these programs is carried out by program technical committees (PTCs) consisting of scientists from the NARS in the region. External scientists and consultants may be called upon for assistance, but the ultimate responsibility for program formulation rests with the PTCs. When a program is approved, SACCAR creates a program steering committee (PSC) with representatives from participating countries to guide the project's implementation. Annual program reports prepared by the steering committees are presented to the SACCAR board.

The PSCs ensure that the actual implementation of regional programs meets the expectations and needs of the countries involved. This appears to have worked reasonably well, although some difficulties do arise. For example, members of the PSCs are dispersed throughout the NARS of the region, making it difficult and costly for them to meet and review programs. NARS managers are already overburdened with many complex tasks, and the cost of these regional linkages is often underestimated. Second, programs largely depend on support from external agencies and donors. IARCs often provide technical backup and advice to the programs and can have a strong influence on the way programs are implemented.

A major limitation of the SACCAR planning process is the way programs are initiated. Many additional phases and activities are grafted onto ongoing activities, which introduces the risk that any weaknesses in the existing program will influence any new activities. Some regional programs were in existence prior to the establishment of SADC and predate the mechanisms now in place to regulate them. Another risk is that the newly grafted activities may end up undergoing less rigorous procedures to ensure their relevance to individual country priorities.

Programs also tend to be derived from the programs of the larger NARS in the region. This may be a good thing for the small NARS who can benefit directly from the expertise of the larger systems; however, the disadvantage for the smaller NARS is that they often end up following rather than leading. This is where SACCAR as a regional forum becomes important in distributing responsibilities.

### ***Impact on National Priorities and Management***

All SACCAR regional programs are implemented at the national level and managed by the NARS themselves. This means that it is sometimes difficult to distinguish between research activities that are defined as national and those that can be considered regional. There is also a tendency for national programs to duplicate or emulate regional programs in the hope that external funding can be attracted from the regional programs. The result can be a distortion of national priorities for research and uncertainty as to what should be done nationally or regionally.

The problem of managing regional activities within national systems is quite pronounced for the smaller NARS. Although national programs have been able to influence the research direction of some participating IARCs in the region, the NARS have not yet become equal partners in implementing regional projects (Gakale

1992). The strength of individual NARS may be a factor; larger and more developed NARS have perhaps benefitted more from regional programs because their national scientists are able to collaborate as equal partners with international scientists working for regional projects. Smaller NARS have been somewhat disadvantaged because they lack experienced officers who can identify technologies relevant to their specific national needs from the regional programs. They, therefore, tend to serve as technicians for the international scientists' multilocational trials.

### ***Defining Levels of Participation in Regional Activities***

Establishing a division of labor and defining regional and national-level priorities entails the creation of mechanisms for identifying a common scope of research, program priorities, and levels of resource allocation for each country and for the region. Assuming that there are no major increases in funds for research in the region, the most effective regional research agenda is one that addresses the needs of individual members and makes the best use of their existing activities. This means that NARS need to define the areas of their national research scope that should be handled regionally and the proportion of their national resources that should be allocated to regional efforts.

Identifying problems to handle regionally must include consideration of the type and complexity of the problem. Some research problems are best tackled by a group of countries rather than individually. For example, large, costly projects that are beyond a single country's capacity can best be implemented by pooling the resources of several countries in the region. Similarly, when a research problem crosses national boundaries and requires concerted action from several states, the solutions developed by a single small country would be ineffective. Effective research on pests and diseases such as locusts or rinderpest require countries to

work together. Research on managing water resources for agriculture, rivers, and watersheds may also need to be regional in scope.

The other major consideration that determines what research is conducted regionally is the overall scale of resources available to research in the region and the relative contribution from national systems. Support for regional activities may be at the expense of national programs.

Assuming that a number of programs would benefit from regional collaboration, the NARS themselves must decide how they can best achieve the desired coverage of research topics. Effective participation by small-country NARS in regional priority-setting exercises requires that national decision-making, priority-setting, and resource-allocation structures be well established. Research policy and management is also crucial in small countries, since what may be considered modest inputs into a regional scheme may, in fact, represent major allocations of staff time and resources in a small NARS.

