

# Planning and managing forestry research: guidelines for managers

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by  
**Hans M. Gregersen**  
**Allen L. Lundgren**  
and  
**David N. Bengston**



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## FORWORD

This publication is the product of sustained consultation and cooperation with a representative sample of forestry research directors in both developed and developing countries over a period of three years. It has been prepared in response to requests, in particular from developing countries, for a comprehensive document on the planning and management of forestry and forest products research.

The publication comes at a time of mounting concern about the future of the world's forest resources and of growing interest in establishing and managing appropriate research programmes in an effort to find solutions to such concerns.

The distinguishing mark of sound research is in anticipating needs rather than responding to problems as they arise. Such anticipation must be followed by good planning and management if research is to be internally efficient and externally effective.

In attempting to provide a comprehensive document on the subject, in-depth treatment of some of the topics has had to be sacrificed. This will be put right in the coming years when we intend to produce supplementary publications dealing with the financing and budgeting of research programmes, training of research staff at all levels, purchasing of equipment, management of local networks, integration of a well-funded international research initiative with the rest of a national research programme and with other related topics.

The present publication, therefore, is the first in a planned series on forestry research, and is indicative of FAO's substantially increased commitment and support to the subject worldwide. Recipients of the report are invited to write to us in this Division giving their suggestions as to how best we can serve their interests through our publications and other means at our disposal.



J.P. Lanly  
Director  
Forest Resources Division  
Forestry Department

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## AUTHORS' PREFACE

These guidelines represent a cooperative effort that goes far beyond that of the authors. A great many researchers and research administrators contributed their insights and experiences. Choice of topics and the relative emphasis given to each was based on both formal surveys of research administrators and informal discussions with a variety of individuals involved with various aspects of research planning and management.

Some of the formal surveys that contributed to the design of the Guidelines include:

- a survey of forestry research planning and evaluation in developing countries, undertaken by the University of Minnesota in collaboration with the International Union of Forestry Research Organizations (IUFRO) (Gregersen 1984);
- a survey of factors influencing research capacity in forestry research organizations in developing countries, undertaken by the University of Minnesota in collaboration with IUFRO (Bengston 1986b, Bengston and Gregersen 1988);
- a survey of research directors in the Asia-Pacific region, undertaken by the East-West Center (Lundgren, Hamilton and Vergara 1986);
- a survey of research organizations in developing countries that are members of IUFRO, undertaken by the International Task Force on Forestry Research (ITFFR) as background material for the Bellagio II (Wiston House) meeting (ITFFR 1988, Gregersen 1988);
- regional surveys undertaken by members of the ITFFR (Bellagio II Task Force), published as background papers to the main report of the Task Force (e.g., deCamino 1988, Iyamabo and El-Lakany 1988, Huguet 1988, Nor and Ahmed 1988);
- numerous FAO surveys and studies (see FAO studies cited in bibliography);
- a survey of participants in the International IUFRO Workshop on Management of Forestry Research; Farnham, U.K., April, 1989;
- a survey of, and consultations with, heads of forestry research organizations from African countries during the IUFRO Workshop on Forestry Research Management, Nairobi, June-July, 1989; and at the FAO Expert Consultation of the Asia-Pacific Network on Forestry Research, Bangkok, 22-25 August 1989.

In addition to the surveys and studies, we had the benefit of advice from an informal advisory group consisting of Dr. Robert Buckman, Dr. George Holmes, and Dr. Ronnie de Camino. We wish to thank them and also the FAO staff members who made valuable contributions to development of the Guidelines--Haluk Hilmi, Jean-Paul Lanly, and Larry Roche. Thanks also to Oscar Fugalli, Dominic Iyambo, and John Palmer, of the IUFRO/Special Programme for Developing Countries, and to Howard Elliot at ISNAR. A special note of appreciation is due to Clara M. Schreiber who helped in organizing and editing the manuscript and who typed many drafts of it.

We also wish to thank all the other individuals who provided guidance and input. Hopefully, we have adequately reflected this input in the Guidelines. Any shortcomings remain, of course, the responsibility of the authors.

## Acronyms and Abbreviations

APFC	Asia-Pacific Forestry Commission
ASEAN	Association of Southeast Asian Nations
CARE	Cooperative for American Relief Everywhere
CATIE	Centro Agronomico Tropical de Investigacion y Ensenanza
CGIAR	Consultative Group on International Agricultural Research
CIAT	Centro Internacional de Agricultura Tropical
CSIRO	Commonwealth Scientific and Industrial Research Organization
CTFT	Centre Technique Forestier Tropical (France)
DANIDA	Danish International Development Agency
EEC	European Economic Community
ERR	economic rates of return
FAO	Food and Agriculture Organization of the United Nations
F/FRED	Forestry/Fuelwood Research and Development Project
FINNIDA	Finnish International Development Agency
FORS	Forestry Resources Systems Institute
FRIM	Forestry Research Institute of Malaysia
FRIN	Forest Research Institute of Nigeria
FRO	forestry research organization
GTZ	German Agency for International Development
ICRAF	International Council for Research on Agroforestry
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IDRC	International Development Research Center
IITA	International Institute of Tropical Forestry
ILCA	International Livestock Centre for Africa
ILO	International Labour Organization
ISNAR	International Service for National Agricultural Research
ITFFR	International Task Force on Forestry Research
IUCN	International Union for Conservation of Nature and Natural Resources
IUFRO	International Union of Forestry Research Organizations
JICA	Japanese International Cooperation Agency
KEFRI	Kenya Forestry Research Institute
LAN	Local Area Network
LF	logical framework
LKS	lesser known species
MAB	Man And the Biosphere Program
MADELEÑA	Regional Tree Crops Production Project (of CATIE)
MUCIA	Midwest Universities Consortium for International Activities
NFTA	Nitrogen Fixing Tree Association
NGO	nongovernmental organization
OFI	Oxford Forestry Institute
PBS	Program Budgeting System
R&D	research and development
SAREC	Swedish Agency for Research Cooperation with Developing Countries
SCFER	Southeastern Center for Forest Economics Research
SEARCA	Southeast Asian Center for Graduate Study and Research in Agriculture
SPAAR	Special Programme for African Agricultural Research
SPDC	Special Programme for Developing Countries (IUFRO)
SSE	small-scale enterprise
TAC	Technical Advisory Committee

TFAP	Tropical Forestry Action Plan
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
USLE	Universal Soil Loss Equation
WERD	Wood Energy Research and Development
WRI	World Resources Institute

## Introduction

Research dealing with tropical forestry and forest products has produced many important benefits. For example, over the past 15 years research in Brazil has resulted in a more than doubling of yields of certain eucalyptus species. Similarly, research undertaken in Malaysia has contributed to the 5.5 fold increase in rubber yields since 1920. Research in Colombia, the Philippines and elsewhere has opened up possibilities for use of a broad array of tropical hardwoods in the production of critically needed paper supplies. Research in the natural tropical forests of the world has resulted in the identification of a number of important sources of medicines and in the identification of means for sustainable, productive use of the tropical forests and conservation of the gene pool which the world may need for future survival.

Expanded support for research in developing countries could result in a significant increase in benefits flowing from forests and trees. Such expanded support for research must include direct support for research programs, as well as investment in equipment and facilities and in expanded institutional support, for example, in training and education.

The present paper contributes to meeting the training and education needs in research organizations. It provides an overview of the elements involved in planning and managing forestry and forest products research. We hasten to add that no attempt is made here to suggest that what follows represents the only way of looking at planning and management.

At the same time, even though details of the organization and functions of management may differ from situation to situation, most experienced managers would probably agree that there are some basic principles, some basic components of research management which are useful to know, no matter how one is going to manage a program and organization. These are the principles and components of management which hopefully have been identified and are discussed in the Guidelines.

### THE NATURE OF FORESTRY RESEARCH

When we talk about "planning and managing forestry research," we are defining research to cover experimentation (physical manipulation with control), and other types of controlled inquiry not involving physical manipulation, such as research in economics and other social sciences (Ackoff et al. 1962). We are referring to a continuum of scientific inquiry from basic research through applied and adaptive research.

A number of terms are used to describe various kinds of research. In our use of the terms, **basic research** is done to understand basic processes and to provide basic knowledge that can be used in a wide variety of applied research. **Applied research** is done to solve specific problems, and to produce knowledge and technologies that can be used in practice. **Adaptive research** is the most applied, and involves taking applied research results from elsewhere and adapting them to a specific situation or environment. Most research organizations also conduct some **strategic research**, which is inquiry aimed at defining research strategies and priority areas in which specific applied research projects should focus.

Forestry research is broadly defined to include all types of research which relate to understanding the basic nature and functioning of trees and forests, the role of trees in land use, and how that role can be improved or made more effective. As such, forestry research includes social science inquiry as well as the more traditional biological and physical science inquiry. Throughout most of these guidelines, when we refer to forestry research, we also mean to include forest products research, unless indicated otherwise. The term FRO (standing for forestry research organization) includes both forestry and forest products research organizations.

In most cases the research manager will have to deal with all of these types of research. To do this effectively, he or she ideally should have some background in research and some understanding of the scientific method and the tools, techniques and methods used in scientific inquiry in the field of forestry. Research managers need experience and/or training in organizational management and administration. In addition, the research manager or administrator also must understand the politics of science, and the ways in which he or she can convince politicians and the public of the benefits from science.

### **AN OVERVIEW OF THE FORESTRY RESEARCH MANAGEMENT PROCESS**

Planning is often viewed as a separate function apart from management. In many cases it can be. However, we view planning as an on-going function within the overall management process. In most cases there is an existing forestry research management structure, and it is within this structure that planning for change will (or should) take place, not as a one-time activity, but as a continuing function of management. In cases where there is no existing research framework--where an entirely new research institution is being considered --one could argue that planning takes place, at least initially, as an independent function. However, this is the exception rather than the rule. Thus, in the following discussion, we consider planning an integral part of management.

One could organize a set of guidelines for forestry research management (including planning) in a number of different ways. After considerable discussion, it was decided to organize the topic here in terms of the normal process of "management by objectives." In this approach to research management the basic process involves:

**A. Setting goals and objectives to be accomplished in a given amount of time, and developing internal policies. Specific tasks include:**

- developing or maintaining external relations with client groups and public decision makers that influence national policy affecting forestry research and that define the needs to which research should respond;
- setting goals and objectives that are clearly articulated in an operational fashion and that are consistent with existing laws, regulations and mores; and
- setting internal policies to guide the functioning of the organization and its employees in achieving the goals.

**B. Planning how to achieve the stated objectives. Major steps include:**

- assessing existing research capacity and monitoring and evaluating performance;

- determining gaps between existing capacity and that needed to achieve objectives;
- designing a program and activities to achieve the objectives; including choice of organizational options, research priorities, and decisions regarding personnel, program size, location, and timing;
- developing a program budget; and
- securing financing for the program.

**C. Implementing the plan and managing research;** this includes such functions as:

- establishing appropriate accounting procedures;
- managing people--recruiting and motivating scientists, technicians, and support personnel, and monitoring and controlling their performance;
- training and educating personnel;
- working with outside research groups--networking, twinning, etc.; and
- managing and allocating equipment, facilities and infrastructure.

**D. Disseminating the results of the research so they may be put to use, including:**

- documenting/publishing/distributing research results,
- interfacing and coordinating with extension, education and training institutions.

In reality, this management process is not a neat set of sequential steps. Rather, in an existing organization it is a dynamic process, where objectives and priorities change over time as goals, resources and constraints change. In the same way, planning is an on-going process, where needs, capacity, and performance are being monitored and evaluated formally and informally on a regular basis and adjustments in plans and activities take place incrementally in response to the results of such evaluation. In discussing the management process, this dynamic element needs to be kept in mind.

To implement the above management-by-objectives process, managers have resources and constraints to deal with. Specifically, at any given time they have:

- people (scientists, technicians, support staff);
- operating funds;
- facilities, equipment, and other infrastructure; and
- institutional constraints that have to be met--laws, mandates, and higher level policies, cultural constraints, and so forth.

With regard to these resources and constraints, the task of management is:

- to deploy available resources in an effective and an efficient way within the bounds of existing constraints;
- to monitor and account for expenditures of funds and available resources to those who provide the funds;
- to increase the quality of existing resources, e.g., through staff training, development of increased international contact, improved maintenance of equipment and facilities, etc; and
- to increase the availability of resources and remove the constraints which particularly hinder the achievement of objectives. This management can do by insuring closer concern with client objectives and needs, building political support for research, increasing the relevance of work to potential funding agencies, becoming more involved with the international community of researchers and funding agencies, and so forth.

#### **SCOPE OF THE GUIDELINES AND HOW THEY CAN BE USED**

We have attempted to cover briefly all the topics that are important considerations in managing a research program and organization. Obviously, if detailed discussion of every topic had been included, the result would have been an unmanageably large document. Thus, we have tried to introduce in a practical way the essence of what a research manager should know about each topic. The reader is encouraged to contact the FAO Forestry Department or the authors for more detailed references and documentation concerning specific topics.

It is recognized that these Guidelines will be used primarily by students and professionals moving into management positions. As such, the text has been oriented toward this group --people without much experience in research management. It has been organized in such a fashion that individual chapters can be used as short modules in training courses and workshops or as a whole in independent study.

The Guidelines are organized into five main parts, with a number of chapters in each part. Part I deals with the present forestry research situation in developing countries. The purpose of this part is twofold: First, it provides a perspective on the overall forestry research situation against which the reader can compare his or her particular situation. Second, it provides the research manager with some "ammunition" which can be used in arguing for a strengthened forestry research system. Specifically, we discuss a number of positive contributions of forestry research to development in specific countries. While ideally each manager would have such impact assessments for his or her own country, in reality most do not have them. Thus, the next best thing is to use real examples from other, generally similar countries.

Part II deals with the policy environment and organizational structure of a research organization. Desirable interactions between research manager and policy maker are explored; and the pros and cons of different organizational structures are discussed.

Part III gets into the planning of forestry research programs and the elements which go into such planning. Several different types of planning--strategic, program, and annual planning and budgeting--are discussed and their importance for different purposes is analyzed. Financing of research organizations and programs also is discussed.

Part IV deals with the implementation of forestry research programs. Topics include: managing researchers, creating appropriate incentives, research leadership, training and education, networking, and support services.

Finally, Part V deals with the communication of research needs from client or stakeholder groups to researchers and communication of research results to users, two of the most critical linkages that must be dealt with in an effective program.

# PART I

## The Present Situation in Developing Countries<sup>1</sup>

This part of the guidelines sets the stage for the rest of the text. It puts in perspective the existing forestry and forest products research system in developing countries. Chapter 2 provides an overview of the contributions which forestry research has made to development. Chapter 3 provides a brief summary of the dimensions of the existing forestry research system in developing countries. Chapter 4 then lays out, in general terms, the factors which are determining the capacity of the system, and the research organizations within it, to carry out effective research.

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<sup>1</sup>This Part is adapted from Gregersen (1988) and ITFFR (1988).

## Contributions of Forestry Research To Sustainable Development

There is every reason to believe that forestry research and forest science fits Nobel Prize winning economist Robert Solow's theory that

*"technology--broadly defined as the application of new knowledge to the production process--is chiefly responsible for expanding an economy over the long term, even more so than increases in capital or labor. And since basic and applied research is often the prelude to the birth of new technologies, the work of researchers has increasingly been perceived to have economic--not merely intellectual and cultural--significance" (Garfield 1988).*

To achieve a sustainable development, a country must be able to develop, adapt, and implement new technologies to meet changing needs, resources, markets, and social and other conditions. In fields such as forestry and agriculture, national research systems play a key role in meeting this need (ISNAR 1987b). The diverse, often highly localized conditions encountered in various parts of a country require a strong national research capability for conducting localized studies to develop and adapt appropriate technologies to meet these diverse local needs (Bengtsson 1980, Swaminathan 1980). National leaders need to be convinced that forestry research has a key role to play in achieving a sustainable national development. However, if forestry research is to generate widespread support as an important element in sustainable development programs, it must identify and publicize the contributions that it can make to that development.

