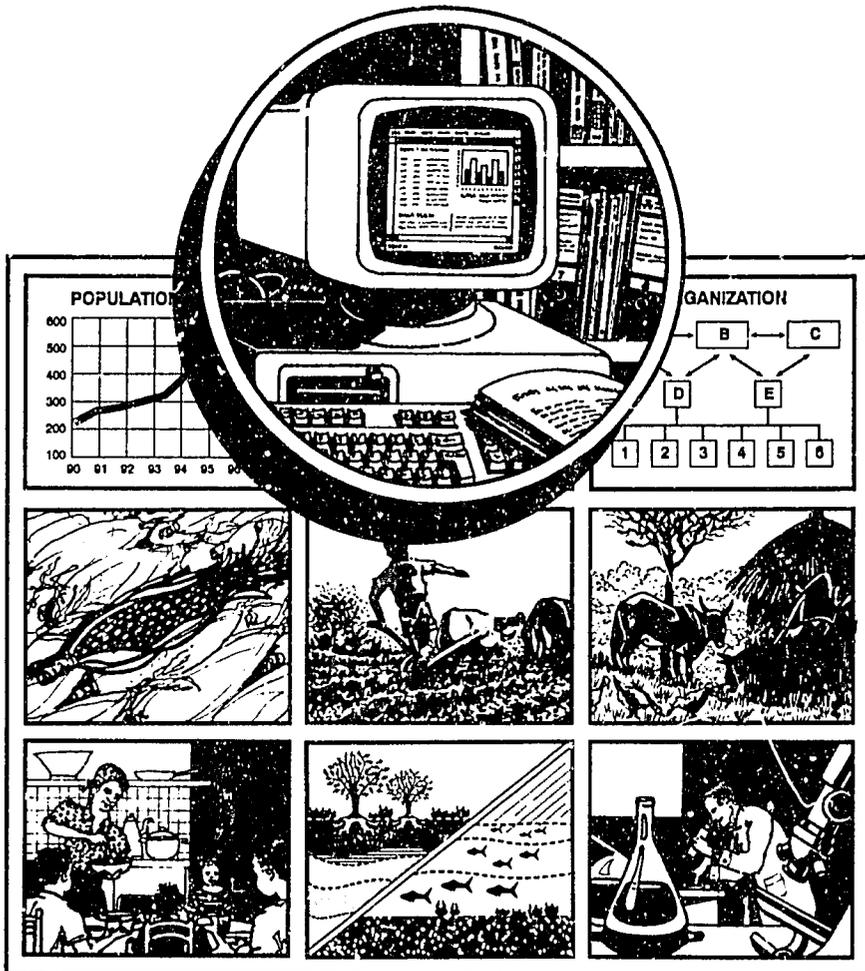




Management of Scientific Information for Agricultural Research in Mauritius

Rosemay Ng Kee Kwong
and
Peter Ballantyne



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.



This publication is part of a project entitled "Managing Scientific Information in Agricultural Research Systems in Small Countries," jointly sponsored by the Technical Centre for Agricultural and Rural Cooperation (CTA) and ISNAR.

STUDY PAPER #6

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International Service for National Agricultural Research

Isnar

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information services; management; research; Mauritius

CARIS Descriptors

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ISNAR Small-Country Project

Introduction

In 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

Fifty 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

Honduras, 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

Regional 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

The 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 areas 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.

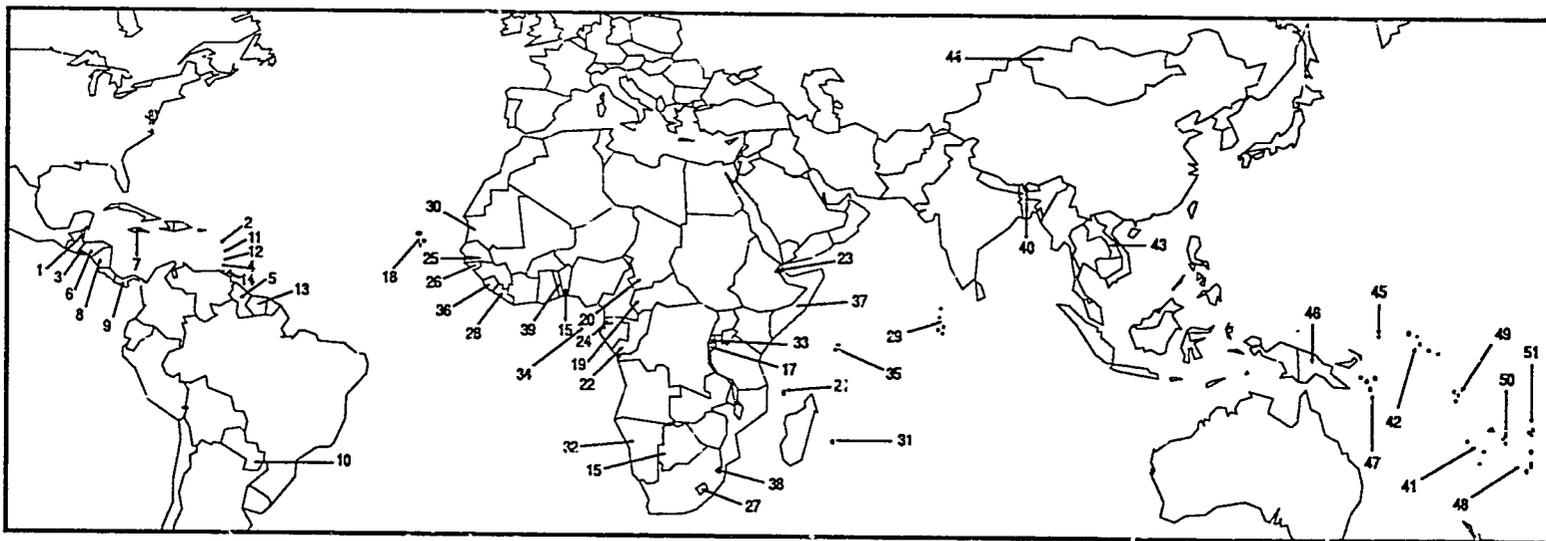
Dissemination of Results

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

Preface

The Mauritian Minister of Agriculture recently stated that "nowadays, the success of the agricultural producer depends very much on how **well-informed** he is" (Ministry of Agriculture, Fisheries and Natural Resources 1990a). Producers, in turn, depend on technical advice from researchers who should themselves be well informed. Finding appropriate ways to inform these researchers is the main thrust of this study paper.

The basic hypothesis underlying this study is that research in small countries is different from research in large countries: in the way it is organized and managed, in the amount of resources available to it, and in its priorities and orientation. These differences suggest that the role of information services for research in small countries will also be different.

In general, small developing countries do not have sufficient capacity in research to generate the knowledge and information that their agricultural sector requires. They must therefore rely on external institutions for much of their technology and information needs. This suggests that research systems in small countries must have the capacity to scan, identify, evaluate, and acquire technologies or knowledge about them. Without this capacity, they will be unable to obtain what they need. The issue for research managers is to determine what resources and efforts are required to build the capacity that their system needs.

This case study is part of a joint ISNAR and CTA project entitled "Managing Scientific Information in Agricultural Research Systems in Small Developing Countries." Its objectives are to identify mechanisms and strategies that can be used by agricultural research systems in small developing countries to gain access to relevant scientific information. Four case studies of national experiences in Mauritius, the Seychelles, Swaziland, and Trinidad and Tobago have been commissioned by the project. They provide a description and a basis for discussion of information approaches to support agricultural research in each country. These will form the basis for further discussion with research managers and information specialists, and they will be incorporated into guidelines on how best to organize scientific information systems in small countries.

The case study is not intended to be a prescription for information development in Mauritius; instead, it is a study of information services in relation to the research system that they serve. The intention is to learn from Mauritian experience and disseminate the lessons to a wider audience. At the same time, major information issues that need to be addressed by research managers and information specialists are raised and discussed. Any subsequent changes or modifications to the systems and services are for national staff to debate and implement if appropriate.