The number of researchers in the NARS is a major factor to be considered when national participation in regional networks is planned. Botswana, for example, currently has fewer than 50 national researchers (with 10 project-related research positions) and 146 technicians (Gakale 1992). Its staff participate in several networks within SADC and elsewhere; however, this participation often demands extensive staff time and may impede implementation of national programs.

The experience of the four countries in this study suggests that effective participation by small-country NARS in regional research requires the following:

- NARS capacity to execute and manage national and regional programs;
- clearly defined national priorities for agricultural research (strategic plans

are important for this — they direct research towards the country's problem areas and should form the basis for prioritizing regional programs);

- national-level mechanisms for identifying priorities that could be undertaken with regional and external support;
- NARS participation in decisions relating to regional programs.

### *Alternative Models*

Despite the problems that small NARS have in realizing the promise of increased capacity, effectiveness, and efficiency through regional cooperation, the SACCAR framework meets many of the essential preconditions for effective regional research based on NARS participation:

- a strong political will to cooperate among the member countries;
- many shared elements of institutional history and organizational culture among the member NARS;
- the existence of many common problems in the areas of food security and natural resource management;
- the limited ability of any single country to mount a large enough research effort to do justice to all the demands on research.

Comparing regional research cooperation in Southern Africa with other regions

where institutional differences between countries and NARS is much greater highlights the potential that these regional fora provide for the small countries of SADC. Common institutional and cultural factors, such as a similar type of university training for researchers, the common use of English as the scientific and official language,<sup>7</sup> and the similar organizational structures of public-sector research organizations, make it that much easier to establish collaborative research activities.

The geopolitical changes that are occurring as a result of the dismantling of apartheid in the Republic of South Africa and the signing of peace agreements in Angola and Mozambique may affect the nature of the political will that binds the SADC countries together. It is possible that the SARCCUS model of regional cooperation based on a central source of technology and cooperation, i.e., the Republic of South Africa, will assume greater importance alongside the SACCAR approach of networked national programs. For the small countries, the SACCAR approach offers a greater voice in regional programming, while the central-source approach of SARCCUS may facilitate transfer of available technologies. NARS will still have an important role to play in scanning and screening that technology and in finding the ecological and economic niches where new technology can be introduced most productively. Finally, NARS may find that SACCAR is in fact more accountable to national systems than are the central-source networks and agencies.

## **Institutional Diversity and Policy Coordination**

Most of the regional collaboration and coordination of research relates to government research units. This results from the intergovernmental nature of SACCAR's parent organization, SADC, and provides a useful starting point from the policy perspective. A problem that arises, however, is the limited scope of public re-

search organizations in small countries. Public research is focused primarily on

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7. The lusophone countries, Angola and Mozambique, have been isolated by both language and war, which has made their participation in SADC research programs less intensive than it has been for other countries in the region.

global staples. This is understandable given the scale of the relevant organizations and the comparative advantages that private and parastatal organizations may have in conducting research in traditional export crops, such as sugar and wood pulp in Swaziland, or in high-value nontraditional export crops, such as fresh fruits and vegetables in Swaziland and Lesotho. An important role for public-sector research units is to provide support and guidance in policy and in research monitoring and evaluation.

In the area of natural resource management, several NGOs, donor projects, and universities collect data and germplasm without always having adequate scientific support to evaluate these materials. Government research organizations may be able to guide and support these efforts in a cost-effective way through shared facilities and information. The long-term collection of socioeconomic and resource data on natural resources may be carried out by universities, thus complementing the work of government research units that are primarily concerned with the production of staple food crops and livestock.

Since the policy coordination role of a NARS becomes more important as the number of institutions involved in research increases, those public research organizations that make up the core of the NARS in small countries will need to regularly examine their links to national policy. In a country such as Swaziland where the private sector is well organized and has money and strong linkages, there is

still a role for public research organizations to ensure compatibility with national goals. Private-sector research and development on sugarcane, forestry, cotton, and pineapple has important implications for the structure of the farming system, as well as considerable impact on the environment, both of which are public concerns.

Making the most of diverse research and development activities demands greater policy coordination from the core research organizations within the government. None of the four countries studied had formal mechanisms to allow these diverse institutional actors to contribute to a coordinated research policy. The trend towards increased cooperation between research in development ministries and research in universities is notable in Lesotho, Botswana, and Swaziland. But more needs to be done to broaden the scope of this coordination to include the full range of institutional contributors to research in agriculture and natural resources.