Few quantitative evaluations have been made of the contributions of forestry research to development and conservation. This dearth of solid evidence of such contributions probably hurts the funding potentials of many forestry research organizations (FROs). While it is not possible in many countries to undertake such evaluations without importing experienced evaluation researchers, it is possible to: 1) put together some good specific qualitative examples of contributions and successes, and 2) bring in as additional support quantitative and qualitative studies from other countries that indicate research successes in fields similar to the ones for which funding is being applied locally.

This chapter deals with point 2 above, by providing some quantitative evidence on the contributions of forestry research and providing a number of examples of contributions which can be used as support in presentations to planning boards, finance ministries and other groups determining the budgets of FROs.

### QUANTITATIVE EVIDENCE OF POSITIVE ECONOMIC IMPACTS OF FORESTRY RESEARCH

Since much forestry research is similar to agricultural research, some indications of the economic contributions of forestry research can be drawn from the great volume of documentation on the value of agricultural research. Ruttan (1982) has summarized the

results of this work. The estimated economic rates of return to investment in agricultural research vary widely, but generally are over 20 percent.

Studies of the economic rates of return to investment in forestry and forest products research are available, mainly for temperate countries. Results of various studies are summarized in Table 2.1. As indicated, average rates of return are in the 9 to 111 percent range, and benefit to cost ratios ranged between 15 to 1 and 34 to 1.

Table 2.1. Economic impact evaluations of forestry research.

Study	Research Evaluated	Measures of Economic Impact		
		Marg. ERR(%) <sup>a/</sup>	Avg. ERR(%) <sup>b/</sup>	B/C Ratio <sup>c/</sup>
<b>Wood Products and Engineering Research</b>				
1. Bengston (1984)	Structural particleboard	27-35	19-22	
2. Bengston (1985)	Lumber and wood products		34-40	
3. Haygreen et al. (1986)	Timber utilization		14-36	
4. Brunner & Strauss (1987)	Wood preservation			15/1
5. Seldon (1987)	Softwood plywood	300+		
<b>Forest and Tree Management Research</b>				
6. Levenson (1984)	Tree improvement			34/1
7. Bare & Loveless (1985)	Forest nutrition		9-12	
8. Chang (1985)	Growth and yield model			16/1
9. Westgate (1986)	Containerized seedlings		37-111	
10. Pee (1977)	Rubber production		22	

<sup>a/</sup>Marginal economic rate of return (ERR), i.e., the ERR on additional funds invested.

<sup>b/</sup>Average economic rate of return, i.e., the ERR on total investment; ranges given reflect different sets of assumptions.

<sup>c/</sup>Benefit to cost (B/C) ratio, when benefits and costs are both discounted back to a common point in time.

There are many reasons to believe that societal returns to public investment in research related to tropical forestry will be at least as high as in the case of temperate forestry research. In fact the one study available for the tropics (Pee 1977) produced an estimated rate of return on investment in rubber research in Malaysia of 22 percent. This is in the middle of the range of returns indicated for temperate forestry research.

Some argue that rates of return on investment in forestry research will be higher for the tropics because the potentials for gains in such research areas as species selection and breeding could be larger due to: 1) the higher potential for greater per unit biological gains in tropical environments, and 2) the existence of a larger human population that potentially could benefit from implementing and utilizing the results.<sup>1</sup>

This argument is supported further if one accepts the parallels between forestry and agricultural research, since the rates of return for agricultural research are generally higher for developing (mainly tropical) countries than for developed countries.

<sup>1</sup> We stress the fact that we are talking about economic rates of return to society and not financial rates of return based strictly on market priced goods and services. Thus, adoption of faster growing species by the rural poor to produce nonmarketed fuelwood and other goods and services for their own use would be included as benefits from society's point of view, even if such benefits do not show up directly in the market place.

Forest products and utilization research tend to be generic, and in most cases results are readily transferable from one environment to another with some adaptation. Thus, there is little reason to believe that rates of return on investment in such research would be any less for developing than for developed countries.

What can one conclude from the various studies that are available? The relatively high rates of return on investment in forestry research indicate that such investment has been productive.

### OTHER IMPACTS

There are many benefits derived from forestry research that go beyond traditional economic returns to research itself. One needs to keep these benefits in mind as additional reasons for establishing and supporting a strong forestry and forest products research capacity. For example, even if the basic technology a country needs can be imported, the country still needs research capacity to screen and adapt such technology.

*"A country without an indigenous scientific or technological capacity has no means of being aware of its own needs, nor of the opportunities existing in science and technology elsewhere, nor of the suitability of what is available for its own needs."* (United Nations 1971)

This point is supported by Evenson and Binswanger (1978), who suggest:

*"A ...barrier to direct transfer is the frequent absence of research capacity at the applied level. As we have seen, there is a strong complementarity between the capacity for applied research and the ability to screen technology, and even direct transfer may be difficult without the former."*

This point needs to be made quite strongly to governments and potential and actual funders of research.

### EXAMPLES OF BENEFITS FROM FORESTRY RESEARCH

This section provides some specific examples of benefits from research which can be used in arguing the case for research funding. The examples are taken from work done by the International Task Force on Forestry Research (1988) and Spears (1988). The examples are divided into five categories, to reflect five major areas of forestry related research.

#### BENEFITS FROM AGROFORESTRY AND WATERSHED AND DRYLAND MANAGEMENT RESEARCH

\*\* Singh, Panday and Tiwari (1984) researched energy interrelationships for two Himalayan villages. They found that animals accounted for more than 70 percent of total energy input into the farming system. Beyond this, the animals themselves depended on the forest for 87 percent of their fodder. To sustain the existing system, more than five hectares of forest were needed per family, while the actual forest available was slightly over one hectare.

\*\* Work by Flemming (1983) indicates that improved harvesting and management practices can increase significantly the yields from grass and forest grazing lands in Nepal. For example, the increase was from 1,200 to 6,000 kilograms per hectare per year for grasslands and from 3,000 to 6,000 kilograms per hectare per year for forest lands.

\*\* Researchers have developed a method of predicting the influence of trees upon landslides (Hawley 1988). Reforestation can reduce shallow soil landsliding by at least 70 percent. The occurrence of landslides

dramatically increased when forest areas were converted to pastures; over 60 percent of the converted areas had landslides. Productivity on these landslide areas was reduced by 20 percent to 30 percent for over 80 years following the landslides (Trustrum et al. 1984). This research did not follow the effects downstream—although research elsewhere suggests that landslides that occur into channels are major sources of sediment to downstream areas.

\*\* Achliil (1984) reports 48 percent, 20 percent, and 17 percent reductions in peak monthly runoff, annual sediment transport, and peak monthly sediment transport, respectively, caused by improved farming, terracing, and tree planting in the Solo watershed on Java, Indonesia.

\*\* Wiersum (1984) studied surface erosion rates under different agroforestry systems in Java, Indonesia. This led to better understanding of the role of trees, in combination with crops, in protecting the soil. Soil surface management was recommended—trees without soil conservation measures beneath them will not adequately control erosion.

\*\* Openshaw (World Bank 1986a) summarizes the potential of improved management of natural savannah woodlands to contribute to tree fodder and fuelwood needs in the Sudan. Research has shown that, in many cases, application of simple management techniques, such as control of harvest and burning, can more than double sustainable outputs from less than one to two cubic metres per hectare per year (Winterbottom and Hazlewood 1987). Costs can be very low, creating cost-effective management opportunities. Similar results have been demonstrated for Niger and other countries.

\*\* CATIE researched combinations of pasture and various tree species, such as *Cordia alliodora* and nitrogen-fixing *Erythrina poeppigiana* (Enriquez 1983). The presence of Erythrina resulted in a 70 percent increase in total grass and protein production. Other similar studies exist.

\*\* Kang and Wilson (1987) have researched alley cropping in Nigeria, involving production of maize intercropped with rows of *Leucaena leucocephala*. Maize yields were consistently higher when Leucaena prunings were maintained on the fields. When nitrogen was added in addition to the prunings, yields increased even further.

\*\* A well-documented case is the shelterbelt program in the Maijja valley of Niger. Use of windbreaks resulted in an average 17 percent increase in crop yield, despite the fact that land was taken out of crop production for growing the shelterbelts. In addition to the protection benefits, the shelterbelts provide fuelwood estimated at 52 cubic metres every four years per linear kilometre of windbreak, and fodder estimated at four tons every four years per linear kilometre of windbreak (Rorison and Dennison 1986; Long and Dennison 1986).

\*\* Research by El-Lakany (1987) and others in Egypt has demonstrated yield increases as high as 47 percent for maize grown with windbreak protection. Protection benefits vary widely by crops.

\*\* A shelterbelt research program in Nigeria was initiated in the '70s under IDRC sponsorship. At the expiration of the IDRC project in 1984, the Nigerian government was so impressed by the results achieved and the effects of shelterbelt on agricultural yield, livestock production and amelioration of the living conditions of the rural communities living in the immediate vicinity of the belts, that extra-budgetary funds have been provided to continue the research (personal communication, P. Kio).

\*\* Farnsworth (1976) has researched the effects of shade or shelter trees and found that cattle with access to shelter gained 676 grammes per day, while the control group (without shade) only gained 472 grammes per day. Similarly, research has found that under high temperatures, milk yields increase when cattle have access to shade.

#### CONTRIBUTIONS OF RESEARCH IN NATURAL TROPICAL FOREST CONSERVATION AND MANAGEMENT

Examples of past research in these priority areas show the significant impacts that can be obtained:

\*\* Winterbottom and Hazlewood (1987) have summarized research being undertaken in the Gusselbodi forest in Niger. This research has shown that simple, low-cost management techniques in the natural forest, such as early burning and careful timing of lopping and felling, can produce three cubic metres of fuelwood per hectare

per year, or roughly six times the yield that is generally assumed for unmanaged forests. At the same time, a number of other products results (gums, fodder, medicines).

\*\* Research by Anderson et al. (1987) documented the significant economic and ecological roles that the naturally occurring babassu palm (*Orbignya* spp.) plays in the Maranhao state of Brazil. Some 64 percent of total cash and noncash income in three municipios of Maranhao came from babassu products during the peak harvest period of October to December. This has policy implications in terms of protection and management. Findings led to management guidelines for the palm areas.

\*\* Based on his research, Repetto (1988) notes that nonwood forest products brought in US\$120 million in 1982 in Indonesia. Most of the associated harvesting and production activity involved employment in local economies, whereas much of the wood export value was retained by timber companies as profits.

\*\* Two major anti-cancer compounds derived from the periwinkle plant, which only occurs naturally in Madagascar. With these drugs, there is now a 99 percent chance of remission in children suffering from lymphocytic leukaemia and a 58 percent chance of remission from Hodgkin's disease.

\*\* Based on previous experiences in improving natural forests, gathered in several West African countries between 1945-1965 CTFT and SO.DE.FOR started in 1976 a research program on different management systems on three types of Forest of Cote d'Ivoire. In subsequent years this program was extended to Central African Republic and French Guyana. This long-term research work has already given some indications on the dynamics of tropical moist forest and early results on response to interventions such as thinning and selective logging. This research should lead in the future to simple silvicultural prescriptions applicable to large areas (personal communication C. Cossalter).

\*\* Many otherwise obscure insect species in the tropics have major economic importance. For example, the oil palm (*Elaeis guineensis*) is pollinated in the wild in Africa by a weevil (*Elaeidobius kamerunicus*). The oil palm was introduced in what is now Malaysia in 1917 without the weevil and thus required costly, inefficient hand pollination. In 1980-81 the pollinator was collected from its native habitat in the forests of the Cameroon and brought to Malaysia after a six month quarantine; significant improvement in pollination resulted, with the percentage of fruit set increasing by 8 to 28 percent. After considering other factors of production, it is estimated that the increase in national oil palm production could reach 12.3 percent (Salleh Mohd. Nor, personal communication). The improvement was worth some US\$50 to US\$60 million in foreign exchange in the first year alone (Goodland 1985).

\*\* Research by Dourousseau (1978 as cited in Falconer 1987) showed that in the Ucayali region of the Peruvian Amazon, some 85 percent of protein consumed came from wild game and fish. Similar results were obtained in a study of the forest from Botswana (Butynski and von Richter 1974).

## CONTRIBUTIONS OF RESEARCH IN TREE IMPROVEMENT AND TREE BREEDING RESEARCH

Examples of past research include the following:

\*\* FAO's project on genetic resources of the arid zones, focussing on woody species, is a worldwide effort. The initial eight countries involved collected seed, explored natural ranges of species (mainly *Acacia* and *Prosopis* species) conserved seeds on site, evaluated materials, did field trials and made seed available to other countries. Over the years 1980-1987, a total of 281 well-documented seedlots (provenances) of 43 species were explored, and seed distributed for testing and conservation. Work was undertaken in at least one institution in some 17 countries. The potential yield gains from use of results of this work are significant.

\*\* Research has shown that great gains in productivity can be made simply by identifying and selecting the seed source most adapted to planting locality. In provenance trials in Nigeria with *E. camaldulensis*, the best provenance had a mean annual increment of 17.3 cubic meters per hectare, while the poorest only had 5.1 cubic meters (FAO 1979). In the Congo and Brazil, the yield of eucalyptus plantations has been increased by up to 80 percent by selection of the best seed sources (Chaperon 1978; Brune and Zobel 1981). FAO, CTFT, DANIDA and other groups have established seed procurement systems around the world which aim at improved seed selection, exchange and distribution.

\*\* Panday (1982) has shown the great variation in production of dry matter in different fodder tree species, which in the Himalayan region varies from as low as five to seven kilograms to as high as 50-70 kilograms annually per tree. There are significant implications in terms of tree selection and selection of provenances for given species.

\*\* Research in India by Pathak and Patil (1982) found that the difference in forage production between the best and worst provenances of *Luecaena leucocephala* over a three-year period were around 70 percent.

\*\* Much useful work on nitrogen-fixing trees has been done by various countries (Senegal, Egypt, China) and various groups including CTFT, NFTA, IITA, FAO and others. Dommergues (1987) indicates the importance of research in this area. Certain trees can fix significant amounts of nitrogen in the humid tropics, substituting at least partially for purchased nitrogen fertilizers or providing a source where access to fertilizers is limited.

\*\* Genetic improvement research over the past 15 years in Brazil has resulted in doubling eucalyptus yields from 33 to 70 cubic meters per hectare per year (Aracruz Florestal).

\*\* Research has contributed in a major way to the five-fold increase in rubber yields achieved in Malaysia since 1920. The estimated rate of return on investment in rubber tree research in Malaysia is 22 percent (Pee 1977).

\*\* FRIN has had major achievements in the area of vegetative reproduction of *Triplochiton scleroxylon*, an indigenous species threatened with over-exploitation almost to the point of extinction. Due to difficult phenology (it fruits every five years), the only reliable means of mass regeneration in plantation is by vegetation propagation, a system now perfected for the species and being extended to equally valuable but silviculturally difficult indigenous species, particularly the West African mahoganies. The project is the nucleus of the proposed network of West African Hardwood Improvement Project being considered for sponsorship by the EEC (personal communication P. Kio).

\*\* Large-scale trials of mechanised afforestation in the semi-arid zone of Nigeria has been attracting tremendous interest inside and outside the country. As a strategy to save the remaining moist forest stands of the south, emphasis for large-scale plantations has shifted to the Savanna belt of Nigeria which makes up over 75% of the country's land area. The project is sponsored by the Japanese International Cooperation Agency (JICA) and plans to set up 690 ha of plantation of pines (*Pinus caribaea*, *P. oocarpa*), eucalypts (*E. citriodora*, *E. cloesiana*, *E. camaldulensis*, and *E. saligna*) and some indigenous savanna species (*Prosopis africana*, *Parkia biglobosa*, *Acacia* spp., and *Khaya senegalensis*). The project is in its third year of operation and has executed several espacement and land preparation experiments, some of which are already showing astonishing results in terms of highly improved growth rates (personal communication, P. Kio).