Acknowledgements

The participation and cooperation of the Mauritius Sugar Industry Research Institute (MSIRI) was essential for this study. We especially thank the Director, Dr. C. Ricaud for his support and for making the many facilities of the Institute available to us, also the MSIRI staff who provided their research perspectives on the information issues.

Many staff in the Ministry of Agriculture, Fisheries and Natural Resources also supplied useful information. In particular, we acknowledge the assistance of Dr. M. F. Mosaheb (Chief Agricultural Officer), Dr. G. M. Lallahomed (Principal Agricultural Officer, Crops), Dr. M. Munbोध (Principal Fisheries Officer), and Dr. A. W. Owadally (Conservator of Forests).

The Executive Chairman of the Food and Agricultural Research Council, Mr. R. Antoine, shared with us his views on the state of agri-

cultural research in Mauritius. In the University of Mauritius, thanks are due to Professor A. M. Osman, Head of the School of Agriculture, and Professor S. R. Ramadas, Head of the School of Science. Mr. J. N. Humbert from Food and Allied Industries Ltd. and Mr. J. M. Huron from the Camaron Hatchery provided valuable comments on the information sources used by private-sector companies.

The support of Ms. J. Hul Sin Nen (Officer in Charge, Documentation Center, Ministry of Agriculture) and the staff of the MSIRI Library and Scientific Information Service staff is much appreciated.

We also acknowledge the assistance of Dr. H. Elliott, Dr. P. Eyzaguirre, Dr. C. Falconi, Dr. C. Hoste, and Dr. B. Nestel of ISNAR who reviewed and commented on the manuscript. Ms. K. Sheridan was responsible for its editing and layout.

Abstract

This case study discusses the approaches used by the agricultural research system of Mauritius to obtain and manage scientific information. Information access is reviewed in relation to the demand for information by the research system, the sources of information that it has access to, and the mechanisms used to actually obtain and manage the information. The most significant characteristic of demand is the overwhelming importance of the sugar crop to the national economy, the desire to make the industry more efficient, and the need to diversify the agricultural sector without prejudicing sugar production. Libraries and information centers are the dominant formal mechanisms that are used to acquire and manage scientific information. These have developed in relative isolation from each other and examples of joint activities and active collaboration are rare. In addition, professional and technical associations or socie-

ties play an important role among scientists, especially in the sugar industry where they are a major linking mechanism with research elsewhere in the world. Participation in research networks is limited but will increase as the research system builds stronger contacts with the international agricultural research system and other national agricultural research systems. The study illustrates the difficulties that even a small country faces in trying to develop a coordinated information system from a group of disparate units with differing objectives and clientele, and little experience with working together. Other issues raised by the case study include the importance of organizational status and management support to an information unit, the need for appropriate information technologies, the difficulties posed when research project information systems are lacking, and the need for well-trained information personnel.

Résumé

Cette étude de cas analyse les approches utilisées par le système de recherche agronomique de l'île Maurice pour obtenir et gérer l'information scientifique. L'accès à l'information est examiné par rapport à la demande d'information émanant du système de recherche, les sources d'information auxquelles il peut accéder et les mécanismes qu'il utilise pour obtenir et gérer l'information. Les principales caractéristiques qui déterminent la demande sont la part prépondérante de la culture sucrière au sein de l'économie nationale, le désir d'optimiser l'industrie et la nécessité de diversifier le secteur agricole sans porter préjudice à la production sucrière. Les bibliothèques et les centres d'information sont les principaux mécanismes formels utilisés pour obtenir et gérer l'information scientifique. Dans une certaine mesure, ils se sont développés indépendamment l'un de l'autre ; rares sont les exemples d'activités conjointes et de collaboration active. Selon les scientifiques, les associations ou sociétés profession-

nelles et techniques jouent un rôle important dans ce domaine, plus particulièrement dans l'industrie sucrière où il y a un lien important avec la recherche menée dans le reste du monde. Cette étude de cas illustre les difficultés que même un petit pays peut rencontrer dans sa tentative de développement d'un système d'information coordonné à partir d'un groupe d'unités d'information disparates caractérisées par différents objectifs et clients, ou par un manque d'expérience de travail en commun. D'autres problèmes soulevés par cette étude comprennent l'importance du statut organisationnel et du soutien que peut obtenir une unité d'information de la part de la direction générale, la nécessité de disposer de technologies informatiques appropriées, les difficultés rencontrées en absence de tout système d'information au sein du projet de recherche et la nécessité de bénéficier d'un personnel d'information qui soit bien formé.

Resumen

Este estudio de caso analiza el planteamiento que el sistema de investigación agrícola de Mauritius utiliza para obtener y manejar la información científica. Esta información es analizada y actualizada con relación a la demanda de información del sistema de investigación, su acceso a las fuentes de información y los mecanismos que utiliza para obtener y manejar dicha información. La característica más resaltante de la demanda de información es la gran importancia del cultivo de azúcar en la economía nacional, el deseo de aumentar la eficiencia de la industria y la necesidad de diversificar al sector agropecuario sin perjudicar la producción azucarera. Centros de información y bibliotecas son los mecanismos frecuentes y formales para adquirir y difundir información científica. Estos se han desarrollado de manera aislada e intentos para realizar actividades conjuntas no es común. Además de estos meca-

nismos formales, las asociaciones y sociedades de científicos, profesionales y técnicos tienen un rol importante especialmente en la industria azucarera donde ellos son el principal mecanismo de interacción con la investigación mundial. El estudio presenta las dificultades que aún un pequeño país encara en tratar de desarrollar un sistema de información coordinado de un grupo de unidades de información desvinculadas, con diferentes objetivos y clientela, y poca experiencia de trabajar en conjunto. Otros puntos que resalta el estudio de caso son la importancia de un estatus organizacional y apoyo administrativo a una unidad de información, la necesidad de información apropiada de tecnologías, las dificultades que surgen cuando no existe un sistema de información de proyectos de investigación y la necesidad de personal bien entrenado.

Acronyms

ACCT	Agence de Coopération, Culturelle et Technique, France
AGRIS	International Information System for the Agricultural Sciences (FAO)
AIRDOI	Association des Institutions de Recherche et de Développement de l'Océan Indien
ASSCT	Australian Society of Sugar Cane Technologists
AVRDC	Asian Vegetable Research and Development Center
CABI	CAB International
CARIS	Current Agricultural Research Information System (FAO)
CD-ROM	Compact Disk-Read-Only Memory
CEEMAT	Centre d'Études et d'Expérimentation en Mécanisation Agricole et Technologie Alimentaire
CEMAGREF	Centre National du Machinisme Agricole, du Génie Rural, des Eaux et des Forêts
CERF	Centre d'Essai, de Recherche et de Formation
CIAT	Centro Internacional de Agricultura Tropical
CIMMYT	Centro Internacional de Mejoramiento de Maíz y Trigo
CIP	Centro Internacional de la Papa
CIRAD	Centre de Coopération Internationale en Recherche Agronomique pour le Développement
COCOLAG	Comité de Collaboration Agricole (Indian Ocean)
COI	Commission de l'Océan Indien
CTA	Technical Centre for Agricultural and Rural Cooperation
ENDA	Environment and Development of the Third World
FAO	Food and Agriculture Organization of the United Nations
FARC	Food and Agricultural Research Council
IAALD	International Association of Agricultural Information Specialists
IARC	international agricultural research center
ICLARM	International Centre for Living Aquatic Resources Management
ICRISAT	International Crops Research Institute for the Semi Arid Tropics
IEMVT	Institut d'Elevage et de Médecine Vétérinaire des Pays Tropicaux
IITA	International Institute of Tropical Agriculture
INTIB	Industrial and Technological Information Bank (UNIDO)
IRAT	Institut de Recherches Agronomiques Tropicales et des cultures vivrières
IRFA	Institut de Recherches sur les Fruits et Agrumes
ISNAR	International Service for National Agricultural Research
ISSCT	International Society of Sugar Cane Technologists
IUCN	International Union for the Conservation of Nature and Natural Resources
MAFNR	Ministry of Agriculture, Fisheries and Natural Resources
MRC	Mauritius Research Council
MSIRI	Mauritius Sugar Industry Research Institute
NARS	national agricultural research system(s)
NRI	Natural Resources Institute
OIE	Office International des Epizooties
ORSTOM	Institut Français de Recherche Scientifique pour le Développement en Coopération
RECOSCIX	Regional Cooperation in Scientific Information Exchange in the Western Indian Ocean Project
RSTCA	Regional Sugarcane Training Centre for Africa
SOA	School of Agriculture (University of Mauritius)
TEC	Tertiary Education Commission, Mauritius
UNIDO	United Nations Industrial Development Organisation
WWF	World Wide Fund for Nature

The Agricultural Sector and Agricultural Research

Mauritius is an island situated in the Indian Ocean about 900 km east of Madagascar. Along with more than 20 islets around its coast, it covers an area of approximately 1864 square km. The economy is heavily dependent upon agriculture; however, the relative contribution of agriculture is declining, with agricultural products accounting for 32.7% of total export values in 1990 (Manrakhan *in press*). This decline is mainly due to the country's vigorous economic diversification into sectors such as tourism, textiles, manufacturing industries and services. The growth and attractiveness of these sectors has created a labor shortage in the sugar industry which has had a major influence on policies in the sector.