The experience of the four small countries in Southern Africa suggests that even in small countries, an effective research system will consist of a plurality of organizations working in complementary domains of the national research portfolio (see table 8). In these cases, public-sector organizations will need to place greater emphasis on setting overall research policy and on coordinating the different contributors to the research effort.

## The Natural Resource Management Challenge

The four small countries of Southern Africa all have significant problems associated with the management of their natural resource base, either because it is vast and fragile (Botswana and Namibia) or very limited and under great pressure from competing users (Swaziland and Lesotho). Much of the research on natural

resource management will be country specific and closely linked to national policy; however, there are also issues that require close intercountry cooperation on resource management. For example, the recent development of water resources and hydroelectric power in the highlands of Lesotho is designed, in part, to meet the

**Table 8. National Research Portfolios**

Institution	Global staples	Traditional export crops	Minor food crops	High-input nontraditional exports	Livestock	Socioeconomics & rural engineering	Natural resource management
<b>Botswana</b>							
Department of Agric. Research	Beans Cowpeas Groundnuts Maize Sorghum		Cabbage Millet Peas Peppers Tomatoes Vegetables Sunflowers	Fruits	Cattle Goats Nutrition & Feeds	Farm Management	Soil Management Water Management Rangeland Manage. Pest & Disease Control Genetic Resources
Faculty of Agric, Univ. of Botswana						Socioeconomic Studies Environmental Studies	Genetic Resources
Botswana Livestock Devel. Corporation						Marketing	
Botswana Devel. Corporation						Marketing Vegetables	
Rural Industries Innovation Center						Farm Equipment Farm Buildings Farm Structures	
Thusano Lefatsheng				Indigenous Plants			Plant Genetic Resources
<b>Lesotho</b>							
Agricultural Research Division	Beans Cowpeas Groundnuts Maize Sorghum Soya Wheat		Beets Cabbage Carrots Chickpeas Mustard Onions Peas Radishes Tomatoes	Sunflowers	Goats Sheep Poultry Swine Nutrition & Feeds	Storage Farm Structures Farming Systems Research	Soil Fertility Rangeland Management
Forestry Research Section							Forestry Conservation
Development Projects			High-Value Fresh Vegetables		Poultry		Forestry Agroforestry Soil Conservation Water Conservation

**Table 8. (continued)**

<b>Institution</b>	<b>Global Staples</b>	<b>Traditional Export Crops</b>	<b>Minor Food Crops</b>	<b>High-input Nontraditional Exports</b>	<b>Livestock</b>	<b>Socioeconomics &amp; Rural Engineering</b>	<b>Natural Resource Management</b>
<b>Namibia</b>							
Division of Agricultural Research	Sorghum Wheat Beans Cowpeas Cassava Maize Groundnuts	Cotton	Date palms Lentils Peas		Cattle Goats Sheep Game		Rangeland Management
Directorate of Forestry							Forestry Agroforestry
<b>Swaziland</b>							
Agricultural Research Division	Beans Cowpeas Groundnuts Maize Sorghum	Cotton	Apples Chickpeas Millet Onions Pigeon Peas Vegetables	Broccoli Citrus Pyrethrum	Cattle Goats Sheep Nutrition & Feeds		Rangeland Management
University of Swaziland					Cattle	Socioeconomics Agroprocessing	Soil Conservation
Swazican				Pineapples			Silviculture Forest Products
Usuthu Pulp Company Ltd. & Shiseiwini Forestry Co.							
Simunye Sugar Company		Sugarcane					
Inyoni Yamf Swaziland Irrigation Scheme		Sugarcane		Citrus			Irrigation Management
Swaziland Sugar Association		Sugarcane					

agricultural, urban, and industrial needs in the neighboring Republic of South Africa, but it will also have major implications for agriculture and natural resource use in Lesotho. This is a clear case where natural resource management cuts across national boundaries and spans several sectors.

Much research in natural resource management is of a public nature and is long term. Some of it will be linked to agricultural production; other research will be more policy oriented to provide governments with the information they need to decide on the most productive and sustainable use of natural resources. Government research organizations and universities can be important actors in this field because of the former's links to policy and the latter's ability to conduct longer-term studies and to access to global information sources.