\*\* A program of eucalyptus selection and breeding initiated in the early 1950s by CTFT in the Congo has led to improved commercial plantations that are planned to produce several million cubic meters of wood per year, mainly for pulp and paper. Mean annual growth per hectare is in the 25-40 cubic meter range (L. Huguet, personal communication).

\*\* In the Tree Seed Centre programme for developing countries of Australia's CSIRO, estimates were made of the value of timber and areas likely to be planted with improved seed in nine developing countries. Financial internal rates of return on incremental investment in the most productive seeds were calculated (Development Digest 1988). They ranged from 22 percent in Lesotho to over 80 percent at Dongmen, China. In addition to financial benefits from timber, other benefits included improved tree form, earlier harvest possibilities, reduced maintenance, and improvements in agroforestry and soil conservation results.

\*\* OFI has promoted worldwide distribution and use of Central American tropical pines through its research network. Through the network, OFI has helped collect, distribute, test, and evaluate various genetic stocks of these pines. By exchanging seed, standardizing experimental design, and developing information systems, the network has enabled countries to match the genetic material to a site, thereby increasing plantation yields.

## CONTRIBUTIONS OF UTILIZATION RESEARCH

Examples of useful research include the following:

\*\* Economics research by Reiche and Campos (1986) shows that drying coffee in Costa Rica with electricity is about six times—and using diesel fuel is three to four times—more expensive than using wood. This type of research has significant direct implications for fuelwood and other energy markets and indirect implications for policies on forest protection and energy in Costa Rica.

\*\* Research has permitted Malaysia to increase the number of species it uses commercially from 100 to more than 654 in 100 timber groups (Salleh Mohd. Nor, personal communication). Similar progress in species utilization has been made in Costa Rica and other countries. Research in the Philippines, Colombia and several developed countries has vastly increased the range of species from the natural tropical forest which can

be utilized in paper production, thus opening up opportunities for productive, sustainable use of previously unused resources.

\*\* Ten years ago, rubberwood was unknown as a commercial species in Malaysia. Research on species properties, processing, protection and utilization led the way to markets for rubberwood. As a result Malaysia exported over 258,000 cubic meters of rubberwood in 1987 with a value over M\$37 million (Salleh Mohd. Nor, personal communication).

\*\* As one of the oldest research institutes in West Africa, FRIN has taken the lead in popularizing the use of lesser known species (LKS), having expanded the resource base of the timber industry twofold by conducting research into the LKS properties (strength, seasoning characteristics and durability) at first in collaboration with Princes Risborough Laboratory in Britain and, from the 1970's, in its own laboratory at Ibadan.

\*\* Research in six countries reported by Fisseha (1983) indicates that the contribution of forest-based small-scale enterprises (SSEs) to total SSE employment varies between 13 and 34 percent. Their contribution to total value added varies between 16 and 47 percent, and to total value of production from 14 to 49 percent. In all cases forest-based SSEs were one of the more important sectors.

\*\* Some of the developed country technologies which are being considered or applied because of potential rapid payoffs in tropical countries through adaptive research include:

- \* power backup rolls for veneer production, which permit higher veneer recovery and peeling of difficult species;
- \* press drying in paper making, which uses short fiber hardwoods and consumes less energy;
- \* wood preservation to overcome decay and termite problems;
- \* improved wood engineering for cost savings and other benefits in housing production;
- \* developing uses for lesser known species;
- \* waferboard and other reconstituted wood products technologies permit use of many different species and treatment for fire, decay, and insect resistance; and
- \* improved harvesting and transport technologies which can lower costs and reduce environmental damage from logging.

\*\* Bengston (1984, 1985) found average economic rates of return (ERR) of 19-22 percent for structural particle board research and 34-40 percent for lumber and wood products research in the United States. Haygreen et al. (1986) calculated that public investment in all timber utilization research in the United States had economic rates of return between 14 and 36 percent, depending on assumptions used concerning costs to be included. (In the lowest rate, 14 percent, all costs of research on timber management, forest products utilization, and forest products marketing were included).

## CONTRIBUTIONS OF POLICY AND SOCIOECONOMIC RESEARCH

Examples of useful research include the following:

\*\* Kumar and Hotchkiss (1988) show how the progressive encroachment of cultivation into forested areas forces women and other members of farm families to walk increasing distances to gather fuelwood and fodder from trees. This reduces the time that they can work on their farms and reduces farm productivity. As a result, families are forced into a further extension of area under crops to produce enough food, perpetuating a downward spiral of decreasing output from both arable and forest areas.

\*\* Arnold (1987) reviewed selected research on agroforestry from an economic point of view. He considered the influence of relative scarcity of factors of production on farmers' decisions and found that they often maximize returns to labor input rather than capital. Often this is because the opportunity cost of labor is high, and tree growing takes less labor and involves more flexible timing.

\*\* Dewees (World Bank 1986b) researched how farmers in parts of Kenya are conditioned by availability of capital and labor. In areas where labor is scarce, tree growing may take place where the returns per hectare are lower than from other crops, but the returns to labor are some 50 percent greater than from maize production. Reduced risk also entered the picture.

\*\* Research at CATIE shows that returns to farmers can be more than twice as high when pure pasture management using post fences is changed to pasture management using living fences with clumps of trees scattered throughout the pasture (personal communication from R. de Camino).

\*\* Anderson (1987) carried out detailed research on the economics of multipurpose tree species in Nigeria. The results indicate that rates of return can increase from 7.4 to 16.9 percent when soil conservation benefits are included in addition to wood and fruit benefits in agroforestry components, and from 4.7 to 21.8 percent when shelterbelt soil conservation benefits are added to wood benefits (poles and fuelwood) alone.

\*\* An ILO study in 1987 showed that subsidy policies to encourage substitution of kerosene for wood-based fuels were very effective in Addis Ababa, Ethiopia; some 60 percent of the population shifted to kerosene within four years. On the other hand, a World Bank household energy study in 1974 showed that in Senegal it was the more affluent urban households who benefitted from the campaign initiated in 1974 to encourage substitution of butane for wood-based charcoal. At the national level, introduction of liquid propane gas led to savings of only about 16-17,000 tons of charcoal annually, after 13 years of promotion and subsidization. The impact on forest conservation has been minimal.

\*\* A recent study by the WRI (Repetto 1988) reveals that, in Indonesia, Sabah/Malaysia, Ghana and the Philippines, government policies on forest revenue systems and wood-processing industries provided strong economic incentives, which led to accelerated rates of forest depletion and substantial losses of government revenue, due to lack of adequate rent capture from concessionaires. The economic losses due to these policies, in addition to other social and environmental impacts, are enormous.

\*\* Research by Hecht and Schwartzman (1988) indicate that the costs of recuperation of three million hectares of degraded forest land in Acre, Brazil, would be some US\$781 million in direct recuperation costs and some US\$150 million in extractive benefits foregone.

\*\* Santa Cruz (1988) researched the Chilean forestry incentives program (Law 701) and concluded that the financial rates of return on *Pinus radiata* growing are, on average, high enough without incentives to attract investment. However when Law 701 was passed, there were high risks and uncertainties surrounding investment in pine growing, and particularly a lack of secure markets and liquidity of such investment over the first years. The development of the major Chilean pine export business would likely have been delayed a number of years without the incentives to ease the burden of risk and uncertainty.

More examples could be cited. However, the above serve to emphasize the basic point: Forestry research has had a significant beneficial impact through positive economic, social and environmental effects on human welfare. However, research has not been able to keep up with the needs and the expansion of activity involving tropical forest use.

## Dimensions of the Existing Forestry Research System

Many different types of organizations are involved in forestry research in developing countries. There are national research institutes, universities, regional research groups, international research organizations, nongovernmental organizations, industries, and various organizations which carry on informal research as part of the implementation of their programs. Forestry research is carried on by both forestry organizations and nonforestry organizations. Because of lack of data on the latter group, we are forced to limit our discussion to the formally defined national, regional and university forestry research programs and organizations. However, the reader needs to keep in mind that these organizations are merely a subset, albeit an important one, of the total forestry research system.

Two points are relevant here. First, the fact that many nonforestry research organizations work on forestry related problems provides some flexibility in terms of expansion of research activity, i.e., one can look beyond forestry research organizations for competent and experienced researchers to work on various specialized forestry problems. Second, while we will be discussing averages, or mean values in a number of places in this chapter, it should always be borne in mind that differences among countries and among organizations in a given country are great.

### NUMBER OF ORGANIZATIONS BY REGIONS

As indicated in Table 3.1, FAO has a list of 538 organizations in developing countries that work on research related to forestry and forest products (FAO 1986). The largest number of organizations is in Latin America and the smallest in the Near East (see Table 3.1). As mentioned above, the actual number of organizations working on some aspect of forestry research and development (R&D) is much larger than 538.<sup>1</sup> It should be emphasized that a majority of the 538 organizations listed by FAO are small. Some have only one or two persons--sometimes not even trained scientists--working on tropical forestry research problems. So even with 538 organizations, one can see that the research effort is quite small on a global basis in developing countries. This point is supported by the discussion below concerning the low level of support for individual scientists and the generally low levels of research intensity compared with research intensities for agriculture.

In terms of the 85 organizations that provided information to the Bellagio II International Task Force on Forestry Research (ITFFR), 27 percent said there were two or less organizations of all types in their countries working on forestry related research; 58 percent

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<sup>1</sup>For example, a workshop proceedings on strengthening forestry research in Kenya lists some 31 organizations in that country alone that are involved with forestry research and development (Ministry of Environment and Natural Resources 1983). This compares to FAO's listed total for all of Africa of 76 indicated in Table 1. Even though much of the work being carried out by these 31 organizations cannot be considered "research" in the strict sense of the word, their field trials and other efforts all contribute to our knowledge base and thus should be considered within the context of the Tropical Forestry Action Plan (TFAP).

said that there were fewer than five; and three-quarters of the respondents said that they had ten or less (ITFFR 1988).

Table 3.1. Numbers of forestry and forest products research institutions, by major ecological regions, and major geographical regions, in developing countries.

Major Ecological Regions		Africa	Asia and Pacific	Latin America and Caribbean	Near East	Four Regions
Humid Tropics	Compendium*	19	36	51		106
	Total	33	87	105		225
Dry Tropics	Compendium	32	1	3		36
	Total	34	28	14		76
Arid or Temperate zone	Compendium	8	21	54	13	96
	Total	9	77	125	26	237
Total	Compendium	59	58	108	13	238
All regions	Total	76	192	244	26	538

\* "Compendium" refers to those listed in FAO *Forestry Paper 71*, whereas "Total" refers to the numbers in FAO's master list. (Only 44 percent responded to the "Compendium" questionnaire).

Source: FAO. 1987. *Forestry Research in Developing Countries: Status and Trends*. Supplement to Secretariat Paper FO:FDT/87/4, presented at the 8th session of the Committee on Forest Development in the Tropics, Rome, Italy, 14-18 Sept. 1987. Rome: FAO. 43 pp.

### TYPES OF RESEARCH ORGANIZATIONS

Based on responses to a FAO questionnaire returned by 238 organizations (44 percent of the 538 organizations on FAO's master list of research organizations), Table 3.2 indicates that national/provincial public research bodies (107) make up almost half of the total. The next largest category consists of universities (67). Again, it should be pointed out that the FAO questionnaire was sent out only to organizations identified in the "formal" forestry and forest products research system.

Table 3.2. Numbers of forestry and forest products research institutions, by type of institution and major geographic region, in developing countries (238 institutions listed in the FAO Compendium).

Type of Institution	Africa	Asia and Pacific	Latin America and Caribbean	Near East	Four Regions
University	10	15	40	2	67
Forestry Service Branch	12	16	7	2	37
National/provincial research bodies	26	26	48	7	107
Agricultural research institutes	6	—	1	2	9
Private bodies/development projects	5	1	12	—	18
Total	59	58	108	13	238

Source: FAO. 1987. *Forestry Research in Developing Countries: Status and Trends*. Supplement to Secretariat Paper FO:FDT/87/4, presented at the 8th session of the Committee on Forest Development in the Tropics, Rome, Italy, 14-18 Sept. 1987. Rome: FAO. 43 pp.

## NONFORESTRY RESEARCH ORGANIZATIONS DOING TROPICAL FORESTRY RESEARCH

As mentioned, some forestry research is done by nonforestry research organizations. For example, a majority of scientists working on such topics as nitrogen fixing trees were found to be associated with nonforestry research organizations in one survey. In a study of scientists in Asia working on agroforestry research, it was found that some 160 nonforestry organizations in 27 countries report on agroforestry research (Polson and Lundgren 1987). A report for Africa also indicates many nonforestry research institutions involved in various types of forestry research (FAO 1987a).

In some cases, key issue areas have not been researched by any organization. For example, watershed management research has been largely ignored in most countries. It has not fit in agriculture; and it has not fit in forestry and natural resources. Some serious thought needs to be given to the problem of where the important areas of concern in forestry fit institutionally.

In the international arena, ICRAF, which directly addresses agroforestry issues, is not a forestry organization. Only a few of its professional staff are formally trained as foresters. Rather, it is one of a growing number of organizations that address integrated agriculture-forestry issues. The common denominator is trees in land use. IITA, CIAT, ICRISAT, ILCA and other international agricultural research centers also do research related to agroforestry, as do regional organizations such as CATIE and a number of international conservation organizations such as UNEP, UNESCO/MAB, IUCN, World Wildlife Fund, Nature Conservancy, etc. Forestry research has broad linkages and interrelationships with agriculture and other fields of research.

### TYPES OF FORESTRY RESEARCH UNDERTAKEN

Table 3.3 indicates that a majority (148) of the organizations sampled by FAO engage in forestry research only, while 74 organizations engage either in forest products research (28) only, or in a mixture of forestry and forest products research (46). The latter two categories are significant since a number of the potential early breakthroughs in research are in the utilization/products field, including utilization of nonwood forest products. Detailed discussion of types of research being carried out by different organizations is available elsewhere (cf. FAO 1987a,c; World Bank 1981a).

Table 3.3. Numbers of institutions engaging in pure forestry research, pure forest products research, and in both types of research for the major geographical regions in the developing countries (the 238 institutions listed in the FAO Compendium).

Main field of research	Africa	Asia and Pacific	Latin America and Caribbean	Near East	Four Regions
Pure forestry research	35	36	67	10	148
Pure forest products research	5	11	12	—	28
Mixture	15	9	20	2	46
Other	4	2	9	1	16
Total	59	58	108	13	238

Source: FAO. 1987. Forestry Research in Developing Countries: Status and Trends. Supplement to Secretariat Paper FO:FDT/87/4, presented at the 8th session of the Committee on Forest Development in the Tropics, Rome, Italy, 14-18 Sept. 1987. Rome: FAO. 43 pp.

It should be mentioned here that research on domesticated forest tree crops producing nonwood products, such as rubber, coconuts, and oil, is quite intensive in some countries. For example, there are 11 national rubber research institutes and a number of research stations maintained by the private sector.

## Issues in Building Up Capacity of National Forestry Research Systems<sup>1</sup>

The capacity of a national forestry research system is determined by its own characteristics, by the national social/economic system in which it operates, and by the interaction it has with the international research system and the bilateral and multilateral organizations that provide support for forestry research. The relationships and key factors involved at each level are shown in figure 4.1, which provides an overall framework for the remainder of the discussion in this chapter.

As indicated in figure 4.1, in addition to the national social system two major sets of factors determine the capacity of a given national research system, namely, the quantity and quality of resources available and the ways in which those resources are organized and managed. The relative importance of various factors is indicated in figure 4.2, based on the views of administrators of research organizations in 46 developing countries.<sup>2</sup> Naturally, the importance of a given factor will vary between countries.

### RESOURCES

As indicated in figure 4.1, three major types of resources are needed, namely, human resources (scientists, technicians, other staff), financial resources (the funds to put manpower to productive use) and physical resources (the infrastructure, equipment, buildings, etc.)