Sugarcane is the dominant crop on the island. It occupies 90% of the arable land

and accounted for 92.5% by value of agricultural exports in 1990 (Manrakhan *in press*). There are two distinct groups of producers: plantations attached to the island's 19 sugar factories, which account for 51% of the land under sugar and 59% of total sugar production, and about 35,000 independent planters who cultivate plots of less than two hectares. Other important agricultural activities include the production of tea and anthuriums for export, as well as tobacco, fruits, and vegetables, mainly for local consumption. Livestock are significant in the local economy and are raised both intensively by commercial operators and on a small scale by individual farmers. Traditional artisanal and deep-sea fisheries are increasingly important industries that have recently been supplemented by a growing mariculture and aquaculture industry.

Agricultural Policy

Current government policies are intended to achieve self-reliance in food production and to reduce food imports. A more diversified agricultural sector is the basis for achieving these aims, and the government has introduced a number of measures such as tax exemptions and fiscal concessions to encourage diversification efforts. The 1988 Sugar Industry Efficiency Act, for example, provides various incentives "for an efficient and viable sugar industry, to preserve agricultural land, to promote agricultural diversification and diversification within sugar"

(Government of Mauritius 1988). The current strategy gives more priority to the selective production of high-value commodities for export and the setting up of new agro-based industries.

To ensure the long-term viability of the agricultural sector, a global investment of 7.3 billion rupees is available under the Indicative Investment Program for 1991-1995. These funds will be used for modernization of the sugar industry, as well as for field derociding, mechanization, irrigation, research, and staff training.

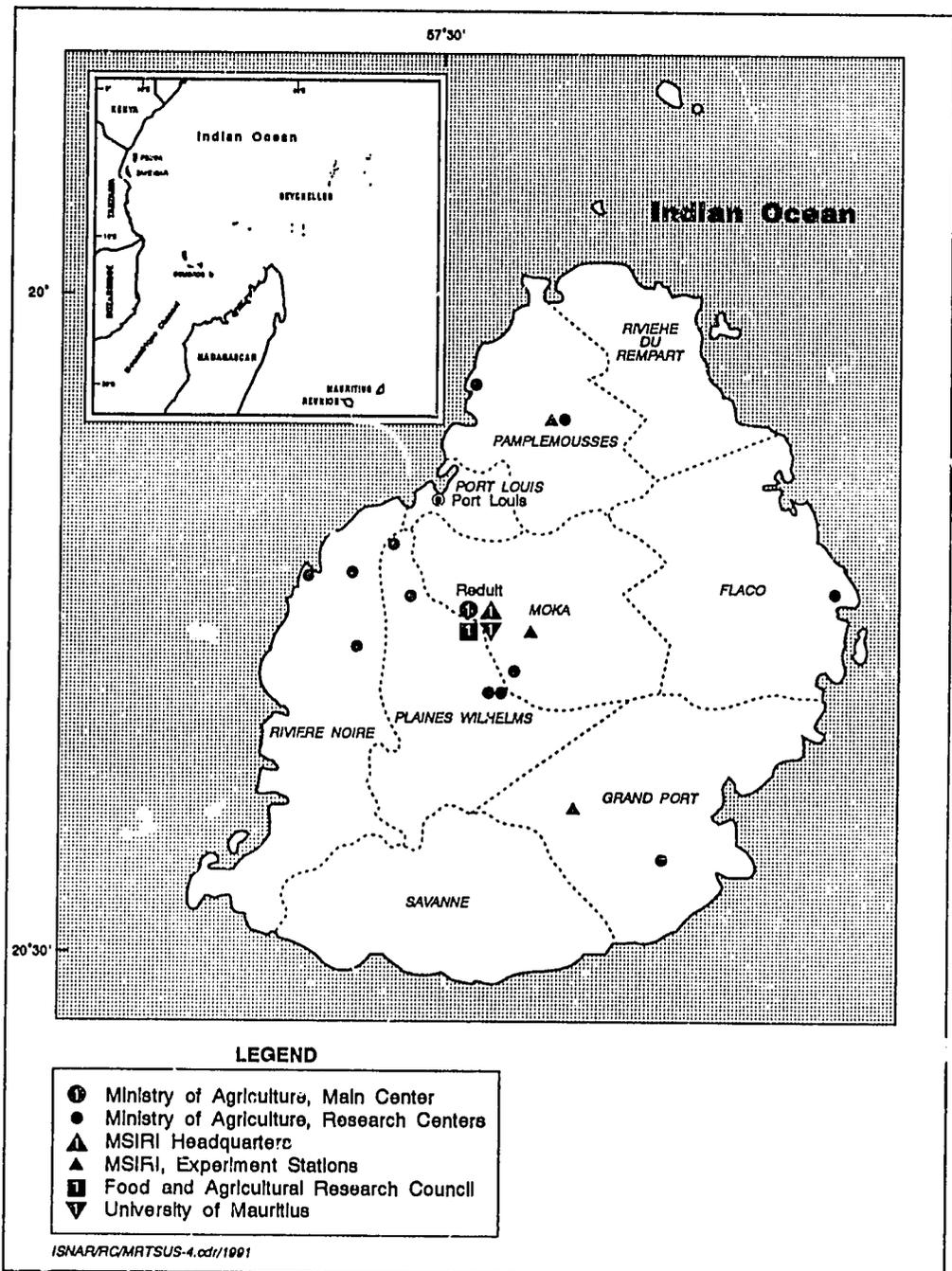


Figure 1. Mauritius, showing the distribution of research facilities and the island's position in the Indian Ocean

Organization of Agricultural Research

Organized research in agriculture began in 1893 with the creation of a *Station Agronomique*, which was later incorporated into the Department of Agriculture when it was created in 1913. In 1930, a Sugar Cane Research Station was created as a division within the Department of Agriculture. It was to be a base for research and experimentation to improve the efficiency of the sugarcane industry. The present situation regarding research institutes, their main programs, and their staff is shown in table 1.

The data in this table indicate that there are many scientists available to conduct research in the country. However, all of them, with the possible exception of those in the Mauritius Sugar Industry Research Institute (MSIRI), have additional functions and tasks that significantly reduce the time they have available for research. In the Ministry of Agriculture, the university, and probably also the private sector, research is not a major activity for most scientifically trained staff.

Table 1. Overview of Institutions in Agricultural Research, November 1991

Organization	Status	Major Programs	Number of Scientists	Info Staff
Ministry of Agriculture Fisheries and Natural Resources	Ministry	Crops Livestock Fisheries Forestry	88	1
Mauritius Sugar Industry Research Institute	Parastatal	Sugarcane Sugar Technology Food Crops	50	1
University of Mauritius ^a	University	Agriculture Science Sugar Technology	35 ^b	2
Food and Agricultural Research Council	Parastatal	Biotechnology	2	1
Food & Allied Industries Ltd	Private sector	Agroindustry Poultry Animal Feeds Food Science	11 ^c	0
Camaron Production Company Ltd and Camaron Hatchery Ltd	Private sector	Fish Culture Freshwater Prawns	3	0
Total			189	5

a. Research is not the main activity of university staff; no library staff are allocated to agricultural information.

b. Includes 6 graduates on leave and 2 expatriates on contract.

c. Includes one person in training (for feeds). Other personnel are not engaged fulltime in research.