Government research organizations concentrate mainly on production-oriented research in global staples. Perhaps a more efficient use of the rich information and technology that is available on global staples in the region would enable small-country NARS shift their efforts into areas

of natural resource management. A recent trend linking government research organizations in Lesotho, Botswana, and Swaziland more closely to universities is promising because it has increased attention to natural resource use and conservation in agriculture.

Local and international NGOs are also active in research on community-based natural resource management. This work is aimed at the local level and specific situations that are difficult for a central research agency to handle. There is a need to make the most of the NGOs' contributions to research on natural resources, but public research organizations could provide more policy guidance and coordination. In Lesotho, for example, some NGOs and development projects have been conducting technology testing and introduction, which could be at cross-purposes with public-sector research. In brief, research on natural resource management will need to be more policy oriented: first, to provide advice drawn from strategic research on the optimal uses of a country's resources; second, to provide guidance, and coordination for the activities of NGOs involved in environmental research and conservation.

## **Realigning National Research Portfolios to Maximize Spillover Benefits**

If the NARS are to confront the problem of research on natural resource management, there must be better targeting of national programs, more borrowing and adapting of technologies from outside sources, and more critical involvement in and influencing of regional programs and organizations. One strategy would be for small NARS to optimize the use of available research on global staples (such as maize, sorghum, and beans) based on results from larger research systems in the region and from the IARCs. For certain other traditional export crops, advanced technology is readily available and can be

adopted by countries with small NARS. However, if these opportunities are to be fully utilized, key institutional and policy factors must be considered.

Limiting the scope of activities among NARS within a region and between NARS and regional networks allows small NARS to channel resources into exploiting new opportunities. In order to be efficient borrowers of technology, NARS need to dedicate more resources to areas where external knowledge and technology are unavailable or where research must be conducted locally to meet the demands of

specific agroecological regions. Some areas of research, including production systems and the natural resource base, deserve greater emphasis.

Table 9 illustrates the tendency for countries in the region to work on similar crops and on crops where there has also been substantial investment by IARCs and regional networks. Given the wealth of information and technology available on global staples in the Southern African region (table 9), it might be possible for small countries to shift their priorities to other domains. This shift could involve increasing the emphasis placed on natural resource management and identifying potential niches for high-value crops. Reference to research domains and the scope of research in Botswana, Lesotho, Namibia, and Swaziland could be used to show how further adjustments in scope can lead to better utilization of NARS capacities.

The size of the agricultural sector in small countries (which usually have small NARS) makes it difficult for them to compete with larger countries. Therefore, small countries have to consider exploiting specific niches in the market (particularly the export market), in order to acquire a comparative advantage over

larger producers. One such opportunity arises from the seasonal nature of some high-value commodities, which provide a window of opportunity that can sometimes be filled by smaller producers at times when production conditions are less favorable for larger ones. It is sometimes also possible to create a specialized market based on the supply of high-quality produce.

Although regional linkages need to be capitalized on to the maximum degree possible, there will be some areas in which small NARS will have to focus their efforts independently or establish linkages outside the region. This may be due to a specific agroecological situation. For example, the search for promising technologies for Lesotho's cool-temperate growing regions and pastures is likely to take it outside its traditional partnerships in the region. Another example is the many "veld products" in Botswana and Namibia that have potential as high-value nontraditional exports unique to the local ecological zones. Development of these will be guided by highly competitive marketing considerations, and countries may find it necessary to develop these technologies independently, possibly with help from local or international private-sector interests.

## Targeted National Programs

The information presented in this paper indicates that small research systems would benefit from streamlining and prioritizing their research programs to enable them to use their capacities and resources more efficiently by eliminating unnecessary duplication and concentrating their efforts. There may also be niches of national comparative advantage, which will require individual NARS to adopt distinct strategies for each area of research identified. Discerning niches of national comparative advantage for high-value

nontraditional exports would require the following, for example:

1. taking strategic economic decisions at the highest level of national policy;
2. accounting for risk factors, such as market uncertainties, in research planning;
3. ensuring that the production system remains ahead of competitors when a new niche is identified.