#### HUMAN RESOURCES

Table 4.1 indicates that forestry research organizations in developing countries have an average of 50 scientists and technicians per organization (for the 238 developing country organizations that returned questionnaires in the FAO survey). The seemingly high number per organization is due in part to the averages being influenced by responses from the larger organizations. In fact, this latter point is supported by the results of another study of a sample of 39 developing country institutions (Bengston, Xu and Gregersen 1988). As in the case of the FAO study, it shows a large mean number of scientists of 42 per institution. However, there is a wide variation around that mean, and the median number of scientists per organization is only 16.

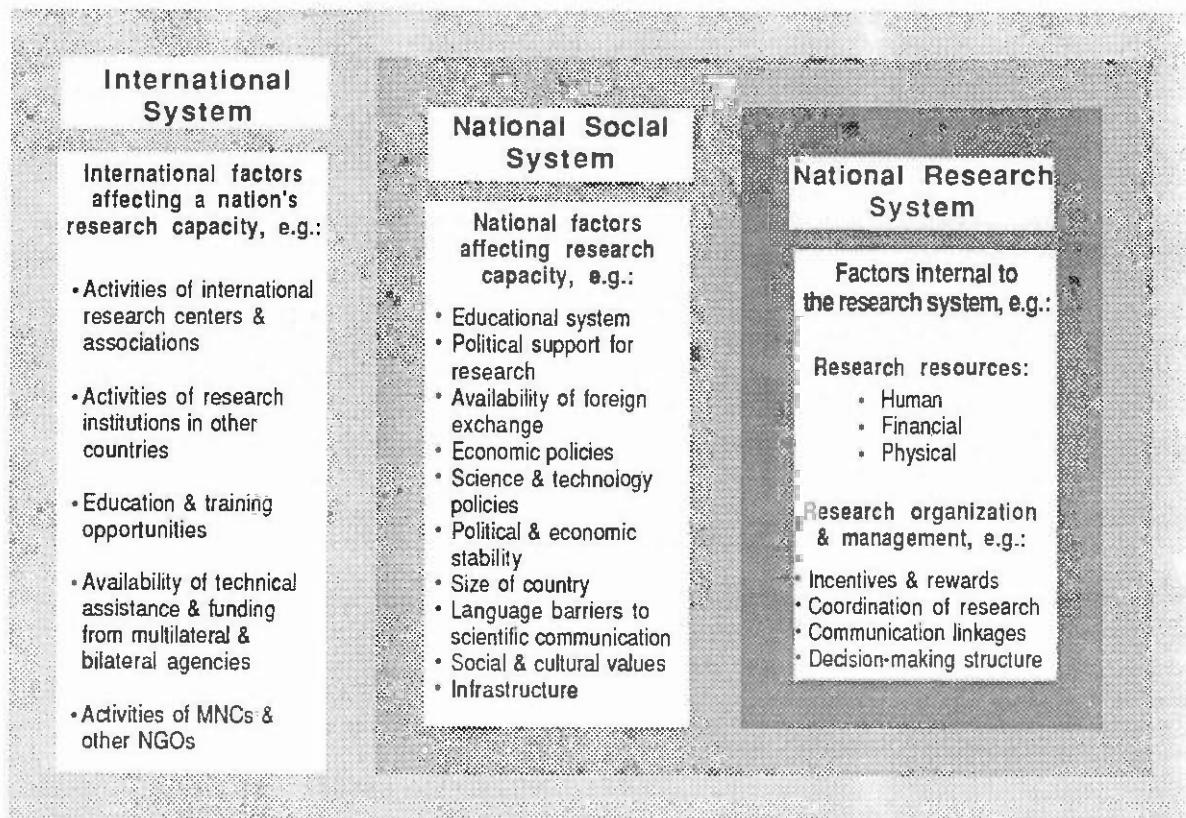
In this study of 39 institutions, about two-thirds of the sampled organizations had between 0 and 5 Ph.D. and between 0 and 10 Masters level scientists. Almost half the sampled organizations had only between 0 and 10 technicians. More than one-quarter of the researchers and administrators had degrees from universities outside their home countries.

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<sup>1</sup> Adapted from Gregersen 1988.

<sup>2</sup> As a point of comparison, the views of administrators in 45 developed country research organizations are also shown.

Degrees are received in many different countries. Many receive their degrees in other developing countries.

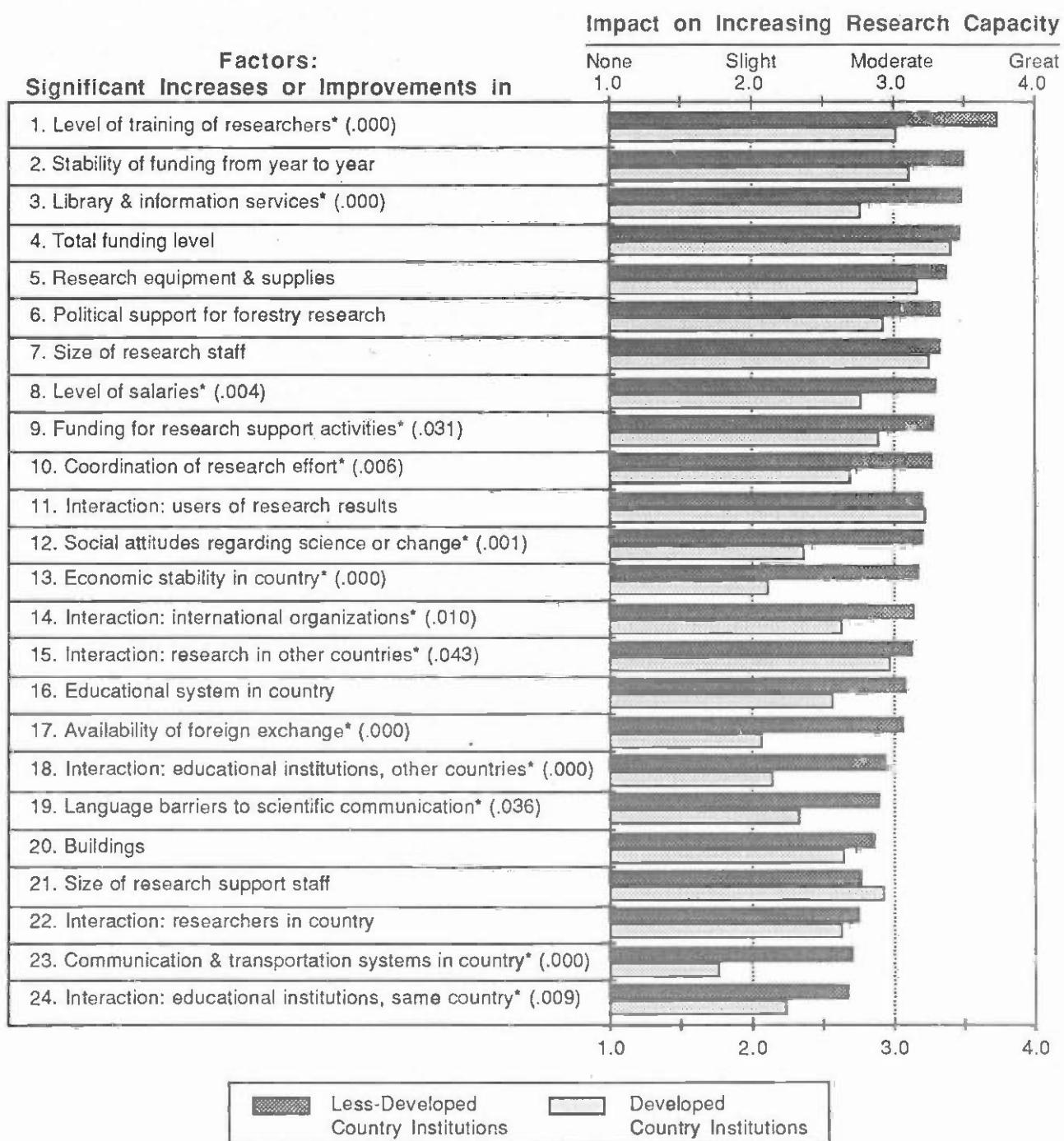


**Figure 4.1.** A variety of national and international characteristics may affect a nation's research capacity.  
Source: Bengston, Xu and Gregersen 1988.

**Table 4.1.** Numbers of researchers by category and by major geographical region in developing countries (the 238 listed in the FAO Compendium).

Staff Categories	Africa	Asia and Pacific	Latin America and Caribbean	Near East	Four Regions
Research Scientists	706	3,538	2,121	361	6,716
Average per institution	12.0	60.8	19.6	27.8	28.2
Technicians	962	2,442	1,657	187	5,248
Average per institution	16.3	42.1	15.4	14.4	22.1
Researchers and technicians	1,668	5,970	3,778	548	11,964
Average per institution	28.3	102.9	35.0	42.2	50.3

Source: FAO 1987b, c.



- Indicates significantly different ratings by developed and developing country respondents. Numbers in parentheses indicate levels of statistical significance as calculated for the chi-square statistic.

**Figure 4.2.** Average rating of factors affecting research capacity in forestry research institutions ( $n = 46$  developing country institutions,  $n = 45$  developed country institutions. Standard errors range from 0.079 to 0.136 for developing countries, and from 0.093 to 0.164 for developed countries).

Source: Bengston and Gregersen 1988a.

Differences among regions in the levels of training among research personnel are not great in terms of Ph.D.s--all three regions have about the same, small percentages. However, differences are great in terms of other categories, with Latin America having a significantly greater percentage of researchers with masters degrees. However, there is great variation among organizations within a given region.

Lack of trained personnel is identified by research directors as one of the most critical problems facing developing country forestry research organizations (see figure 4.2). Human capital formation or investment in the education and training of researchers is a critical issue which must be addressed.

Many developing countries do not have adequate capacity to educate and train forestry researchers. As indicated earlier, a significant proportion of existing researchers obtained their education and specialization outside their own country, but oftentimes in an environment where many things learned were irrelevant in terms of home country problems. Because of lack of career incentives in their own countries, many of the skilled persons who go outside for training never return, thus further contributing to the scarcity of skilled researchers. Finally, many of the researchers who do return end up as administrators, not researchers. It is quite clear that something needs to be done to improve incentives and to strengthen training systems which prepare researchers to work on forestry problems of relevance in their home countries.

#### FINANCIAL RESOURCES

A number of factors related to financial resources are important to consider in looking at the research system dealing with tropical forestry issues.

##### *Expenditure on forestry research in developing countries.*

Expenditure on forestry research in 1981 for Africa, Latin America and Asia (excluding Japan) was on the order of magnitude of US \$186 million (see Table 4.2). This is up from an estimated \$107 million in 1975 and \$70 million in 1970. As a point of comparison, the U.S. Forest Service alone spent \$128 million on research in 1981. Estimates for more recent years for developing countries are not available. However, if the past trend is any indication, then current annual expenditure is well in excess of \$200 million.

Table 4.2. Forestry research expenditures by major geographical regions.

Region	Total expenditures in millions of 1980 U.S. dollars			
	1970	1975	1980	1981
Latin America	11	23	27	35
Africa	11	25	26	39
Asia (less Japan)	47	59	102	112
World Total	564	740	887	1,025

Source: From Mergen et al. 1988.

Developing countries represent a relatively small part of total world investment in forestry research (in 1981, about 3, 4 and 5 percent of the total, respectively, for Latin America, Africa and Asia, excluding Japan). Thus, developing countries account for only about 12 percent of the total investment in forestry research worldwide (Mergen et al. 1988).

*Relation of developing country forestry research expenditure to value of production and to research intensity in agriculture.*

The US\$200 million or more being spent on forestry research can be put in better perspective by looking at the ratio of expenditure on research to value of production. This ratio is a measure of research intensity. Research intensity is very low for forestry relative to agriculture. Available estimates indicate that forestry research intensity in developing countries is considerably less than one-tenth of agricultural research intensity (see table 4.3). If the value of nonmarket forest products such as home produced and consumed fuelwood, poles and posts were included in the value of production, the differences would be even greater.

**Table 4.3.** Research expenditures as a percent of the value of production, by region and income group for forestry research and agricultural research.

Region/Income Group	Forest Research Expenditures as a % of Production			Agricultural Research Expenditures as a % of Production		
	1970	1975	1980	1970	1975	1980
Africa (6)	.071	.119	.122	.765	.764	1.272
Asia (10)	.056	.079	.075	.983	.998	1.117
Latin America (4)	.060	.068	.053	.510	.648	.887
Europe (19)	.272	.299	.246	1.036	1.010	1.214
North America/Oceania (3)	.316	.291	.269	1.491	1.352	1.234
Low-Income Developing (5)	.019	.023	.019	.222	.230	.451
Middle-Income Developing (7)	.046	.077	.059	.553	.508	.863
Semi-Industrialized (10)	.096	.100	.070	.612	.652	.816
Western Europe (13)	.281	.329	.267	1.106	1.128	1.456
Other Developed (4)	.272	.266	.253	1.723	1.614	1.515
Planned (3)	.166	.133	.148	.853	.795	.690

Note: Number of countries in parentheses.

Source: Mergen et al. 1988.

*Cost per scientist year.*

The cost per scientist year is higher for forestry research than for agricultural research in most regions (see Table 4.4). This could be because of diseconomies of small scale and many other reasons. There is a great variation among organizations and countries.

*Sources of funds for tropical forestry research.*

Of the total expenditure on forestry research in developing countries in 1988, it is estimated that \$48.3 million came from international donors (FAO 1987b). However, this represented only 4.7 percent of total bilateral and multilateral financing for the forest-based sector. Four countries--France, Federal Republic of Germany, the United Kingdom and the United States--accounted for 75 percent of the \$48.7 million (FAO 1989).

Several studies have looked at the overall sources of funds for forestry research in developing countries. One study, involving 58 developing countries, indicates that in the early eighties about 64 percent came from regular public budget appropriations, 19 percent from public grants or contracts, 10 percent from private grants or contracts and 6 percent

Table 4.4. Expenditures per scientist year by region and income group for forestry research and agricultural research (number of countries in each group shown in parentheses).

Region/Income Group	Forestry		Agriculture	
	1970	1980	1970	1980
(thousands of 1980 U.S. dollars)				
Africa (6)	63	103	67	67
Asia (10)	44	59	39	41
Latin America (4)	90	89	38	57
Europe (19)	69	90	60	63
North America/Oceania (3)	88	102	133	127
Low income developing (5)	36	27	32	36
Middle income developing (7)	92	86	41	49
Semi-industrialized (10)	102	88	44	55
Western Europe (13)	69	95	77	79
Other developed (4)	79	94	84	81
Planned (3)	40	52	27	28

Source: Mergen et al. 1988.

from other sources (Gregersen 1984). No breakdown is available for international donor contributions to these various sources.

Another study, involving a different sample of countries, found that between 84 percent of middle income and 96 percent of low income developing country funds came from government, with the respective percentages for private sources being 15 and 0 percent, and the respective percentages for international organizations being 1 and 4 percent (Mergen et al. 1988). However, the latter figures probably underestimate considerably international contributions, since there often is some international funding in each of the other categories that is not recognized by respondents as being international.

Data from the organizations which provided information to the Bellagio II International Task Force on Forestry Research gives further insight into sources of funding (Bengston, Xu and Gregersen 1988). For example, African organizations report much higher percentages of funding from international donors than in the case of the other two regions, which both have significant percentages of funding for tropical research coming from private firms as compared to African organizations. About 40 percent of all forest research organizations in developing countries report some international funding. This varies from a high of 71 percent in Africa to a low of 22 percent in Latin America.