After independence in 1968, the Department of Agriculture became Agricultural Services in what is now known as the Ministry of Agriculture, Fisheries and Natural Resources (MAFNR). It is involved in aspects of applied research on the improvement of crop and livestock production, prevention and control of plant and

animal diseases and pests, and other aspects of agricultural development, including extension. Information on the ministry's present research programs and staff allocations is presented in table 2.

Following a recommendation by the 1947 Mauritius Economic Commission, in

Table 2. Ministry of Agriculture, Fisheries and Natural Resources — Structure and Human Resources for Research, November 1991

Unit	Major Programs	Scientists ^a
Agronomy Division	Field Crops Vegetables	13
Animal Husbandry Division	Livestock Feeding, Nutrition, and Management	21
Plant Pathology Division	Plant Health Diagnostic Services Quarantine	3
Agricultural Engineering Division	Biogas Production	2
Entomology Division	Pest Control Biocontrol	4
Land Use and Projects Division	Soil Conservation	2
Horticulture Division	Fruits Vegetables Flowers	7
Veterinary Services Division	Animal Health Diagnostic Services Vaccine Production	6
Agricultural Chemistry Division	Fertilizers Soil Analysis Pesticide Residues	4
Dairy Chemistry Division	Milk and Dairy Science	4
Remote Sensing Unit	Remote Sensing	1
Forestry Service	Forest Ecosystems Forest Plantations	1
Fisheries Services (Contains 4 Divisions)	Aquaculture Offshore Fisheries Marine Conservation Artisanal Fisheries	20
Senior Management ^b		6 ^a

a. The numbers indicate actual staff available for research. There are many vacant posts in some divisions (Engineering, Pathology), sometimes staff are on extended leave without pay (Horticulture), and total establishment numbers are larger than those noted here.

b. One chief agricultural officer, three principal agricultural officers, one conservator of forests, and one principal fisheries officer coordinate and manage the divisions.

1953 the Mauritius Sugar Industry Research Institute was set up "to promote by means of research and investigation the technical progress and efficiency of the sugar industry" (Government of Mauritius 1953). Research on food crops was added to MSIRI's mandate in 1970 when the Division of Food Crop Agronomy was created. Information on its present programs and staff allocations is presented in table 3.

Limited research in the agricultural sector is also carried out at the University of Mauritius (School of Agriculture, School of Science, and School of Engineering). Research in the private sector is difficult to quantify and seems to be more directed towards the production problems of the private sector itself.

In 1985, a Food and Agricultural Research Council (FARC) was set up "to promote and harmonize research activities in

Table 3. Mauritius Sugar Industry Research Institute — Structure and Human Resources for Research, November 1991

Division	Major Programs	Scientists
Agricultural Chemistry	Soils and fertilizers Agrochemicals Geographic Information Systems	5
Biometry	Landindex Database Agrometeorology Database Yield Forecasting	2
Botany & Irrigation	Agrometeorology Plant Physiology Irrigation	5
Cane Breeding	Breeding and Selection Genetics	5
Cultural Operations & Weed Agronomy	Crop Husbandry Herbicides Mechanization	4
Economics	Socioeconomics	2
Entomology	Integrated Pest Management	2
Food Crop Agronomy	Breeding and Selection Intercropping Potatoes Maize Groundnuts Beans Tomatoes	8
Plant Pathology	Plant Health Biotechnology	6
Sugar Technology ^a	Factory Performance Processing Chemical Control	6
Senior Management ^b		5

a. Eighty to ninety percent of staff time in sugar technology is for services and troubleshooting for the factories.

b. One director and one assistant director supported by three principal scientific officers.

agriculture, fisheries and food production" (Government of Mauritius 1985).

The Mauritius Research Council was created in 1992 to "foster, promote, and coordinate research and development in all

spheres of scientific, technological, social, and economic activities, and to advise government on all matters concerning scientific and technological policies" (Government of Mauritius 1992).

Programs and Scope of Research

The grouping of agricultural research activities used here is based on the characterization of research topics and technologies developed by Eyzaguirre (1991) (table 4). He suggests that commodities can be grouped according to the way in which research is conducted on them globally, and that these groupings influence the flows of information for a specific crop. Thus, crops like rice, maize and cassava fall into a group of "global staples," each of which is a major focus of international, publicly funded research efforts. Although the crops themselves are very different, patterns of information dissemination are similar. The producers of this information use widely available journals and publications as well as research and information networks to disseminate their results. In contrast, the available stock of information on a high-value, non-traditional export crop such as anthurium is small and difficult to locate. This is partly because of the limited number of institutions involved in research, but it is also due to growers restricting some information for their own benefit.

This breakdown of research domains is intended to facilitate the assessment of information sources and flows; however, it is useful to categorize current programs of research so that the links between research efforts and information sources can be made more explicit.

Global Staples

Research on global staples is distributed between MSIRI and the Ministry of Agriculture. MSIRI has the mandate for work

on maize, beans, groundnuts, and potatoes, and is recognized by the international agricultural research centers (IARCs) as being the national focal point for each. Five scientists in MSIRI's Food-crop Agronomy Division are allocated to these crops (two to maize and one each to the others).

In the Ministry of Agriculture, the Agronomy Division works on pulses, beans (although MSIRI has the official mandate), and tropical wheat, which is replacing rice as a priority crop for research. Presently the ministry has one scientist working on pulses and one on wheat and rice.

Traditional Export Crops

Funds for research on sugarcane are allocated from a global cess on the proceeds of the sugar crop. MSIRI, with a scientific staff of 50, does research on sugarcane (agricultural chemistry, biometry, botany, irrigation, cane breeding, cultural operations, weed agronomy, economics, entomology, and plant pathology) and sugar technology. MSIRI's research is primarily directed toward technology generation and adaptation to local conditions. A certain amount of basic research in plant physiology, biotechnology, and genetics, for example, is also undertaken.

Research on tea (for export) and tobacco (for local consumption) is the responsibility of the Ministry of Agriculture and is carried out by the Agronomy Division, which has two scientists allocated to tea and one to tobacco. This research is funded by growers and industry. Funds are

Table 4. 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	SMALL RUMINANTS:	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	LARGE ANIMALS:	Marketing research	Pests, diseases, weed control and management
Groundnuts	Coconuts	Cabbage	Citrus	Cattle	Postharvest and storage	Plant genetic resources
Maize	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	POULTRY/SWINE:		Irrigation/water management
Sorghum	Sisal	Date palms	Grapefruit	Chickens		
Soya	Sugar	Figs	High-value vegetables	Ducks		
Wheat	Tea	Fruits (local use)	Jajoba	Turkeys		
	Tobacco	Garlic	Kava	Swine		
		Lentils	Mangoes		Animal traction	
		Melons	Papaya		Dairy technology	
		Millet (<i>Elusine</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>)				

allocated by the Tea Board and the Tobacco Board, respectively.

Nontraditional Export Crops

As part of the drive towards diversification, producers are growing more high-value crops with both a local market and high export potential. Research on fruits and flowers to support these interests is conducted by the Horticulture Division of the Ministry of Agriculture. The division has three staff working on fruits for export (litchis, pineapples, mangoes, passion fruit, and papaya) and one scientist working on anthuriums. The potential importance of these crops can best be highlighted by anthuriums, which in terms of value, are now the third most important agricultural export after sugar and tea.

Minor Food Crops

The Horticulture Division also works on vegetables, tropical apples, citrus, grapes, bananas, mangoes, garlic, onions, peppers, and tomatoes — mostly for local consumption. Three researchers work on vegetables, including one committed to research on organic agriculture. MSIRI is responsible for national research on tomatoes, and it has one scientist allocated to research on its suitability as an intercrop with sugarcane.

Ministry of Agriculture staff recently visited the Asian Vegetable Research and Development Center (AVRDC) to set up collaborative research links in integrated pest management for vegetable crops, and MSIRI staff already have good collaboration with AVRDC in areas such as varietal testing and germplasm exchange.