**Table 9. National Programs in a Regional Context: Global Staples**

Beans	Cowpeas	Groundnuts	Maize	Sorghum	Soya	Cassava	Wheat
DAR Botswana	DAR Botswana	DAR Botswana	DAR Botswana	DAR Botswana	ARD Lesotho	DAR Namibia	ARD Lesotho
ARD Lesotho	ARD Lesotho	ARD Lesotho	ARD Lesotho	ARD Lesotho	DRT Tanzania	DRT Tanzania	DAR Namibia
DAR Namibia	DAR Namibia	DAR Namibia	DAR Namibia	DAR Namibia			DRT Tanzania
ARD Swaziland	ARD Swaziland	ARD Swaziland	ARD Swaziland	ARD Swaziland			SACCAR/CIMMYT
DRT Tanzania	DRT Tanzania	DRT Tanzania	DAR Malawi	DRT Tanzania			
SACCAR/CIAT	SACCAR/IITA	SACCAR/ICRISAT	DRT Tanzania	SACCAR/ICRISAT			
			DOA Zambia				
			DRSS Zimbabwe				
			SACCAR/CIMMYT				

*Note:* The information shown here for larger countries is for illustration only — most countries in the region do some research on each of these crops.

In line with this approach, resource-poor countries may need to allocate a proportion of their meager resources to high-risk research designed to develop nontraditional commodities. These may not currently be high-priority areas for research but might, in the future, provide new breakthroughs into international markets. The success of a strategy for selecting niches depends on the NARS's awareness of its own role and its ability to identify the research being developed by other countries. Other determining conditions are the existence of a sound marketing strategy based on thorough market research and parallel development of the infrastructure for product handling. In addition to the traditional areas of research such as agronomy and plant breeding, socioeconomic and postharvest research will also be important.

Lesotho illustrates the problem of targeting national programs efficiently. ARD's annual reports for 1988 and 1989 show major areas where duplication of research has taken place. All three of its research units were separately involved in research on peas and maize, with the Horticultural Unit doing variety and fertilizer trials, the Agronomy Unit doing variety screening trials, and the Plant Protection Unit carrying out pest and disease screening. These activities could have been combined and integrated into fewer trials. Moreover, the three units were working with different varieties of the same crops, and the recommendations produced are of limited practical use to producers. A similar problem is illustrated by fodder research, which involves both the Range Management and the Animal Science Units, working independently of each other despite the similarity of their goals.

Problems of a different nature occur in programs involving regional collaboration with IARCs. A large number of pea and bean varieties supplied from the IARCs' regional programs are screened each year. Although research activities are confined to testing and adapting technologies, the

number of materials received for testing is often far greater than the capacity to handle them in these small NARS. In Lesotho, during the 1987-88 season, ARD's Agronomy Unit tested 17 bush bean varieties for yield performance, 15 bush bean cultivars from an earlier test for adaptability and yield performance, 44 cowpea varieties from the Zimbabwe and Botswana programs, and 42 groundnut varieties from the Malawi Groundnut Regional Improvement Program. Testing such a large number of materials overloaded the ARD and constrained its limited resources. If the aim was to improve the yield of cowpeas, for example, how many varieties would a country need in order to achieve this? In all probability, improved scanning capabilities would have allowed for the selection of a narrower range of varieties matching the country's ecological zones and conditions of production. Further examination of past research on the same crop shows that in a number of cases, the same varieties have been screened several times in independent evaluations over several seasons or years, when a few experiments might have been enough to determine a variety's potential.

This problem of repeating unnecessary experiments can be eased by improving the program formulation procedure within the research institution. The procedure for designing actual experiments should take into account existing information about the problem the experiment intends to address. This would require maintaining an internal memory within the institution that could store such information and to which research scientists could always refer. In the long run, an internal memory would reduce costs to NARS, although the nature and form of such a memory would need to be carefully considered, as this could range from a check list of key research areas to a complete database.

Problems of duplication are also compounded when research is organized by discipline, as in the case of ARD-Lesotho.

Organizing research by discipline makes it difficult to reallocate resources for a single crop from one discipline to another. Money designated for plant disease research on maize, for example, might be difficult to appropriate for agronomic research with similar objectives, such as crop management aimed at reducing disease susceptibility. This difficulty cannot be overcome simply by establishing multidisciplinary teams to deal with specific research problems or groups of commod-

ities. Production systems and a commodity focus may reduce duplication of effort in order to achieve greater efficiency at a given scale. Grouping resources together is itself an exercise in priority setting, limiting the number of subjects and commodities that require funding. In this way, the commodity group approach may actually prevent resources from being dispersed across too many commodities and thus help to concentrate the impact of research.