#### *Stability of funding from year to year.*

A major concern is the stability of core funding for research organizations. This concern has been a central one in agricultural research. In forestry it takes on even greater significance because the research undertaken often requires even longer periods to achieve results, and thus stability and security of funding is essential. Few forestry research institutions in developing countries have the stability and security of funding needed to establish efficient and effective long term programs. Clearly, mechanisms need to be found to overcome this problem so organizations can count on stable funding. If such funding mechanisms are not developed, then it will be very difficult for even the best existing research institutions to expand research programs significantly, and to undertake the longer term research programs that are needed.

### PHYSICAL RESOURCES (INFRASTRUCTURE, EQUIPMENT, BUILDINGS)

The situations in different countries with regard to the adequacy of physical resources to carry out research are highly variable. In some there are facilities that go unused, while in others scientists work out of makeshift labs and offices with inadequate equipment and infrastructural support (computer facilities, communications, transportation, etc.). The key to strengthening research institutions dealing with issues related to the Tropical Forestry Action Plan (TFAP) is to balance the support for training, institutional reform and investment in physical infrastructure, considering each FRO's mission, research priorities, and capabilities.

It is evident from figure 4.2 that lack of adequate library facilities is a major concern of research administrators in the sample countries. Similarly, access to relevant nonpublished information and data is a concern. There is need for expansion of computerized data base systems which can improve access to data and information for all research organizations joining in the systems.

An indication of the inadequacy of library and information sources is the small average number of subscriptions (23) in developing country research libraries compared to the much larger average number of subscriptions (365) in developed country research libraries (Bengston et al. 1988). Similarly, FAO surveys of forestry research institutions in developing country indicate that only about half have subscriptions to foreign journals (FAO 1984b,e,f).

The same FAO surveys indicate inadequacies in equipment and facilities to be widespread in developing countries. Thus, they found that only a few organizations in Africa have adequate equipment and laboratory facilities; and only about 25 percent in Asia/Pacific and about 50 percent in Latin America have adequately equipped laboratories. Specialized research equipment is lacking in most organizations. Based on information provided by 76 developing country research organizations, it is evident that equipment is a top priority for investment if additional funds became available. Additional researchers is the next most important need.

### THE INFLUENCE OF RESEARCH ORGANIZATION AND MANAGEMENT ON CAPACITY

Merely having resources on hand does not guarantee that good, productive research will result, or even guarantee that the capacity to do productive research exists. Much depends on the way in which resources are organized, managed and used over time (see figure 4.1).

#### INCREASING POLITICAL SUPPORT FOR FORESTRY RESEARCH

A fundamental barrier to more effective forestry research in developing countries has been a lack of political awareness of the critical nature of the policy and other problems which need to be resolved with the help of research. To a great extent, the resulting apathy has led to underfunded forestry research programs that do not receive political support. Part of the blame for this lack of awareness can be laid squarely on the shoulders of forestry researchers and administrators. They have tended to be too inward looking, ignoring the significant links between forestry progress and resolution of the broader issues of development and welfare that are of concern to political leaders. Part of the need here is for a substantial increase in policy/economics/social science research to establish clearly the links between forestry, as broadly defined, and social and economic welfare in developing

countries. This need is implied in a number of the recommendations put forth at the Bellagio Forestry I meeting.

#### COORDINATION AMONG NATIONAL RESEARCH ORGANIZATIONS

Again, experience is highly variable from country to country. However, a composite picture is available for a sample of 38 countries from the three major tropical regions. A summary of responses for these countries is presented in figure 4.3, which indicates that 74 percent of these countries had some type of national coordinating body for forestry research. The most common function of such a body is to develop a long-term national research plan. (Such plans often exist only on paper and are seldom made operational). Developing national plans is followed closely in importance by the roles these bodies play as providers of funding. In about half the cases, the coordinating bodies also coordinate training programs and international assistance and exchanges.

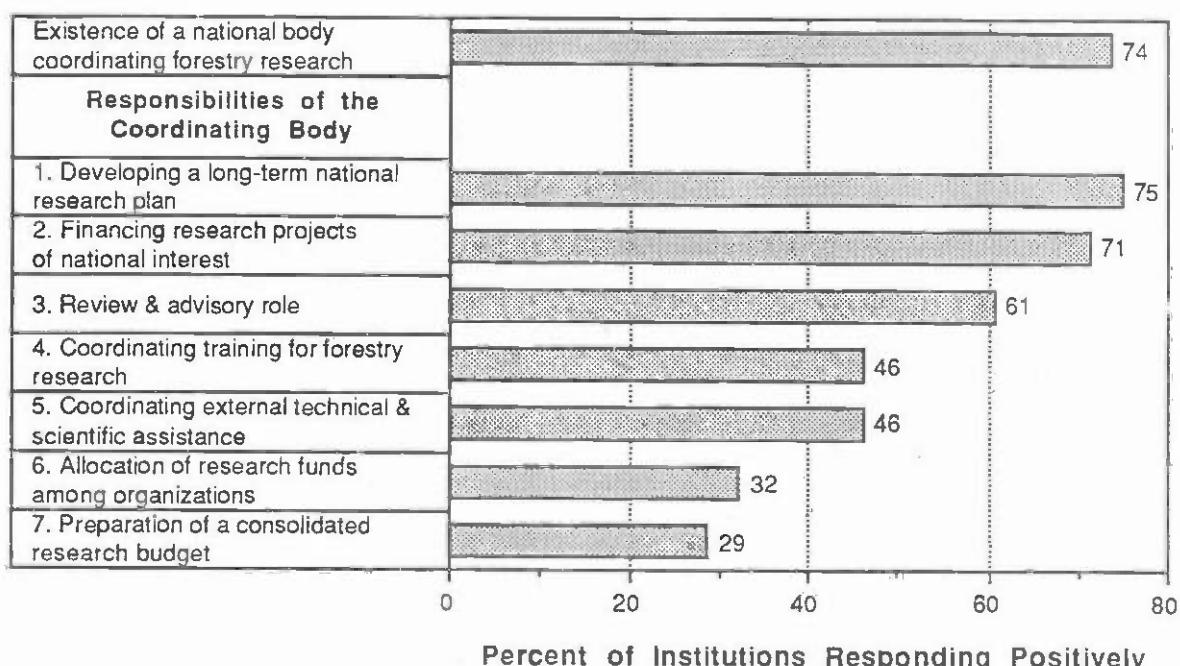


Figure 4.3. Coordination of public forestry research in developing countries (n = 38 developing country FROs).

Source: Bengston, Xu and Gregersen 1988.

#### INTERACTION OF RESEARCHERS AMONG THEMSELVES, WITH EDUCATORS, AND WITH EXTENSION

One of the factors which has to be considered with particular caution is the whole area of "interaction" among institutions, both research and educational ones. Note that improvements in interaction ranks fairly low in figure 4.2. Yet, one gets the sense from available documentation that many of the problems faced are related to failure of the outreach or extension services that should be disseminating and helping to implement research results in the field and at the same time be bringing new, relevant research ideas back to the researchers. This need was clearly identified as a top priority in another study (Bengston, Xu and Gregersen 1988). Outreach, or the extension of research results to

potential users, is a critical area which needs to be addressed in parallel with research improvement.

Lack of interaction among researchers can result in inefficiencies, unneeded duplication of efforts and waste of resources. Experience indicates that having a critical mass of researchers in an area can help in achieving significant progress in a reasonable time. This critical mass is not available in most developing countries.

As indicated in table 4.5, the percentage of organizations that never formally interact with other research or educational institutions in their own country (in cooperative research or training and staff exchange) is disappointingly high--almost half of them in the case of the sample of 39 countries mentioned above. Interestingly, formal interaction with agricultural research organizations is almost as frequent as with other forestry research organizations. Informal interaction in the form of information exchange is more frequent, as might be expected. Similar results were obtained in a survey of forestry research organizations in 85 countries. Only 55 percent of the respondents reported having any cooperative arrangements with either domestic or foreign research organizations (ITFFR 1988).

Part of the problem here relates to coordination among all the different institutions engaged in various types of R&D related to the objectives of the TFAP. The lack of coordination and communication among research organizations in developing countries is discouraging in many cases. This shows up as an important bottleneck in Figure 4.2.<sup>3</sup> Mechanisms need to be developed for expanding and improving the interactions among researchers themselves. This can be partly achieved through effective research networks, but there also are other things which need to be done, such as increasing the funding available for exchanges of scientists, attendance at scientific meetings, and so forth.

#### INTERCOUNTRY INTERACTION AND COOPERATION

As indicated in table 4.5, formal interaction between countries is almost as frequent as intracountry interaction. The interaction with international institutions indicated in table 4.5 is mainly through FAO, World Bank, and other projects.

Progress is being made in the area of information exchange. As indicated earlier, networks are being established and promising results are being achieved with data base management systems to collate, process and analyze data from sites around the world on species trials and the results of other biological research. For example, through IUFRO's "program for developing countries" a number of cooperative information-sharing activities are being established. Others have been established with the support of various bilateral and multilateral agencies. Still, much remains to be done, and substantial expansion of funding is needed to meet the key opportunities which exist right now for information exchange and research interaction. Development of additional networks is needed. However, caution has to be exercised and quality/productivity controls developed to insure that funds are used effectively and efficiently to deal with key research opportunities (see Burley 1985, 1989).

A number of intercountry cooperative programs exist, operating mainly as networks. Examples related to provenance trials include: Central America, for certain tropical pines, coordinated by Oxford Forestry Institute (OFI); Australian species of acacia, casuarina and eucalypts, with CSIRO; various species with CTFT, nitrogen fixing trees with NFTA. There

<sup>3</sup> As indicated, the significance of this factor varies greatly between developing and developed countries.

	Type of Interaction					
	Cooperative Research	Training or Staff Exchange	Exchange Information	Never	Occasionally	Frequently
1. Forestry research organizations in your country	43	32	24	41	35	24
2. Agricultural research organizations in your country	46	38	15	62	36	3
3. Educational institutions in your country	54	8	38	44	33	23
4. Research organizations in other countries	51	31	18	38	44	18
5. Educational institutions in other countries	59	36	5	23	54	23
6. International institutions (FAO, World Bank, etc.)	54	28	18	33	44	23
7. Organizations that use research results (firms, landowners, etc.)	54	36	10	59	33	8
				18	54	28

Table 4.5. Formal interaction between public forestry research organizations in developing countries (n=39) and other organizations. Numbers in the table are the percent of respondents for each level of interaction (never, occasional, and frequent), type of interaction, and type of organization with which interaction occurs.

Source: Bengston, Xu and Gregersen (1988).

are many more in existence and in the planning stages which deal with many aspects of the TFAP objectives, such as watershed management (USAID sponsored ASEAN network) and so forth.

A number of active research networks exist that cooperate to work on common problems. A good example is the CATIE Madelena project in Central America. This network also has put in place an operating data base management system which is being supplied with data from at least five of the Central American countries.

A number of developed country research institutions cooperate with developing country institutions in tropical forestry research on a one-to-one basis. A few examples out of many are the CTFT of France, the OFI of the UK, the Institute of Tropical Forestry of the U.S., the GTZ of the Federal Republic of Germany, and the IDRC of Canada. A number of Scandinavian agencies also cooperate in research with developing countries. These types of interactions need to be encouraged so twinning and networking arrangements can be expanded in a productive and effective manner.

#### **IMPROVING FORESTRY RESEARCHER INCENTIVES**

A number of the factors which are critical to success of forestry research organizations relate to the incentives which attract and retain skilled and bright people in research. Indications are that such incentives tend to be weak in forestry research. Salary levels for forestry researchers in developing countries often are considerably below those for comparable professionals in the same country. Based on a sample of 36 organizations, it was found that half the administrators responding indicated that salaries of their researchers were at least ten percent below those of comparable professionals in their countries. Seventeen percent indicated that salaries were 40 percent or more below those of comparable professionals. Administrators of forestry research organizations in developing countries believe that financial awards are one of the most effective mechanisms for stimulating the productivity of forestry researchers. Yet, because of scarcity of funds, it also is one of the least used mechanisms among the major categories shown (Bengston, Xu and Gregersen 1988).

Many forestry researchers in developing countries express frustration at the lack of a critical mass of scientists--the lack of fellow researchers with whom they can interact and find stimulation. Peer group recognition is a major reward for researchers. As indicated in figure 4.2, size of research staff shows up as an important factor in the eyes of the responding research administrators from developing countries.

The evidence is accumulating that lack of researcher incentives in research related to tropical forestry and forest products is a critical barrier. A clear need exists to support national research organizations in their attempts to build improved incentives into their systems, in some cases through drastic reorganization and in other cases through greater inputs of financial and other resources into existing, relatively effective organizations. Caution is needed in moving ahead with programs to improve researcher incentives and productivity. Obviously, all the problems cannot be solved by infusing the system with more funds to reward researcher initiative and productivity. As mentioned, much of what is needed relates to improving the environment in which researchers can interact with each other. A major reward to researchers is peer praise, and this can be forthcoming only if peers have a means of communicating with one another. Communication links need to be improved in a number of ways. Researchers need to have better access to shared

information and, perhaps, even shared facilities and equipment which cannot be justified by one small research organization acting alone.

### PRIORITY INSTITUTION BUILDING NEEDS

Based on the above analysis of research capacity in relation to needs, the following institution building activities emerge as priorities in many organizations:

1. Strengthen education and training systems which prepare researchers to work on tropical forestry problems and which educate the public and political officials about the critical nature of forests and forestry in development.
2. Develop mechanisms to secure needed core funding for national tropical forestry research organizations. The solution to this issue may partly rest on educational efforts discussed in 1 above.
3. Expand information exchange and research interaction within countries. Mechanisms need to be developed for fostering closer association between forestry research organizations and other, nonforestry research organizations working on problems of relevance to the TFAP, e.g., agricultural research groups, basic research organizations working with such topics as biodiversity, genetics, soils, etc.
4. Improve dissemination of research results and access to available technology, in most cases by building on existing agricultural extension programs.
5. Support national research organizations in their attempts to build improved incentives into their systems, in some cases through drastic reorganization and in other cases through greater inputs of financial and other resources into existing, relatively effective organizations.
6. Increase policy/economics/social science research to establish clearly--preferably in quantitative terms--the various links between forestry, as broadly defined in TFAP, and social and economic welfare in developing countries. Make the results of such research widely known to policy makers in tropical countries.
7. Develop additional international networks of researchers working together on priority problems. Improve communication links in a number of ways. Researchers need to have better access to shared information and, perhaps, even shared facilities and equipment.
8. Develop mechanisms to expand and improve the interactions internationally among researchers. This can be achieved partly through effective research networks, but also by increasing the funding available for exchanges of scientists, attendance at scientific meetings, and so forth.
9. Develop the capacity internationally to support development initiatives of national research organizations.

The range in priority needs among countries and organizations is wide and diverse, supporting our belief that the real need is to set up the mechanisms to deal flexibly with the individual priorities of national organizations and to develop the mechanisms whereby

diverse organizations can come together to cooperate effectively and efficiently in solving common forestry problems.

There are no quick fixes possible. Mere infusion of additional financial resources will not solve the problems, although it might help alleviate some. Rather, what is needed is a balanced attack on the problems, one which stresses both short term solutions to specific research problems and longer term financial and institutional support to build up educational, training and extension capabilities and to build up national support for and confidence in forestry research as a contributor to development and increased welfare.

## PART II

### Policy Environment and Organizational Structure

The organizational structure of a public forestry research institution is determined to a great extent by the policy environment within which it exists. While many of the factors determining that policy environment cannot readily be influenced by research administrators, some can. Part II deals with some of these factors and the considerations involved in developing an effective and efficient organizational structure to meet particular needs.

## The Policy Environment for Forestry Research: Interaction Between the Research Manager and Policy Makers

### INTRODUCTION

Research organizations and individual researchers respond to the circumstances and the environment within which they operate. Many factors that are external to a research organization--ranging from public attitudes regarding science to size of the country--may significantly affect the capacity and effectiveness of a research organization (Bengston 1989a). Some of these characteristics of the external environment are obviously beyond the control of research managers. But others--such as the level of political support for research and the adequacy of national research policy and planning--represent key areas in which research managers can have an influence. These characteristics of the external environment are referred to here as the policy environment for research.