Livestock

Research on livestock (cattle, goats, sheep, poultry, pigs, deer, and rabbits) is conducted by the Animal Husbandry and Veterinary Services Divisions of the Ministry of Agriculture. Some limited testing

and adaptive research is also carried out by private-sector companies.

The Animal Husbandry Division works mostly on livestock feeding, nutrition, and management. They want to increase the amount of local ingredients, especially sugar-industry by-products, used in feed formulations. There are now approximately 60 deer farms in Mauritius, and the division is developing a project to conduct research on the local species, about which very little is known.

The Veterinary Services Division has an Animal Health Laboratory staffed by five university graduates. Their role is a combination of research and services (vaccine production, diagnostic services) and amounts to no more than three person-years of research.

Some research on aquaculture is conducted by staff in the Fisheries Services of the Ministry of Agriculture. The aquaculture industry tends to fund and organize its own applied research, which at present consists of a central hatchery (Cameron Hatchery Company), a centralized grow-out farm (Cameron Production Ltd.), and 11 commercial prawn farms.

Socioeconomics and Engineering

Socioeconomic research is conducted mostly by the Economics Division of MSIRI and, to a more limited extent, by the University of Mauritius, the Mauritius Sugar Authority, and the Chamber of Agriculture.

MSIRI uses a farming systems approach in its studies of small sugarcane planters. Specific activities include surveys of technology transfer and adoption, as well as studies of labor availability. The division also works with the sugar estates, focusing more on resource economics issues. Activities in this sector include studies of drip irrigation, mechanization, and diversification.

Limited agroindustrial research is carried out in the private sector by Food and Allied Industries Limited. Research is mostly adaptive and often done through contracts with institutes overseas. The company employs one veterinarian on its poultry farm, two technicians in the dairy products subsidiary, one food technologist, three graduates in the feed factories, and four millers in the flour mill and experimental bakery. These individuals are not engaged full-time in research; they have other quality-control, diagnostic, and management responsibilities.

The Engineering Division of the Ministry of Agriculture is responsible for modification and testing of agricultural implements and machinery to suit local conditions. In addition, it has an on-going biogas production project.

MSIRI previously had an active research program in sugar technology; however, current efforts are concentrated more on services to the sugar factories. Investigations in progress include studies of problems encountered during processing, chemical control procedures, and effluent disposal. Some limited research on sugar technology is also conducted in the university at the School of Engineering.

The sugar industry is being studied to see how it can be mechanized further. MSIRI established a Mechanization Unit within its Cultural Operations and Weed Agronomy Division, and since 1990, the unit has collaborated with Centre d'Etudes et d'Expérimentation en Mécanisation Agricole et Technologie Alimentaire (CEEMAT) on studies of land and seedbed preparation, the evaluation of mechanical planters and harvesters, tractor performance, and the effects of mechanization on soil conservation.

Natural Resource Management

Some forestry research is conducted by the Forestry Service of the Ministry of Agriculture. This is mainly applied re-

search on forest ecosystems and commercial forest plantations. The service employs four local graduates whose work on other issues, such as forest legislation and trade statistics, means that their contribution to research amounts to no more than 1.5 person-years. This is supplemented by expatriate staff, whose contribution to research is roughly another 1.5 person-years. They come mainly from nongovernmental organizations (NGOs) such as the World Wide Fund for Nature (WWF), Environment and Development of the Third World (ENDA), and the International Union for the Conservation of Nature and Natural Resources (IUCN). Some research on agroforestry is also done in the university's School of Agriculture.

The Mauritius Herbarium at MSIRI is an internationally acknowledged center for research on plant life in the Mascarenes and nearby islands. It also provides assistance to researchers engaged in nature conservation and botanical studies.

Research on fisheries is conducted by the Fisheries Services of the Ministry of Agriculture. There are 20 researchers working on aquaculture (freshwater and marine), artisanal and banks fisheries, marine conservation, and offshore fisheries. In addition, two scientists from Institut Français de Recherche Scientifique pour le Développement en Coopération (ORSTOM) are working on tuna stock assessment, and one Japanese expert works in marine aquaculture.

There is some research on soil conservation and soil fertility conducted by one scientist in the Ministry of Agriculture's Land Use and Projects Division.

The Ministry of Agriculture's Divisions of Plant Pathology and Entomology collaborate on pest control — mostly diagnostic, advisory, and quarantine services for the agricultural community. Their capacity to do research is limited by staff shortages — both divisions have many vacancies for scientific officers.

MSIRI has research and advisory activities on sugarcane pests, diseases, and weeds, as well as associated food crops. Priority is given to the development of precise diagnostic techniques for disease control,

the propagation of healthy seed stock, integrated pest management, biological control of pests, and breeding for pest and disease resistance.

Management of Scientific Information

Three main aspects of information flow and management can be expected to have an influence on the way in which information is accessed and managed in small countries. These are the *demand* for information from research, the potential

sources of needed information, and the *mechanisms* that managers use to identify and acquire it. These concepts are discussed in more detail by Ballantyne (1991).

Demand for Research Information

Managers of research respond to staff demands for information by providing information services and by facilitating scientists' contacts with one another. This section assesses the demand for agricultural research information in Mauritius and discusses some of the factors associated with the research system itself that influence the shape and nature of the demands.

Sugarcane — the Dominant Crop

Sugarcane and its products still dominate the agricultural sector, and all research must take this into account, but government interest in diversifying agricultural production away from sugarcane has created new demands on research. There is also the problem of limited land — existing levels of sugar production are to be maintained, if possible, from the same land area or less. This means that productivity levels must be increased.

Alongside the focus on sugarcane, there is intense interest in other food crops that

can be grown on fallow land or that can be "interlined" with sugarcane without detriment to sugar production. Mauritian researchers are among the world's leaders in this area, acting as technology *lenders* rather than *borrowers*, and MSIRI staff are frequently invited to outside workshops and meetings to explain their approaches and results.

Although the stated policy is greater diversification, the major demand for information is still related to sugarcane itself, and excellent information services are required. In practice, this means that information services must not only maintain and strengthen existing information links but must also expand their contacts into new sectors, such as mechanization, biotechnology, production economics, and agriculture in land-deficit countries.

This is in contrast to Trinidad and Tobago, for example, where diversification has meant the transfer of research interests almost totally away from sugarcane. Information services in Mauritius, instead

of reducing their involvement in sugarcane, must maintain and even intensify some aspects of their information support for sugar research, while also moving into new crops.

Research Mandates

Although formal procedures for research coordination have not yet been implemented, there are some clear differences in the research programs at the different institutions: MSIRI works on sugar plus a small group of specified food crops, and the ministry is responsible for the other field and food crops. Such divisions of responsibility, if followed, can provide a measure of predictability to the demand for information and can be used by the information services as a basis for their collection-building efforts. Thus, unnecessary duplication between institutions can be reduced by assigning primary responsibility for certain commodities to individual centers or their component divisions.

Multiple Roles of Researchers

In the Ministry of Agriculture, scientific staff have a wide range of duties and responsibilities. These include advising farmers and growers, collating statistical data, providing diagnostic services, managing development projects, advising policymakers, and enforcing quarantine or other legislation. Similarly, at the university, teaching is more important than research. These many functions usually take precedence over research, so when a division or department is short of scientific staff, little research is carried out. It is only at MSIRI that research is given greatest priority and where a substantial number of staff are committed full-time to research work.

These competing demands on staff time mean that information demands *for research purposes* are diffused and are often not elaborated. Many requests for information have little bearing on research in

progress, so the documentation center of the Ministry of Agriculture, for example, has to consider a much wider spectrum of interests. The university must develop a mechanism to cope with the special information requirements of staff who participate in research projects in addition to their teaching responsibilities. At MSIRI, the task of the information service is narrowed, and perhaps eased, because information demands are oriented towards a well-defined research and development program.

Role of Outside Organizations

Part of the research conducted in the Ministry of Agriculture is linked to projects and programs funded by donors. These projects not only provide operational funds for research, but also some technical and expert assistance. In some areas of forestry and natural resources, they also provide staff to do the research.