## Capitalizing on Borrowed Knowledge and Technologies

Borrowing technology is a complex and scientifically sophisticated process that may be facilitated by the existence of "technology gradients," a high level of political cooperation between countries, a common language, similar research system organization, similar agroecological zones, regional fora for scientific meetings and exchanges, and well-defined programs with explicit priorities in common areas. In order to borrow technologies from external sources, small NARS need a critical mass in scientific capacity to identify problems and scan sources for technological solutions. The minimum threshold of staff may be similar to that needed to conduct adaptive research on existing technologies. The mix of required skills, however, may be different.

Southern Africa has some significant problems that constrain the effective borrowing of research technology. One is that a wide range of commodities is involved, making it difficult to identify priorities for all the nations of the region. Second, even when priorities have been set, clearly identifiable centers of excellence do not always exist in terms of regional needs. Third, the access and flow of information within the continent and the links with external sources of technology present difficulties in terms of current communication systems. Notable improvements

will have to be made in overcoming all three constraints before opportunities resulting from global and regional flows of technology can be fully utilized.

On the other hand, a number of conditions favor borrowing research technology in Southern Africa. One is the existence of technology sources within the region for major commodities of interest to the small NARS. The Republic of South Africa, for example, has well-developed technologies for wheat, oats, rye, agricultural machinery, and pulses. Zimbabwe has also developed strong research programs on maize, tobacco, beans, and peas. Technology is also available from other regions. Technology from Kenya and research on millet and sorghum in Uganda could greatly benefit the research systems of Southern Africa, although neither is currently tapped. IARC programs also cover the major global staples of the region and provide easy links, both to larger NARS and to global sources of technology. Access to such technology would otherwise be difficult for the small-country NARS of the region. And at the regional level, there are few cross-linkages among NARS.

Since the development of linkages requires time and money, small-country NARS are often at a disadvantage. Any plans a small NARS has for participating

in or contributing to external research require careful evaluation of the costs and structure of the linkages involved. This is necessary to ensure that these are consistent with available national capacities and resources. Furthermore, the role of the small-country NARS in these linkages needs to be carefully defined. Precise mechanisms for participation need to be managed so that small NARS do not expend a disproportionate share of their resources on regional and international linkages to the detriment of national activities and roles.

Technology borrowing requires good judgment about the suitability of a technology for solving problems. Thus, for a small country, it is important for it to have the capacity to judge which technologies look

promising and can be easily borrowed for further adaptation. External sources of technology can make this task easier for the NARS by providing sufficient information to permit a preliminary selection.

The small countries of Southern Africa cannot generate all of the technology that is required by their agricultural sector. They must implement a research strategy that emphasizes the screening and adapting of technology and the application of information from external sources. In order to do this, each country will need a minimum capacity of but sophisticated scientific skills to identify problems and evaluate scientific developments. This mix of skills may be different from that of larger NARS that are engaged mainly in experiments and technology generation.

## Implications

In order to implement such a research strategy, the research systems in these countries must have a broader set of functions than normal, and policy formulation and research coordination in particular will have to take a more prominent place than they do at present.

All research systems have regulatory, advisory, and technology monitoring and screening functions in addition to their traditional role of technology generation. In small countries, however, there is a need for a different emphasis among these functions. Greater emphasis may be needed on policy and coordination and on screening and advising, with much less on technology generation.

This reorientation of research in small countries will have major implications for how the research system is organized and structured, how research programs are formulated and implemented, and, perhaps most important, what is required from research staff. The small-country NARS of Southern Africa will need more

broadly trained scientists with a knowledge of natural resources and socioeconomic conditions, including analysis of market opportunities. Education and training have been concentrated in more traditional areas of agricultural research such as increased production of staple crops through experimentation — especially in agronomy, breeding, and pathology. There has been less support and training available for the skills needed to scan and adapt technologies to meet the needs of the local resource base and socioeconomic conditions. One area of growing support is management training that will enable researchers to meet new and complex development and allow them to contribute effectively to policy-making and coordination.

In the final analysis, small NARS can make a greater contribution to world science by focusing on areas that are receiving less attention at the global and regional levels. They will also be able to play a more important role in orienting science policy for agricultural development.

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