The influence of the policy environment on the effectiveness of research organizations cannot be over-emphasized: "Strong political support and a favorable policy environment are usually identified as necessary conditions for the emergence of strong and effective research systems" (ISNAR 1984). A favorable policy environment will greatly enhance a research organization's ability to contribute to national development objectives, and an unfavorable policy environment may negate any potential contributions.

This section examines the policy environment for forestry research, including the impacts of policies on research, the role of the research manager in helping to shape the policy environment, and the development of a national forestry research program, given the influences and policy constraints that exist.

### IMPACTS OF POLICIES ON RESEARCH

While a nation's research policy has the most direct impact on the effectiveness of its research organizations in contributing to national development goals, other aspects of the policy environment may be critically important. For example, forestry research is affected by broader national science and technology policies such as those affecting higher education, innovation in the private sector, and so on. General forestry policies in a country also will affect the nature and effectiveness of forestry research. Of particular concern is the instability of policies in many developing countries brought about by frequent changes in the political atmosphere (El-Lakany 1989).

Weiss and Ramesh (1983) distinguish between explicit science and technology policies (intended to affect scientific and technological capabilities directly) and implicit science and technology policies (not primarily concerned with scientific or technological activities, but nevertheless having a major indirect impact). Economic policies are perhaps the clearest example of implicit science and technology policies.

The economic environment in which a research institution operates often has a significant impact on the effectiveness of its research program. For example, Chaparro et al. (1981) discuss the effect of trade, fiscal, monetary, and exchange policies in Colombia on agricultural research. Colombia followed an import-substitution industrialization policy during the 1950's and 60's, which protected domestic industries by establishing high tariffs and import quotas on consumer goods. Overvaluing the peso was a key component of this policy, constituting an implicit tax on exports. Agricultural products were particularly hard-hit: Taxes on agricultural exports ranged between 17 and 47 percent during the 1960's. Another policy to subsidize industrialization forced farmers to sell raw materials such as cotton to domestic manufacturers at prices below international levels. The effect of policies such as these was to discourage production of many agricultural commodities, reduce the demand for new technology and research, and reduce the impact of research by inhibiting the adoption of agricultural technology.

Economic policies also influence the availability of foreign exchange in a country, which is important for purchasing imported research equipment and supplies, subscriptions to international journals, vehicles, etc. Forestry research institutions in Africa surveyed by FAO (1984) identified difficulties in obtaining foreign exchange as a common problem.

Finally, the policies and activities of international bodies may have a significant impact on the effectiveness of research organizations. For example, the dominance of multinational corporations in the economies of many developing countries has resulted in "technological dependence" and the "marginalization of science" according to some observers (Cooper 1971, Herrera 1973). Multinationals provide easy continuing access to technology from abroad and often impose various controls and pressures that establish their dominance in technological matters. This greatly reduces the demand for locally generated technologies and tends to isolate the indigenous research system from production. The result is research institutions that are alienated from production activities or "marginalized" because there is little demand by firms for locally developed technologies.

Problems also can arise when international donor and technical assistance agencies attempt to impose their policies and research priorities on research institutions (Elz 1984). When research priorities are determined by outside forces, the appropriateness of resulting technology and its potential contribution to meeting national development objectives may be reduced. This type of "donor domination" was identified as a constraint on forestry research in some instances by a group of research directors from the Asia-Pacific region (Brunig 1982).

### ROLE OF THE FORESTRY RESEARCH MANAGER

Given the above issues, what is the role of the forestry research manager in helping to shape the external policy environment for research? The fundamental role of the research manager in this regard is to build bridges between his or her research organization and policy makers and other research stakeholders. Developing and maintaining relationships with policy makers, clients, etc. through frequent interaction is one of the key roles of the research manager. More specifically, research managers need to (1) take an active role in the process of developing national development plans and research plans, and (2) work to build political support for their research programs.

## SHAPING NATIONAL PLANS AND POLICY

One key role is providing guidance and input for national development policy and forestry research policy. The interaction between development policy and research is often top-down, with policy makers determining the broad research agenda. National development goals are expressed in national development plans that specify objectives and operational targets for each sector, including forestry, usually within a five-year time frame.

Forestry research managers can and should have an influence on development policy and plans through participation in the preparation of development plans. Participation of research staff should be institutionalized, if possible, rather than being ad hoc. Research managers and scientists can contribute to national development plans and to national research policy and plans in many ways, including:

Research managers roles in shaping national development plans:

- helping policy makers realistically assess the potential contribution of forestry research to development objectives;
- encouraging policy makers to be more specific in their development objectives (and thus provide scientists with firmer targets to which their research should be directed);
- providing information to help establish priorities among competing development objectives (e.g., import substitution or export promotion).

Research managers roles in shaping national forestry research policy:

- helping match national research objectives with development needs;
- providing opportunities for ensuring that research and extension activities are coordinated;
- linking various client groups with national policy makers.

Adequate background preparation is necessary to fulfill these roles. Research managers must have skills in the use of socio-economic analysis and planning if they are to effectively interact with policy makers and effectively contribute to national development plans and research policy. They must understand how policies are set within the political arena of their country, and work to become part of the policy-setting process.

## BUILDING SUPPORT FOR RESEARCH

Sustained political commitment is crucial for a sustained research effort. A lack of political support inevitably leads to inadequate and unstable funding. A workshop of forestry research directors in the Asia-pacific region identified lack of political support and low status of research as the number one external obstacle to effective research (Brunig 1982). Forestry research directors in 46 developing countries worldwide rated (1) stability of funding from year to year, (2) total funding level, and (3) political support for forestry research among the most important factors affecting the capacity of their research institutions (Bengston and Gregersen 1988). These three factors are clearly interrelated.

Public relations and building political support are key functions of research managers. It is critical that government officials who make decisions about funding forestry research understand the past and potential future benefits of research activities and the contribution of research to development (see Chapter 2). Competition for alternative uses of public

funds is always intense. Forestry research must compete with other areas for a limited budget. Thus, evidence of the contribution of this research to society is needed. Evaluation of the contributions of research to national development goals (e.g., import substitution or export earnings, self-sufficiency in wood products, economic growth, employment, etc.) is one component involved in building political support for research. Such impact evaluations demonstrate to policy makers the value of research programs to society. The case for continued or increased public support can more effectively be made based on hard evidence than on anecdotal information, traditional budget allocations, or blind faith in the value of "science for science's sake." Impact evaluation can provide a solid analytical basis for justifying budgetary support.

Economic impacts--or rates of return to investment in research--often are calculated in impact evaluations. The high rates of return often reported (usually in the range of 20-80% per year) provide evidence of underinvestment in research (Ruttan 1982). A large number of impact evaluations of agricultural research have been carried out both in developed and developing countries. As indicated in Chapter 2, recent economic impact evaluations of forestry research have found rates of return similar to agricultural research (Jakes and Risbrudt 1988, Prado 1989).

Related to political support is client support for research. Forestry research organizations that have a strong program of applied research that meets the needs of clients can solicit their support for future research programs. But building strong, politically effective support requires a carefully planned, sustained effort on the part of the research manager. It is unlikely to develop by itself.

Popular support for research is also important. Research organizations have a role in helping to increase public understanding of the importance of trees and in publicizing the need for forestry research through popular journalism, forestry exhibitions for general audiences, and other means.

Establishing strong ties with international organizations that support forestry research activities is another important role for research managers. Funding and other assistance from international donors and technical assistance agencies can be crucial, especially during the early stages in building up the capacity of a research organization. But support from international agencies may also entail problems. For example, the difficulty of generating long-term political support in the country is often exacerbated when a research organization is started with foreign aid (Pray et al. 1982). The organization may be viewed by key government officials as foreign and not a high national priority if it is funded from outside sources. Without strong political support within the country, a decline in foreign assistance typically results in a period of unstable and inadequate funding. The short-term nature of most foreign aid relative to the long process of building an effective research system adds to this problem.

### DEVELOPING A NATIONAL RESEARCH POLICY AND PROGRAM

National research policy clearly has a significant and direct influence on a nation's forestry research effort. In a broad sense, national research policy reflects public support for research. Generally, it reflects a political consensus as to the relative importance of research in society, and often indicates which broad fields of research are to be given priority. If forestry is to have a place on the national research agenda, the importance and contributions of forestry research must be brought to the attention of those who determine

and influence national research policies. It is the responsibility of forestry research managers to develop and publicize appropriate research programs and policies that are consistent with national research policies, and to get them on the national research agenda.

A nation's formal or explicit forestry research policy can be thought of as a projected research program that addresses the following fundamental questions:

1. What are the desired national goals and objectives for forestry research, i.e.:
  - What are the national priorities for forestry research?
  - How do research priorities contribute to forest sector development objectives and national development objectives?
  - How should they be determined?
2. What are the means to achieve these goals and objectives in general terms, i.e.:
  - What level of resources should be devoted to forestry research?
  - How should research resources within forestry be allocated to research priorities and organizations?
  - How should the national research system be structured and organized?
  - How can forestry research be coordinated effectively at the national and international level?

These are fundamental questions that must be dealt with in shaping forestry research policy. The following sections deal with national priorities for research, size of the research investment, mechanisms for allocating research funds at the national level, and coordination of research at the national level. The question of how to best structure and organize research is addressed in chapter 9 on organizational structure.

#### **NATIONAL PRIORITIES FOR RESEARCH**

What are the national priorities for forestry research? What type of research is needed? How do these research priorities contribute to forest sector development objectives and national development objectives? How are priorities set? These are basic questions that must be addressed in determining the nature and composition of a national research program. Priority setting at the policy level cannot be carried out in isolation, but must be related to other planning activities at the national or institutional level, including:

- determination of national development goals;
- preparation of a national development plan;
- preparation of a national forestry research plan and program.

National research priority setting and program formulation must begin with and be responsive to national development goals and plans. Such top-down, high level guidance is essential to develop a relevant national research program. At the same time, development of national priorities and a realistic and feasible national program of research is also a bottom-up process that takes into account:

- current and projected capacity to carry out research (i.e., the availability and capability of resources, effective organizational structures, etc.);

- research opportunities identified by researchers and research managers.

Contant and Bottomley (1988) discuss at length the case for formal procedures for research priority setting, to complement informal procedures based on experience, intuition, and recognition of national development needs. They identify seven methods, ranging from simple to sophisticated, which can be used to help establish research priorities:

1. congruence
2. checklists
3. scoring models
4. domestic resource cost ratios
5. benefit/cost analysis
6. mathematical programming
7. systems analysis and simulation analysis

The first three methods are the simplest, and are used in some research organizations and in determining national priorities. They may be very useful where no formal methods are currently used. These three methods are briefly described below. Methods 4 through 7 are much more quantitative, with relatively high data and skill requirements, and are unlikely to be used extensively in priority setting in the near future. Daniels (1981) observes that much of the literature on research priority-setting and resource allocation "has focused on untried theoretical models that require an investment of manpower and time that is unavailable to many research managers and policymakers in developing countries.

The congruence method assumes that resources should be allocated to different commodities or areas of research in the same proportions as their current contribution to the value of output in the sector. For example, if fuelwood represents 40 percent of the total value of forest output in a country, then fuelwood research should receive 40 percent of the resources allocated to forestry research. This congruence method for determining national research priorities is less applicable in forestry than it is in agriculture due to the predominance of nonmarket outputs in forestry.

Checklists are perhaps the least sophisticated technique, but they can greatly improve priority-setting with little cost in research systems that rely on historical allocations and personal judgments to determine priorities. The checklist method involves the development of a list of criteria for priority-setting and associated questions which decision makers must consider and answer in determining priorities. Checklist questions generally cover five areas: the anticipated impact of research, contribution to national goals, cost, feasibility, and availability of trained personnel. The usefulness of checklists depends heavily on the relevance of the criteria and the care with which questions are developed. Nestel (1989) provides an in-depth discussion of checklists.

Scoring models are simply a more sophisticated version of checklists, with numerical values assigned to the questions. Criteria weights determined by decision makers are multiplied by the numerical values, and the weighted values are summed to produce a final score. Research programs can then be ranked in order of priority according to their scores. The relative weights applied to each criteria critically affect the outcome of scoring models. Bengston (1986a) reviews agricultural research scoring models.

## SIZE OF THE RESEARCH INVESTMENT

How much should a country spend on forestry research? An economist would recommend that a country should spend up to that amount at which the marginal benefit of research is equal to the marginal cost. Unfortunately, calculating the marginal benefit of research is extremely difficult or impossible given a lack of data in most situations and for most types of research. Moreover, a country may not be able to afford to spend the optimal amount, or it may be unwilling to spend that amount due to a lack of political commitment.

Several rules of thumb have been proposed as rough guides for determining how much a country should spend on research. For example, Johnson (1982) suggests that a country should spend no less as a percentage of the value of its output in a particular sector than is being spent by the average of countries with comparable levels of income. This is the "research intensity" ratio approach, in which public expenditures on research as a proportion of the value of production are compared across countries or across sectors of the economy.

Table 4.3 (in Chapter 4) shows research intensity ratios for forestry and agriculture by region in 1980. The forestry ratios vary among regions, and in Africa, Asia, and Latin America are less than half of those in Europe and North America. Expenditure ratios for agricultural research are from 10 to 15 times those for forestry in Africa, Asia, and Latin America. In this table, "value of production" in forestry includes only the market value of forest products and excludes the value of fuelwood, recreation, wildlife values, etc. Thus, the value of production is underestimated in the case of forestry, and the forestry research intensity ratios are consequently overestimated.

Comparison of research intensity ratios across countries or across sectors may be useful in determining how much a country should spend on a given type of research. Examples of this approach include the suggestion of the 1974 U.N. World Food Conference that developing countries should aim for a 1985 target of spending 0.5 percent of the value of agricultural production on agricultural research (UN 1974). The World Bank has more recently recommended a research intensity ratio of about 2.0 percent (World Bank 1981b). These are considerably above the forestry research intensity ratios in developing countries.

An alternative to the research intensity ratio is the relative research expenditure ratio proposed by Parday et al. (1988), which for the case of forestry would measure the proportion of total public expenditure on forestry that is spent on forestry research. For example, if the total public expenditure on forestry in a country is US\$10 million, and \$1 million of this total is spent on research, then the ratio would be 10 percent. This ratio provides an indication of the relative importance given to research in a particular field within the constraints imposed by overall public spending in that field.

## MECHANISMS FOR ALLOCATING RESEARCH FUNDS AT THE NATIONAL LEVEL

Developing appropriate ways of allocating available research funds among institutions is another important aspect of national research policy. These allocations are made in a multitude of ways in different countries, including:

- formula for allocating federal research funds to states,
- allocations among types of research determined by legislative mandates, and
- allocations based on competition for grants and contracts based on peer review.

Each of these allocation mechanisms is typically found within a single country, except in small countries with a single national forestry research organization. Finding an appropriate mix of methods for allocating research funds at the national level is the challenge that research policy must address.

Economists tend to favor a significant element of competition in the allocation of funds, and often recommend some form of peer review of program or project proposals. Most research funds allocated through a peer review process are for particular projects. Ruttan (1982) provides a thorough discussion of the trade-offs between the allocation of funds by means of a peer review research grant system (project funding) versus allocating funds to support the research program of a particular institution (institutional funding). He concludes that the most efficient policy for allocating funds would include elements of both systems. However, it should be kept in mind that peer review typically relies heavily upon criteria relating to potential contributions to science, and may give little weight to research proposals on the basis of their potential contributions to society.

It should be emphasized that no system can completely take the place of the political process in allocating research funds at the policy level. Political decisions determine the total amount of funds available for forestry research, and often strongly influence the allocation of funds among broad areas of research. While recognizing the role of the political process, mechanisms for allocation of research funds at the national level should minimize political influence where it has no competence, e.g., in matters of scientific method and research procedures (Johnson 1982).