Demand for information on specific topics is variable and, to a large extent, tends to follow the pattern of donor projects. The involvement of foreign experts with their own networks and information sources ensures that much of this demand is satisfied by sources and mechanisms outside Mauritius. Local information mechanisms, such as a library, therefore tend to be by-passed; unless a project has specific activities and budget-line items for information, documentation, or literature support, its effect on strengthening local information resources will be slight.

Location of Researchers

Agricultural research is centralized in a small agricultural campus in Réduit where MSIRI, FARC, the university, and the Ministry of Agriculture are all located. Only fisheries research and some experiment stations are located elsewhere. This concentration of scientists should overcome some of the problems of critical mass associated with small research systems and provide researchers with oppor-

tunities to meet and exchange information. As a corollary, information centers can share resources and develop common approaches for information delivery to potential users in such a small area.

Language

Research staff and scientists in Mauritius are all bilingual in French and English. This is a very positive feature of the research system and facilitates contacts

with both francophone and anglophone information sources. Thus, Mauritian institutions can maintain strong contacts with the Natural Resources Institute of the UK, as well as French research institutes like CEEMAT, Centre National du Mécanisme Agricole, du Génie Rural, des Eaux et des Forêts (CEMAGREF), ORSTOM, and Centre de Coopération Internationale en Recherche Agronomique pour le Développement (CIRAD).

Mechanisms to Acquire Information

In this section the mechanisms that are used in Mauritius to access scientific information are described and discussed in relation to the agricultural research system and its demands for information. This discussion includes libraries and information centers, information networks, research networks, technical societies, and personal contacts.

Libraries and Information Centers

The MSIRI library covers all aspects of sugarcane agronomy and sugar manufacture, as well as some selected food crops (Ng Kee Kwong 1990). In 1978, the traditional library functions for MSIRI research staff and members of the agricultural community were expanded by the creation of a scientific information service.

An information scientist heads the Library and Scientific Information Service and is supported by two assistants with certificates in library studies, a library technician responsible for conservation and copy services, and a binder. The library has a microcomputer and is computerizing its database of documents and publications produced by MSIRI staff since 1953, when the institute was created. MSIRI staff are kept up-to-date through a weekly service that selectively disseminates current information.

The library of the University of Mauritius was created in 1969, and its collections are biased towards support of the teaching programs of its four schools. Its special collection includes documents on agriculture in Mauritius dating back to its early beginnings, as well as theses and dissertations by staff and students. The library has national responsibility for AGRIS and CARIS, but there are no staff allocated specifically to agricultural information.

In 1985 the Ministry of Agriculture, Fisheries and Natural Resources set up a Library and Documentation Center with assistance from the Food and Agriculture Organization of the United Nations (FAO). The officer in charge has a diploma in agriculture and is assisted by four clerical staff (one with a certificate in library studies). Until August 1992, when she attended a short course at CAB International, the officer in charge had no formal training of any kind in information work. This may be a first step towards professional education and training.

The center produces a monthly list of new accessions, and it participated in pilot information and document delivery schemes with CAB International and FAO. It is a depository for FAO and IARC publications and it is responsible for a number of small divisional collections of books

and journals, most of which are old and obsolete. In theory, it is responsible with the university library for AGRIS input, but there has been no progress on this recently.

There are similarities in the approach to information and documentation followed by MSIRI and the Ministry of Agriculture. However, it is the differences in the actual roles and effectiveness of the two documentation services that are more striking. Both have small staff and both encourage decentralized collections of documents in divisional libraries, arguing that closeness to users is more important than large central collections. In implementation, however, there are striking differences.

The Ministry of Agriculture's documentation center has an acute shortage of trained staff, limited financial resources and basic services, and a lack of awareness in both the documentation center and elsewhere of the appropriate function and role that the center could have. By contrast, the MSIRI information service has trained and motivated staff, funds specifically allocated for documentation, supportive research staff and management, and well-established procedures for acquiring and disseminating information. More important, the library and MSIRI management share a common awareness of the library's role and functions.

The latest development in agricultural documentation is a proposal by FARC to set up a scientific research library that will complement existing research libraries (Corbett 1989). It is understood that the Technical Centre for Agricultural and Rural Cooperation (CTA) is providing assistance. Until the new FARC building is completed, the officer in charge of the library at the Regional Sugarcane Training Centre for Africa (RSTCA) is keeping the few materials collected so far. It is unclear what the future relationship between the FARC, RSTCA, and other librar-

ies will be, nor how complementarity will be achieved.

Collaboration among Information Centers

At the national level there is little formal research collaboration, so formal collaboration in information is also very limited. However, there is some agreement on interlibrary lending and the reciprocal use of libraries by research staff in all the institutions.

There is a huge and untapped potential for resource sharing and collaboration between the documentation centers — all of the existing and proposed libraries are within five minutes walk of one another. There seem to be clear divisions of mandates and user groups between the different institutions and these could also be the basis for a division of labor and responsibility between the documentation centers. It should be possible to develop a number of small but useful joint activities that benefit each unit and create a suitable environment for larger projects.

For example, few locally generated documents are indexed and locally accessible through databases such as AGRIS or CAB Abstracts. Furthermore, there are no locally compiled and produced databases of these important materials. Existing procedures for joint or separate collecting and indexing of these documents seem to be ill-suited to the requirements of the individual institutes and agricultural researchers as a group. In a small country, projects to manage local materials must be conducted jointly and should allow each institute to contribute to a joint product and to generate direct benefits for itself in the process.

This lack of collaborative work has already been recognized by librarians in several institutions, and there are plans under the Tertiary Education Commission to establish a common catalog of library holdings. For agricultural infor-

mation, these plans only involve MSIRI and the university libraries; one wonders whether collaboration is needed in areas other than shared cataloging.

Regional projects to improve access to information include the compilation in 1985 of a catalog of periodicals on agrotechnologies available at MSIRI and in Reunion. The Université de la Reunion published a *Catalogue du Fonds "Iles de l'Océan Indien"* in 1989. There was also a regional cooperation program from the National Library of Australia that provided free literature searches and document delivery to some Indian Ocean countries — although this is now no longer free, it is still used to a limited extent. There have been few new regional initiatives in recent years.

The major international information sources are the FAO (especially in the ministry and the university) and the centers of the Consultative Group on International Agricultural Research (CGIAR). All the agricultural libraries receive CABI publications and often have extensive backruns and duplication of titles. CTA is a newcomer to the Mauritius information scene and they have offered to "assist in the setting up of an information and documentation unit through provision of equipment and training in the use of the equipment provided" (Ministry of Agriculture, Fisheries and Natural Resources 1990a). They recently nominated FARC to be the CTA focal point for Mauritius, and the FARC library will receive this assistance.

Information Networks

Mauritius is a member of both the AGRIS and the CARIS information systems of the FAO. Neither has been operative on the island in the past two years, and recent visits by FAO staff indicate their concern to improve this situation. There is some contact between the Fisheries Services and RECOSCIX, a regional project to

strengthen access to scientific information in fisheries and marine sciences.

Research Networks

Staff at MSIRI actively participate in formal regional research networks on maize, beans, and groundnuts, or the vegetable network sponsored by AVRDC. Cropping systems work in the MSIRI Economics Division received its impetus from contacts with the CIMMYT Regional Network on farming systems based in Southern Africa, and this connection has been maintained.

Technical Societies

Institutional and personal memberships in societies and professional associations are major sources of contacts and technical information. These societies function as informal research networks, publishing specialized literature, organizing conferences and meetings, and generally facilitating personal contacts between scientists.

There are many local societies for the agricultural community, such as the Société de Technologie Agricole et Sucrière de l'Île Maurice (STASM), the Royal Society of Arts and Sciences (RSAS) and the Aquasom (Aquaculture Society). Outside Mauritius there are many — the International Society of Sugarcane Technologists (ISSCT), the Australian Society of Sugarcane Technologists (ASSCT), and the Deccan Sugar Technologists Association of India. The ISSCT is a key information resource for MSIRI staff as it organizes technical workshops and an international conference every three years in a sugar producing country. The Ministry of Agriculture's Veterinary Services Division relies heavily for updated information on its membership in the Office International des Epizooties (OIE).