#### COORDINATION OF RESEARCH AT THE NATIONAL LEVEL

National research policy also should establish the means to coordinate research activities. Inadequate coordination of forestry research activities at the national level may reduce the effectiveness of research and result in duplication of effort, excessive resources devoted to low priority projects, lack of communication between researchers, managers, and policy makers, and little or no application of results. Bengston et al. (1988) identified seven key responsibilities of national bodies to coordinate forestry research (see fig. 4.3, chapter 4):

1. developing a long-term national research plan,
2. financing research projects of national interest,
3. reviewing and advising,
4. coordinating training for research,
5. coordinating external technical and scientific assistance,
6. allocating research funds among organizations,
7. preparing a consolidated national research budget.

Organizational approaches to the coordination of research differ widely between countries. Seventy-four percent of developing country institutions surveyed (Bengston et al. 1988) report the existence of a national coordinating body. The most often cited responsibilities of coordinating bodies include developing a long-term national research plan, financing research projects of national interest, and reviewing and advising forestry research institutions. Only 46 percent of the coordinating bodies coordinate training for forestry research. This is a key area for improvement in coordination in light of the importance of increased training for forestry researchers. Another concern is that research coordination sometimes exists only on paper, and thus has little actual influence on the nature or direction of research programs.

## The Organizational Structure of the Research System

Basically, organization is the placing of several parts of a whole in such relation to each other that a desired end may be achieved. For some, the phrase "organizational structure" conjures up an image of an official organizational chart, showing employees, their job titles, and their relationships to one another. An organizational chart does describe one part of organizational structure, but more is involved. Organizational structure also refers to the institutional forms and mechanisms that govern a research organization and by which research priorities are set and resources are mobilized for the implementation of the research program. Trigo's (1986) definition of organizational structure is worth quoting at length:

*"... the organizational structure comprises the durable organizational arrangements through which responsibilities and authority are distributed and the reporting relationships among the different organizational components. These relationships correspond to the patterns for division of labor--single versus multicommodity, basic versus applied research, research and extension--and coordination among the different units responsible for research. The organizational structure also includes the channels for interaction with the system's environment, which reflect the system's guidance and input mechanisms."* (p. 4)

The organizational structure thus provides a framework that links research to the external policy environment, and guides the processes of research management (e.g., human resource development, establishment of scientific linkages and linkages with users, etc.).

A key point is that the way in which a research system is organized can significantly affect its productivity and effectiveness. Organizational structure strongly influences a research institution's ability to use resources effectively and efficiently to generate information, and to promote vital interaction among scientists and between them and client groups. It should be viewed as an additional resource in research, which can either enhance or limit the effective use of other resources (human, physical, financial, and information resources) to achieve the goals of the research organization.

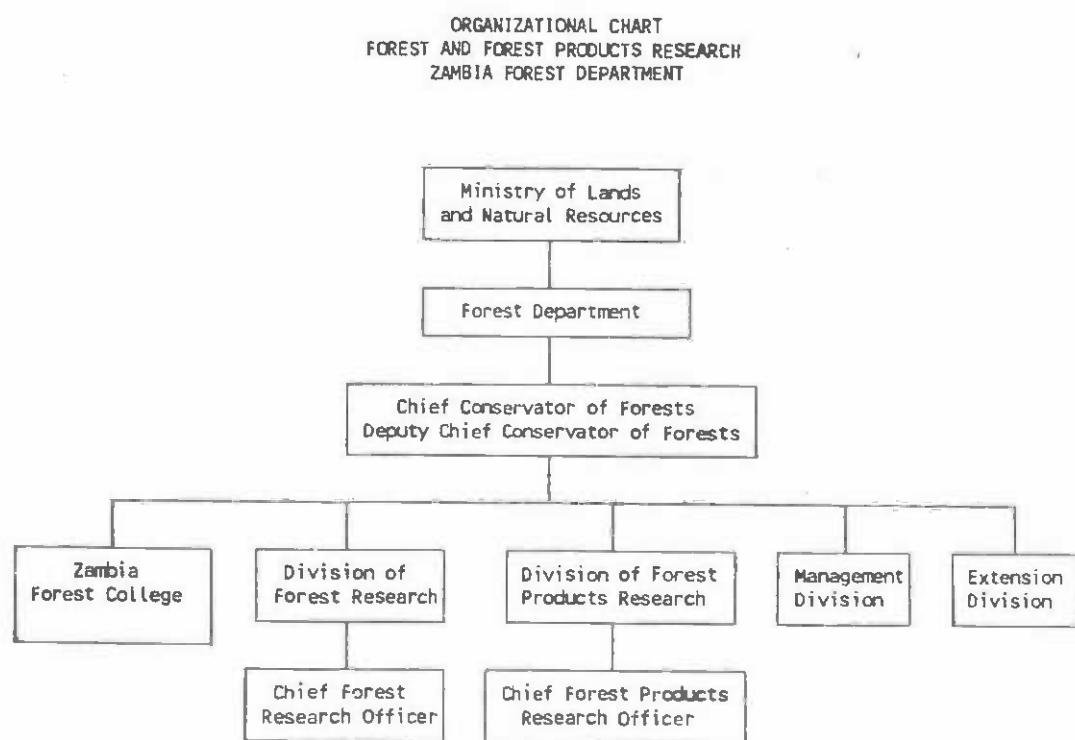
### BASIC ORGANIZATIONAL OPTIONS

Four basic models for the organization of public research may be distinguished (Ruttan 1982, Jain 1989): The ministry model, the autonomous or semi-autonomous institute, the university model, and the research council. In addition to these public sector organizational models, we can add private sector research organizations. These models differ mainly in governance structure or degree of autonomy and funding mechanisms. While these organizational models represent ideal types, each is evident among the forestry research institutions included in the FAO "World compendium of forestry and forest products research institutions" (Hilmi 1986). The basic organizational approaches are briefly described below, highlighting differences in governance structure and funding.

### THE MINISTRY MODEL

**Governance structure:** In the ministry model, forest and forest products research responsibilities are placed within one or more line departments of a ministry, usually the ministry of agriculture or forestry, although other ministries such as natural resources, education, or science and technology could also be involved. This organizational approach is most common in small countries and is usually a component of the integrated federal-state (or national-provincial) research systems in large countries (Ruttan 1982). For example, it is the model used in Zambia (Figure 6.1). The essentially bureaucratic nature of the ministry can create problems for a research organization--research managers may have a low degree of control over policies and procedures concerning the management of personnel, finances and other resources.

**Funding:** Direct allocations in the national budgets are the usual source of funds in this organizational form. Funding instability has been a common problem in many countries according to Trigo (1986). In times of financial crisis, the ministry's research budget is often the first to be cut. Jain (1989) notes that some of the larger agricultural research systems of this kind have been successful in introducing reforms into the existing organizational framework, without severing their links with the government ministry. For example, the Department of Research and Specialist Services in the Ministry of Agriculture and Land Development in Zimbabwe has its own line budget.



**Figure 6.1.** Organizational chart (simplified) for Forest and Forest Products Research, Forest Department, Ministry of Lands and Natural Resources, Zambia, illustrating the ministry model of research organizations.

Source: Adapted from Zambia Forest Department 1987.

### THE AUTONOMOUS OR SEMI-AUTONOMOUS INSTITUTE

**Governance structure:** The autonomous or semi-autonomous institute is an administratively independent research organization. For example, it is the model used in Kenya for KEFRI, the Kenya Forestry Research Institute (Figure 6.2). A board of directors or trustees typically oversees the execution of the institute's mandate and has responsibility for policy guidance and management control. In some cases, a director general or chief executive officer may fill the role of the board of directors. In either case, the institute typically has formal reporting obligations to some public body (e.g., a ministry or research council) but it is legally independent of this body. A relatively high degree of independence results in greater control over internal organization, including criteria for recruitment, conditions of service, and separation from service, which are likely to differ from the country's civil service system.

A semi-autonomous research institute is legally independent of a line division of a ministry, but does not satisfy all of the criteria for definition as autonomous. The powers of the governing board of a semi-autonomous institute tend to be limited and basically advisory in nature. Semi-autonomous institutes are more directly linked with a particular ministry, which exercises considerable influence on policy (Jain 1989).

**Funding:** A special budget line in the national budget is the most common source of funding. In some cases, funding may be tied to specific revenue sources such as a tax on timber production or exports. The autonomy of the institute results in greater control over the management of funds, and has allowed some institutes to attract significant support from international donors. Fully autonomous institutes have complete control over their research budget, while semi-autonomous institutes depend more on the ministry for budgetary support. Neither autonomous nor semi-autonomous institutes are totally independent of the financial norms and audit requirements set forth by the government for publicly funded institutions, however.

### THE UNIVERSITY MODEL: INTEGRATED RESEARCH AND EDUCATION

**Governance structure:** The key feature of the university model is the integration of research and education. Extension activities are sometimes included in the same organizational structure, as in the U.S. land-grant university system. This organizational form has a high degree of autonomy and decentralized decision making due to the nature of university systems. The university model is a researcher-oriented system, with a great deal of decision making power resting with individual researchers.

**Funding:** Funding flows through a variety of mechanisms from public and private, national and international sources.

### THE RESEARCH COUNCIL

**Governance structure:** The research council is an autonomous or semi-autonomous organization governed by a board of directors or trustees, whose members represent various institutions and interest groups. This organizational form is a relatively recent development, and often has been used to achieve more effective coordination and planning in research systems made up of several institutions with overlapping mandates and different organizational structures. Research councils also have been set up to replace ministry-based research systems and free the research service from the civil service system and other bureaucratic constraints.

## KEFRI's ORGANIZATION CHART

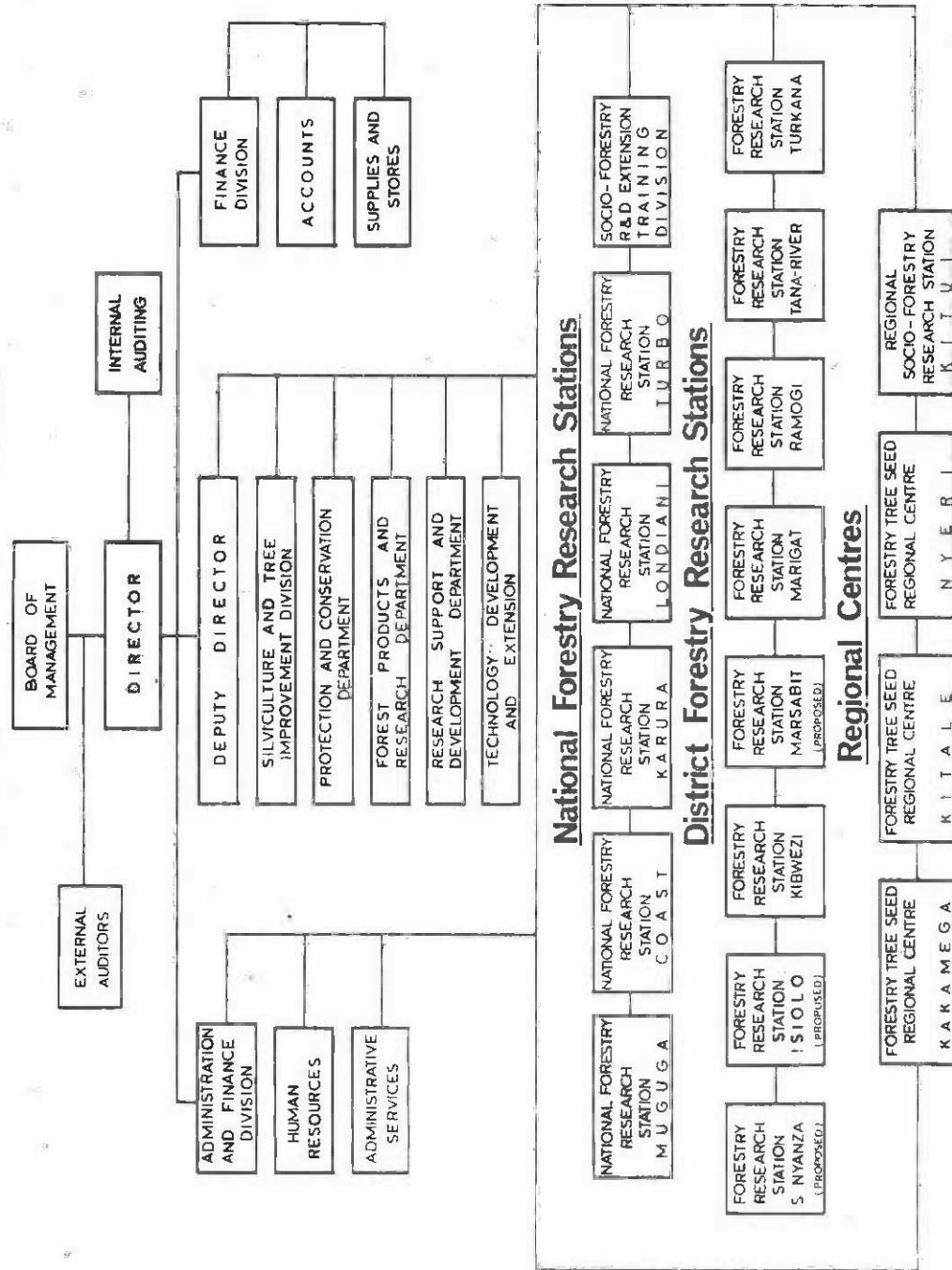


Figure 6.2. Organizational chart for the Kenya Forestry Research Institute (KEFRI), illustrating the autonomous institute model of research organizations.

Source: Kenya Forestry Research Institute. 1987.

Jain (1989) identifies three types of research councils: managing councils, funding councils, and coordinating councils. Managing councils are all-encompassing, with responsibility for planning, organizing, and managing all government-funded research in a particular field. Funding councils control the disbursement of government research funds. Scientists from universities and government research institutes must come to the funding council to get funding for proposed programs and projects. The funding council is, therefore, in a powerful position to define research priorities and shape the national research program. Coordinating councils have much less authority, and focus on coordinating research for the entire country through development of national research plans and periodic reviews of experiment stations.

**Funding:** As indicated above, research councils are sometimes responsible for decisions on the allocation of research funds among institutions that conduct research, and for coordinating external financial assistance. In the case of coordinating councils, they have little or no control over funding.

#### **PRIVATE SECTOR RESEARCH**

Forestry research in the private sector is currently very limited in most developing countries. In developed countries, responsibility for certain types of research and research-related services has gradually been transferred to the private sector over the past 50 years. Jain (1989) states that the developing countries will likely follow the same evolutionary route over time to achieve greater economy, accountability, and relevance in their research programs. In the developed countries, most adaptive research is carried out in private firms, which enables public research organizations to focus their limited resources on basic and applied research.

**Governance structure:** There are two basic types of private sector involvement in forestry research, although the second is very limited in developing countries: (1) research departments of forest products firms or firms producing inputs such as seedlings or wood processing equipment, and (2) research in industry associations or cooperatives. In both cases, research mandates tend to be narrowly focused with program policy subordinate to the firm or industry association. Autonomy in program and administration tends to be low in research departments of firms. Research is closely linked to the firms' production and marketing strategies.

**Funding:** The funding of private sector research through the firm's budget can create instability. Often research budgets are linked closely to company sales or profits, and research is the first area to be cut in a recession.

#### **DESIRABLE FEATURES OF THE ORGANIZATIONAL STRUCTURE**

The fact that one organizational model has certain advantages over other models (e.g., greater autonomy) does not imply that it is superior in all circumstances. For example, a high degree of organizational autonomy may not be congruent with a nation's system of government or culture. No one organizational approach can be considered optimal across all countries. The organizational structure of a forestry research institute should be consistent with the country's forestry conditions and a host of other national characteristics. Moreover, the most effective way to organize research within a country will likely change over time as the political system changes, the economy grows, the educational system

develops, the private sector develops its own research capacity, and so on. Flexibility of the research organization and an ability to respond to change are thus important characteristics.