Personal Contacts

Most scientists agree that they must maintain personal contacts, both in-country and abroad. In the absence of formal or semiformal mechanisms for planning research programs, individual researchers rely heavily on their personal contacts to find out what research is in progress or planned in the country. These personal contacts play a major role for acquiring external information that seems to cut across all subject areas and

institutions and to greatly expedite the flow of information.

Information Technology

Microcomputers are increasingly available in the libraries that serve agricultural research; however, their utilization for information management is still at a preliminary stage. CD-ROM technology is available at the university library, but services for agricultural research are not yet operative.

Information Sources and Flows

Other countries in the region in which a small country is located are often key information contacts, and this is partly true for Mauritius. The most important regional source for Mauritian researchers within the Indian Ocean is Reunion Island, where the Comité de Collaboration Agricole (COCOLAG) was established in 1950 to promote and facilitate the regular exchange of scientific and other information between the two islands. Although it was later enlarged to include other countries in the region (Madagascar and Comoros), contact is strongest between Mauritius and Reunion.

On a global level, knowledge and information flows for individual commodities or research domains vary, and the use and effectiveness of each mechanism for getting access to information differs between crops and domains. Choosing the appropriate blend of mechanisms and approaches is a critical component of information delivery in Mauritius and must take existing information sources and flows into account.

The categorization of technologies developed by Eyzaguirre (1991) and illustrated in table 4 is a useful framework for assessing these flows. It will be used for the following discussion. As was noted ear-

lier, commodities can be grouped according to the way in which research is conducted on them globally, and these groupings influence the flows of information for a specific crop.

This section describes the different sources and suppliers of information that are presently used by the research system in Mauritius and discusses their role in relation to the research system's demand for information.

Global Staples

Almost all the contacts for global staples are with IARCs, such as the Centro Internacional de Agricultura Tropical (CIAT), International Crops Research Institute for the Semi Arid Tropics (ICRISAT), Centro Internacional de Mejoramiento de Maíz y Trigo (CIMMYT), Centro Internacional de la Papa (CIP), and the International Rice Research Institute (IRRI). Information exchange is good and their publications are found in most of the libraries. Research collaboration and personal contacts with these centers are mostly with MSIRI staff, who also have links with Institut de Recherches Agronomiques Tropicales et des cultures vivrières (IRAT) in Reunion for maize.

Traditional Export Crops

The main source of documentation on sugar is the specialized library of MSIRI. It provides access to the core literature on sugarcane agronomy and technology. Personal contacts, visiting experts, overseas study tours, and memberships in technical societies are also used extensively by MSIRI staff.

There are numerous local, regional, and international societies and professional associations in most sugar producing countries. These provide many opportunities for sugarcane researchers to meet and exchange information, and furthermore, a prolific literature on sugarcane emanates from their meetings, conferences, workshops, and technical sessions. The MSIRI library is one of the key mechanisms for scientists who want to gain access to this large body of documentation.

Researchers working on tea have few outside contacts and rely on the Tea Board and Tea Development Authority, which have the necessary infrastructure and contacts. The single tobacco researcher relies on the Tobacco Board for documentation and also to fund study tours overseas. He has personal contacts with the British American Tobacco Company, which provides varieties and some financial assistance.

Nontraditional Export Crops

For most of the nontraditional export crops, research efforts started relatively recently, and information resources are quite limited. For anthuriums, for example, the researcher in the Ministry of Agriculture has made efforts over the years to collect relevant information through literature searches and other means but confesses that his efforts have been disappointing. His experience is that the amount of information available worldwide is very limited and tends to be quite old.

The anthurium industry is thriving, however, so it seems that much information on anthuriums is being exchanged, probably outside traditional published channels. In Mauritius the growers have organized themselves into a group that provides an informal means of sharing information.

Minor Food Crops

The main source of information on vegetables is the AVRDC in Taiwan. Direct contacts between AVRDC and the libraries of the ministry and MSIRI are excellent and supplement the personal contacts already developed.

The Horticulture Division of the ministry relies heavily on contacts with IRFA in Reunion for information on fruits. IRFA has a co-operant attached to the ministry, which greatly facilitates the ministry's access to French resources. Personal contacts with other external institutes such as the University of Florida (for tropical apples), the Citrus and Subtropical Fruits Research Institute in South Africa, and the Queensland Department of Primary Industries are also maintained. Journals and other documents in the university and ministry libraries are other useful sources of information.

Livestock

In the Ministry of Agriculture, the Animal Husbandry Division (AHD) and the Veterinary Services Division (VSD) both have small collections of old books and journals. Researchers in the AHD have emphasized the importance of scientific literature and complained about their inability to gain sufficient access to it. Their approach to this problem is to use donor projects to get funds for books, journals, travel, and training. In general, however, they rely mostly on personal contacts to obtain current information. The VSD also relies on its membership in the OIE and on visiting experts, for example, from the Institut d'Élevage et de Médecine

V terinaire des Pays Tropicaux (IEMVT) in France for updated documentation.

Although the Camaron Production Company has a small collection of specialized journals on aquaculture, most information is obtained through personal contacts or from visiting experts. They request numerous reprints from authors and maintain links with overseas centers in Israel and the International Center for Living Aquatic Resources Management (ICLARM). Although they do not have trained library staff, the research staff are very much aware of documentation in their subject area and have acquired the software for database management of their collections.

Socioeconomics and Engineering

There is little baseline socioeconomic data available on the agricultural sector in Mauritius, which means that most data have still to be collected. Most of the socioeconomic work at MSIRI is in collaboration with other divisions in the institute and, through them, with external institutes. Thus, contacts have been developed with the Natural Resources Institute (NRI) and the Institute of Hydrology on their drip-irrigation project and the Centre d'Etude et d'Experimentation en Machinisme Agricole et Technologie Alimentaire on its mechanization project.

For MSIRI's studies of small planters, there is collaboration with other organizations in Mauritius, such as farmers service centers, the extension services of the Ministry of Agriculture, and the Irrigation Authority. The farming systems perspective was introduced in these studies following a visit from staff of the CIMMYT Economics Program in 1985. These contacts are continuing with the CIMMYT Farming Systems Research Network for Southern Africa based in Zimbabwe.

For the private sector, at Food and Allied Industries Ltd., for example, agroindustrial information is mainly obtained from

abroad. These foreign sources include private organizations such as the Campden Food Research Institute in the UK, and the Premier Milling Company in South Africa. Links with foreign companies, such as Yoplait (for yoghurt), are used to obtain specialized know-how for the company — in one case, Yoplait helped Food and Allied Industries to commercialize a local fermented-milk product by providing advice and technical information. Trade fairs in Europe are another important source of up-to-date information on new technological developments in the food industry.

Researchers in sugar technology rely on literature, visits, meetings, and contacts with outside organizations for new information. Meetings of technical societies are also important opportunities for information exchange. For the sugar industry, MSIRI has developed rapid communication channels with the main sugar research centers in other countries, such as the USA, South Africa, and Australia. A program of collaboration between MSIRI and the Centre d'Essai, de Recherche et de Formation (CERF) in Reunion began in 1990 and involves visits and seminars to share respective fields of expertise. Recent subjects of discussion include steam boilers and undetermined losses in sugar factories.

Natural Resource Management

The Forestry Service maintains a small, yet unorganized library for its own needs. Staff rely on personal contacts to locate information, as well as memberships in technical societies (such as the International Union of Forestry Research Organizations [IUFRO] and the Commonwealth Forestry Association) and institutional links with organizations such as FAO, the Oxford Forestry Institute, ORSTOM, the International Union for the Conservation of Nature and Natural Resources (IUCN), and the WWF. International NGOs are important sources of expertise and project funds. The Conservator of Forests relies

on the Agricultural Services of the Ministry of Agriculture and on MSIRI for assistance with pathology, entomology, and soil problems.

The Fisheries Services also has a collection of books, reports, and journals. They have large collections of FAO materials and are a depository for the International Oceanographic Commission. The materials are not indexed and there is no person specifically responsible for the library. One staff member is being trained in Belgium in information work, sponsored by the RECOSCIX Project based in Kenya. It is hoped that he will be responsible for library affairs on his return. Research staff gain most access to fisheries documentation as a by-product of the assistance of foreign experts. This however is only possible during a project and depends greatly on the experts concerned.

Research staff involved in plant health in the Ministry of Agriculture have access to a large quantity of older journals and books. Their main need is a supply of up-to-date reference materials on insects, diseases, and pests to support their diagnostic and quarantine services.

Discussion

Table 5 presents a summary overview of research efforts and information capacity in relation to research demands in the various research domains. Commodities with the greatest research effort and the best access to information are export crops, particularly sugarcane. Research is increasing on staple crops (maize, beans, groundnuts, potatoes) and nontraditional export crops (fruits and flowers). Access to information on global staples is relatively good and will improve as better contacts are made with the international community. The information needed for research on nontraditional exports such as anthuriums is probably not available. Relatively little research has been done in Mauritius in the areas of socioeconomics and natural resources, including fisheries and forestry, but this is expected to change in the next few years as some of these issues become more important. Access to relevant information in these areas will need to be developed to ensure that this research is well informed.

Table 5. Research Domains, Research Effort, and Information Supply in Mauritius

	Current Research Demand	Current Research Effort	Current Information Capacity
Global Staples	Moderate—rising	Moderate—rising	Moderate
Traditional Exports	High—stable	High	High
Minor Food Crops	Low—rising	Low	Low
Nontraditional Exports	Moderate—rising	Low—rising	Low
Livestock	Low—rising	Moderate	Low
Socioeconomics	Moderate—rising	Low	Low
Natural Resources	Moderate—rising	Low	Low

Conclusions: Issues and Lessons from Mauritius

There is a long tradition of agricultural research in Mauritius and some of the information services for research have also been developed over long periods. Unlike some other small countries where information issues relate more to the creation of new information structures and services, the issues in Mauritius are more closely associated with better management and integration of already existing and well-established services and procedures.

Information mechanisms that are actively used by the research staff in Mauritius fall into two main categories: personal contacts and documentation services. For current information, researchers rely most on personal contacts. For retrospective information, they use the libraries and book collections.

The Mauritian experience also illustrates the value of supportive managers, the role of appropriate organizational structures and communication mechanisms, the interactions and relationships between different mechanisms for obtaining information, and the constant struggle to ensure that documentation centers have appropriately trained staff.

The main information issues that face the research system are how it can coordinate its documentation services and also improve their effectiveness through better collaboration. There is already some division of labor between the main research centers, and a similar division of labor in terms of both subject scope and technical functions, is required for the information sector. The issue is whether the broad subject coverage supported by storage and access to retrospective materials that

characterizes the university's service can be effectively balanced by the more specialized, more current, and more research-focused type of service at MSIRI.

Overall, there is great activity in the documentation centers and libraries. Unfortunately, none of it is collaborative and indeed most could be considered competitive. The limited expertise that is available is not being used, rare training opportunities and trainers are not being shared, some institutions are rushing to make contacts or acquire equipment and thus "get ahead" of the others, projects that require joint efforts are individualized and, as a result, many materials and resources are duplicated. Each center tends to be individualistic; areas of joint effort are virtually nonexistent. The immediate loser is the researcher and, ultimately, also the individual information units. A strong and effective coordination mechanism is needed, and this is a higher priority at this time than creating any new information unit or library.

Each of the major information centers has strengths and weaknesses that mostly are the result of their different clientele and functions. Although the documentation center of the Ministry of Agriculture has large numbers of documents in its central and divisional libraries, they are difficult to retrieve and therefore the value of the holdings to serve research needs is questionable. The university and MSIRI both maintain larger libraries. The former is rather general in scope and is geared towards teaching; it does not satisfy some of the more specific research needs of its staff.

The subject specialization of the MSIRI library is its major strength and perhaps also a weakness as the economy diversifies and new, broader issues enter the research agenda. The regulations governing the activities of the institute mean that it cannot expand its scope beyond sugarcane and its mandated food crops. Information to support changing research priorities will be the responsibility of other institutions whose libraries will have to develop closer contacts with MSIRI and determine how its strengths, including its numerous foreign contacts, can best match their requirements.

Acting as a neutral forum where different parties could meet and develop joint activities could be a more appropriate func-

tion for FARC than attempting to create another information unit which would duplicate existing resources and facilities. The research system is too small, and the scientists located too closely together for the present three or four information centers to operate in isolation from each other.

Developing a mechanism to coordinate and set priorities for information activities and projects in the agricultural sector is a high priority and could be a useful role for FARC. As well as routine coordination, its functions could include the determination of longer-term objectives and goals for information services and systems to support agricultural research in Mauritius.

Organizational Location and Status

Communication between a researcher and the information specialist can be hampered if the library or documentation center is grouped together with other units that are not involved in research, especially if the officer in charge is not given appropriate status and access to necessary information about research activities. In Mauritius, this is a key factor explaining some of the differences between the information services available in the various institutions.

At MSIRI, the head of the Library and Scientific Information Service reports to the director of the institute and also attends weekly management meetings with other heads of divisions. This interaction is a key component in the management of information flows to research. It is an opportunity for the information specialist to become familiar with the research programs and potential information demand, and allows the service to respond accordingly. At the university, the chief librarian or his representative is a member of the

university senate and the boards of the various schools and has access to the major decision-making bodies that determine research activity. In the ministry, the officer in charge of the library attends fortnightly management meetings but may not be in a position to make the best use of the opportunities that these afford.

In the Ministry of Agriculture, the documentation center is part of a miscellaneous group of services that includes field services for experimentation and reports to the senior agricultural superintendent. This confirms observations within the agricultural community that documentation has a very low organizational priority. The challenge for the library in the Ministry of Agriculture is to convince its management that effective research needs access to well-organized scientific and technical information services and that these services must be located organizationally where they will have the greatest impact.

Personal Contacts

Personal contacts between researchers are very important and are the outcome of visits, attendance at meetings, interaction with visitors, and use of scientific literature. Greater use of these contacts might be expected in environments where there are no effective formal information mechanisms. Without a functioning library or information service, scientists rely on

their own sources. However, the experience at MSIRI suggests that personal contacts may also flourish in an institution with well-organized information services. A good collection of scientific literature can, it seems, be used by a researcher to build extensive networks of personal contacts that can later largely replace the library for certain types of information.

Management Support

The effectiveness and productivity of a documentation service is largely determined by the amount of support it receives from managers. Research staff at MSIRI benefit from a well-focused information service that is largely the result of

a long-term commitment to information issues by the institute's management. Ensuring that management approaches similar to that of MSIRI are implemented elsewhere is a challenge for both research managers and information specialists.

Technology Transfer

Models developed for information units in large countries need to be studied and adapted to local conditions in small countries. For example, in Mauritius there is great enthusiasm for introducing direct

on-line connections to international databases. The cost-effectiveness of this approach needs to be evaluated in relation to newer developments in information technology such as CD-ROM.

Research Project Information Systems

At present it is not easy to locate information about current research programs. Annual reports and other organizational publications, especially in the public sector, are often of little help as sources of information about current research programs and projects. A more reliable channel to keep abreast of research in progress is through discussions with scientists.

Systems that monitor and track current research projects would also be useful sources of information if they were available.

There are proposals from FARC to create a Mauritius Agricultural Research Management Information System (MARMIS). MSIRI has an in-house computerized sys-

tem for tracking its research and development program, and there is also a CARIS focal point for Mauritius at the university. The main problem appears to be a lack of coordination and even compatibility be-

tween the different systems that exist or are proposed for managing research projects. Resolving such inconsistencies should be a key component of proposals for the future.

Training for Information Work

The ability to respond effectively to demand for research information requires that information staff have both subject knowledge and adequate training in information work. The experience in Mauritius has highlighted the need for trained staff in each documentation center. Although there are staff in each center with elementary training at present, it is generally insufficient for the work that they are required to do. Greater attention to defining the training needs of these individuals

is a necessary first step in improving the various services.

Mauritius has made considerable advances in establishing information services and facilities. Given the importance and complexity of the information function, further training of information specialists combined with better communication between researchers and information specialists will allow Mauritius to make the most of what is now available.

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