Three key desirable features of an institution's organizational structure are discussed here: a sufficient degree of organizational autonomy, an appropriate degree of centralization, and congruence with national characteristics.

#### **SUFFICIENT DEGREE OF ORGANIZATIONAL AUTONOMY**

To be effective, research organizations need policies and procedures that are consistent with the special characteristics of the research process. A degree of autonomy sufficient to establish such procedures is therefore a highly desirable feature of the organizational structure of research. Due to a relatively low degree of autonomy in the ministry model, research systems organized in this way sometimes use an unmodified civil service system that rewards researchers primarily on the basis of length of service and punctuality instead of the quality, creativity, and relevance of their research. The use of unmodified civil service systems for scientists in public forestry research institutes in some Asian countries has resulted in dissatisfaction among scientists and low research productivity (SEARCA 1982, Putti 1986).

Financial management practices is another area in which a degree of organizational autonomy is desirable. Practices designed to provide a high degree of financial control in large bureaucracies are likely to be too rigid for a research organization, where timeliness and flexibility are essential. A lack of autonomy in financial management and control can create decision making bottlenecks, including delays in training programs, complex accounting systems that require considerable effort for what should be simple transactions, and lengthy delays in the execution of building programs (Iyamabo 1976).

#### **APPROPRIATE DEGREE OF CENTRALIZATION**

Warnings against too much centralization in the organization of research are often heard. A research system with strong "top down" direction may be insensitive to more local priorities. Since forestry research is often highly location specific, decision making should be responsive to local needs and priorities. Centralized research systems also may impose excessive bureaucratic constraints and burdens on researchers and managers.

On the other hand, some degree of centralization is necessary to coordinate programs, direct research toward national priorities, and efficiently provide support such as library and documentation services. It is generally recognized that a trade-off exists between the flexibility and responsiveness of a decentralized research system and the stronger national budget support, more effective coordination and planning, and more efficient provision of support services in a system with a strong central direction. The appropriate balance between these opposing forces will depend largely on various national characteristics.

#### **CONGRUENCE WITH NATIONAL CHARACTERISTICS**

Finally, the organizational structure of research should be consistent with a country's characteristics, especially the availability of resources and institutional and cultural characteristics. Resources devoted to forestry research must be in line with the importance of the forest-based sector and what the country can afford. Administrative costs are likely to be proportionately larger in highly autonomous systems. Trigo (1986) notes that decentralized research systems are more management intensive than centralized

organizational structures. Therefore, an organizational structure with a relatively low degree of autonomy--as in the ministry model--may be most appropriate for small forestry research systems in small countries. Obviously, there may be a trade-off between congruence with national resources and desirable organizational features such as a high degree of autonomy and decentralization.

Congruence with social and cultural characteristics and with the existing political-administrative structure in a country also are important. Ruttan (1981) contrasts the organization and management of public agricultural research in the Philippines and South Korea. Both systems have substantial research capacity. But the Korean system employs a "concentrated" management style and highly centralized administration of research, while the Philippine system is more decentralized. A relatively centralized organizational structure for research might work well in hierarchical cultures, but may be less effective in countries in which vertical social relationships are not stressed.

# PART III

## Planning Research Programs

Planning is a key function of management. Three main types of planning are recognized here. First, there is strategic planning at the policy or agency level, i.e., planning to establish goals and objectives, to set boundaries, and to establish the strategy for achieving goals and objectives (Chapter 8). Second, there is research program planning, which attempts to identify and organize the means for implementing a strategy over time (Chapter 9). Third, there is annual planning, or the planning and budgeting of short-term operational work plans (Chapter 10). In addition to considering these three types of planning, Part III also takes a look at issues related to financing plans, once they have been established (chapter 11).

## Overview of the Planning Process

Planning is a vital activity in research, particularly in developing countries, for several reasons. First, planning is especially important where resources are severely constrained and it is essential that limited means are applied as efficiently as possible to the solution of high priority problems. Second, planning takes on greater importance when a relatively large proportion of research is "mission-oriented" or applied in nature, as opposed to basic research. Gregersen (1984) reports less emphasis on basic research in forestry research institutions in developing countries relative to developed countries. Third, research organizations in the early stages of institutional development, with a significant proportion of relatively inexperienced scientists, often adopt a project-oriented approach to research planning and management rather than a researcher-oriented approach with more autonomy for scientists. This requires careful planning, monitoring, and evaluation (McLean 1988). Fourth, effective planning is related to political support for research. Mobilizing funds for research will be greatly facilitated to the extent that an organization is able to demonstrate that it is responsive to high-priority forestry and national development goals. Finally, the uncertain and long-term nature of research in general and forestry research in particular suggests the importance of the planning function.

This chapter provides a brief overview of the research planning process (the following three chapters cover planning in more detail). Key terms are defined, including mission, goals, and objectives. Three levels or types of planning are briefly described (strategic, program, and annual). Finally, characteristics of effective research planning are described.

The focus in this chapter and the following chapters is on research planning at the organizational level, rather than the national or system level (i.e., the entire national research system). Strategic planning and some form of operational planning should also take place at the national or highest policy level, but the intent here is to focus on research planning that is most relevant for managers.

### DEFINITION OF KEY PLANNING TERMS

A set of definitions for the terms used in describing the planning process is necessary so that everyone involved in research planning has a common understanding of the terminology. Terms such as goals and objectives are often used loosely in everyday speech, and clear definitions are important to avoid ambiguity.

**Mission** is the broad statement of purpose that shapes and guides what an organization is, what it does, and why it does it. A mission statement defines the boundaries of the organization's territory (Theron 1989). It should grow out of answers to the following questions: Why are we here? Who are we as an organization? What social needs should we be filling? What is our philosophy and what are our key values? What makes our organization unique?

**Goals** are broad statements of the intended outcomes of each research program or major activity of the organization; they are the desired impacts on society of the outputs of research. In order to serve as useful guides to research managers, goals should be

well-defined and achievable. They should answer the question: "What do we want to achieve in the next few years?" Goals should relate to broader national development goals. Several categories of goals may be distinguished, including:

*Economic goals, such as:*

- increased productivity of timber production
- increased foreign exchange earnings through exports of forest products
- increased national self-sufficiency in wood products

*Social goals, such as:*

- increased productive employment in forest-based rural enterprises
- more equitable distribution of income between sectors, regions, income groups, etc.
- increased net income to small landowners
- increased community stability

*Environmental goals, such as:*

- protection of endangered species
- preservation of threatened or fragile ecosystems
- preservation of biodiversity
- development of environmentally sustainable forestry practices
- maintain and protect water quality

*Scientific goals, such as:*

- increase basic understanding of tropical forest ecosystems
- increase basic understanding of wood properties

Goals may sometimes be in conflict with each other. For example, increased self-sufficiency in wood products may conflict with the preservation of biodiversity. One of the main functions of research planning is to prioritize research goals while explicitly recognizing trade-offs between conflicting goals.

Objectives are statements of the specific results which the research organization seeks to accomplish in a relatively short period of time. Objectives are the tangible outputs of research, and they should be stated in terms of specific quantities or targets, and the time and cost needed to achieve them. Each broad goal is supported by one or more specific objectives. For example, under the goal of "Increased productive employment in forest-based rural enterprises," research objectives might include:

- development and dissemination of small-scale portable sawmill technology that will result in 2,000 new jobs nationwide when fully adopted in 5 years
- development of high efficiency wood stove technology and promotion of village-level businesses to produce and distribute these stoves

Explicit research objectives are necessary for effective monitoring and evaluation of research. The progress of a research program or project should be monitored and performance evaluated against a set of well-defined objectives. Evaluation of the relevance of a research program or project requires clearly stated objectives that relate to broader research goals and national development goals.

### THREE PLANNING LEVELS

Three distinct types of research planning may be distinguished: strategic, program, and annual. These categories differ in terms of purpose, time frame, level of detail, exactly who is involved in the planning process, and the criteria for priority-setting.

**Strategic planning** is concerned with defining the overall direction and purpose of an organization. As such, strategic planning should address the mission and broad goals for the entire research organization and strategies for accomplishing the mission. The time frame for strategic planning is most often long-term, perhaps five to ten years or more. Senior research managers typically have the responsibility for strategic planning, but others should be involved in the planning process, including top researchers or team leaders and key stakeholders. Chapter 8 describes strategic research planning in more detail.

**Program planning** uses the output of strategic planning as an important input. The research program plan provides much more detail on specific goals and objectives that relate to the organization's mission as set forth in the strategic plan. Proposed research programs should be clearly defined in terms of purpose, relevance to national development goals, and the organization's mission and goals. Estimated resource requirements for each program should be given, and individual research projects that fall under each program should be specified to the extent possible. The time frame for program planning is typically three to five years. Chapter 9 describes program planning in more detail.

**Annual planning and budgeting** uses the output of strategic and program planning as input. Objectives, resource requirements, and the allocation of resources among programs and projects within programs are very specific at this planning level. An annual research plan outlines what the organization expects to achieve over the next fiscal year and the inputs required (money, person-years, etc.). The annual plan is important in monitoring and evaluating programs and projects (comparing planned and achieved outputs), personnel appraisal, and financial control. Budgeting is an integral part of annual planning. Chapter 10 describes annual planning and budgeting in more detail.

### CHARACTERISTICS OF EFFECTIVE RESEARCH PLANNING

**Dynamic.** If planning is to be effective, the planning process must be dynamic. The objectives, goals, and even the mission of a research organization must be responsive to changing social, economic, legal, environmental and other conditions. Government policies and national development goals are not constant. To be relevant, the research mission and goals must be periodically re-evaluated and adjusted in light of such change. Indeed, one of the fundamental purposes of strategic planning is to examine trends in the external environment and assess the implications of change for the research organization. Yet strategic planning is often lacking, even in well-established research organizations.

**Realistic.** Research planning must be realistic. The planned program of research or research project must be capable of being carried out given available or expected human, financial, and physical resources. Research plans that are beyond the capacity of the organization to accomplish will be counterproductive, setting up unattainable expectations for the productivity of individual scientists, projects, programs, and the entire organization. Failure to achieve the objectives or contribute to the goals specified in planning documents because of unrealistic planning may also weaken political support for the organization.

**Tailored to the size and resources of the organization.** How much planning is enough? How much is too much? It is important to strike a balance between insufficient planning and over-planning, or devoting excessive managerial time and other scarce resources to planning activities given the size and resources of the organization. If the planning effort is insufficient, an organization will lack direction and purpose, and ultimately will be less effective in its contribution to society. If planning is excessive, planning may become an unproductive end in itself, resulting in organizational stagnation. Effective planning systems are appropriate to the size and resources of the organization.

**Not burdensome to scientists.** All research planning systems require some input from scientists. But planning systems that place heavy demands on working scientists and keep them from their research will adversely affect the productivity of the research organization. In a review of agricultural research systems, Ruttan states: "I am concerned about excessive administrative burden that stifles both routine investigation and research entrepreneurship." (1981). A survey of forestry research institutions found that some developing country institutions place a heavy administrative work load on scientists (Bengston 1989c). Effective planning systems do not place excessive demands on scientists.

**Include input from the field.** A common shortcoming of research planning efforts is that managers and researchers frequently lack information about problems in the "real world," about forestry problems that forestry agencies, firms, forest rangers, farmers, and other potential research clients continuously face. Research programs become divorced from reality and lack relevance when research planning does not actively seek out and draw ideas and priorities from problems in the field. Potential clients for research results should be used effectively as partners in the planning of research programs, particularly in developing research strategies for the organization.

**Flexible.** Planning should be flexible. It should not become an organizational straightjacket that prevents scientists and managers from taking advantage of new opportunities and promising directions that emerge from on-going work. Managers should recognize that all research plans are based upon inherently uncertain forecasts of future events. As unexpected, unintended changes take place, managers and scientists should be prepared to depart from prepared plans to take advantage of or cope with these changes. Yet, the need to be flexible must be tempered with the need for stability of research programs over long periods of time in many areas of forestry research. Departures from carefully formulated plans should be made only after consultation with the scientists, users, managers, and funders who are likely to be affected by changes in planned activities.

# Strategic Research Planning

## INTRODUCTION

### WHAT IS STRATEGIC RESEARCH PLANNING?

Bryson (1988) defines strategic planning as "...a disciplined effort to produce fundamental decisions and actions that shape and guide what an organization... is, what it does, and why it does it." Strategic research planning is concerned with developing the mission and direction of a research organization (where are we going?) and broad strategies for accomplishing the mission (how do we get there?). Successful strategic planning involves confronting difficult choices, setting broad priorities, envisioning the organization's future, and developing procedures to achieve that future (Pfeiffer et al. 1989). The time frame is long-term, five to ten years or longer in some cases. Strategic planning is the responsibility of senior research management.

A distinction should be made between strategic planning and long-range planning. Strategic planning:

- focuses more on identifying and resolving issues;
- emphasizes assessment of the environment outside and inside the organization to a much greater extent; and
- is concerned more with the "vision of success" of the research organization and how to achieve it.

Long-range planning:

- focuses more on research planning to achieve specified objectives of the organization;
- emphasizes management of the internal environment, the human, financial, and physical resources expected to be available to the research organization; and
- is concerned more with long-term planning for an expected future.

Long-range planning has the flaw of focusing managers' attention on predicting rather than creating the future (Hanna 1985).

### WHY IS IT NEEDED?

Research organizations need to respond quickly and effectively to changing circumstances. Uncertainty and turbulence frequently characterize the external environment in which research organizations operate. Strategic planning helps to define an overall sense of direction and purpose for a research organization, and thereby helps managers respond to change. Hanna (1985) and Barry (1986) identify several potential contributions of strategic planning, including:

- providing direction, coherence, and unity to organizational efforts,
- improving organizational performance,

- introducing a discipline for long-term thinking,
- raising awareness about the external environment,
- enhancing the dialogue among managers on strategy,
- building teamwork and planning expertise,
- stimulating forward thinking in the organization, especially among top managers.

This last point is perhaps the most important contribution. Strategic planning is not an end in itself, but should help research managers think and act strategically. Successful research organizations always have been guided by strategic thought and action, and a strategic planning process can aid in developing this perspective.

### THE STRATEGIC PLANNING PROCESS

This section provides a systematic approach to strategic research planning that can be adapted to the needs of a particular research organization, and implemented by existing personnel at a reasonable cost and in a timely fashion. Worksheets that may be used by the planning team to facilitate the process are given in Appendix 8.1. The following strategic planning process is adapted from Bryson (1988), Pfeiffer et al. (1989), and Barry (1986), and is depicted in Figure 8.1. It involves seven major steps:

1. initiating and agreeing on a strategic planning process,
2. identifying and clarifying organizational mandates,
3. conducting a stakeholder analysis,
4. developing a mission statement,
5. assessing the external and internal environments,
6. identifying strategic issues, and
7. formulating strategies to manage strategic issues.

The following sections describe each step.

#### 1. *Initiating and agreeing on a strategic planning process.*

The first step in strategic planning is to reach initial agreement about the nature, purpose, and process of strategic planning. A strategic planning team should be formed to address the following important preliminary questions: Who should be involved in the effort (individuals and organizations)? Who will be on the strategic planning team? Who will oversee the effort? What are the potential benefits to the organization of strategic planning? What resources are needed to proceed with the effort? What are the desired outcomes? What specific steps should be followed? What should be the form and timing of reports? Exhibit A1 in Appendix 8.1 is a worksheet to deal with these initial questions.

Key research decision makers should be included on the planning team, and perhaps some representatives of important external "stakeholder" groups (e.g., representatives from forest-based industries, conservation groups, government agencies that use research results, etc.). On the other hand, research managers may decide not to involve external stakeholders initially, until they become more comfortable with strategic planning--outside involvement will complicate the process. Representative team leaders and scientists should also be involved from the beginning. In small research organizations, the planning team may be very small, consisting of a few key individuals. In large organizations, two groups may be required to help ensure an effective planning effort: a relatively large group to provide broad representation and legitimization of the planning process, and a smaller

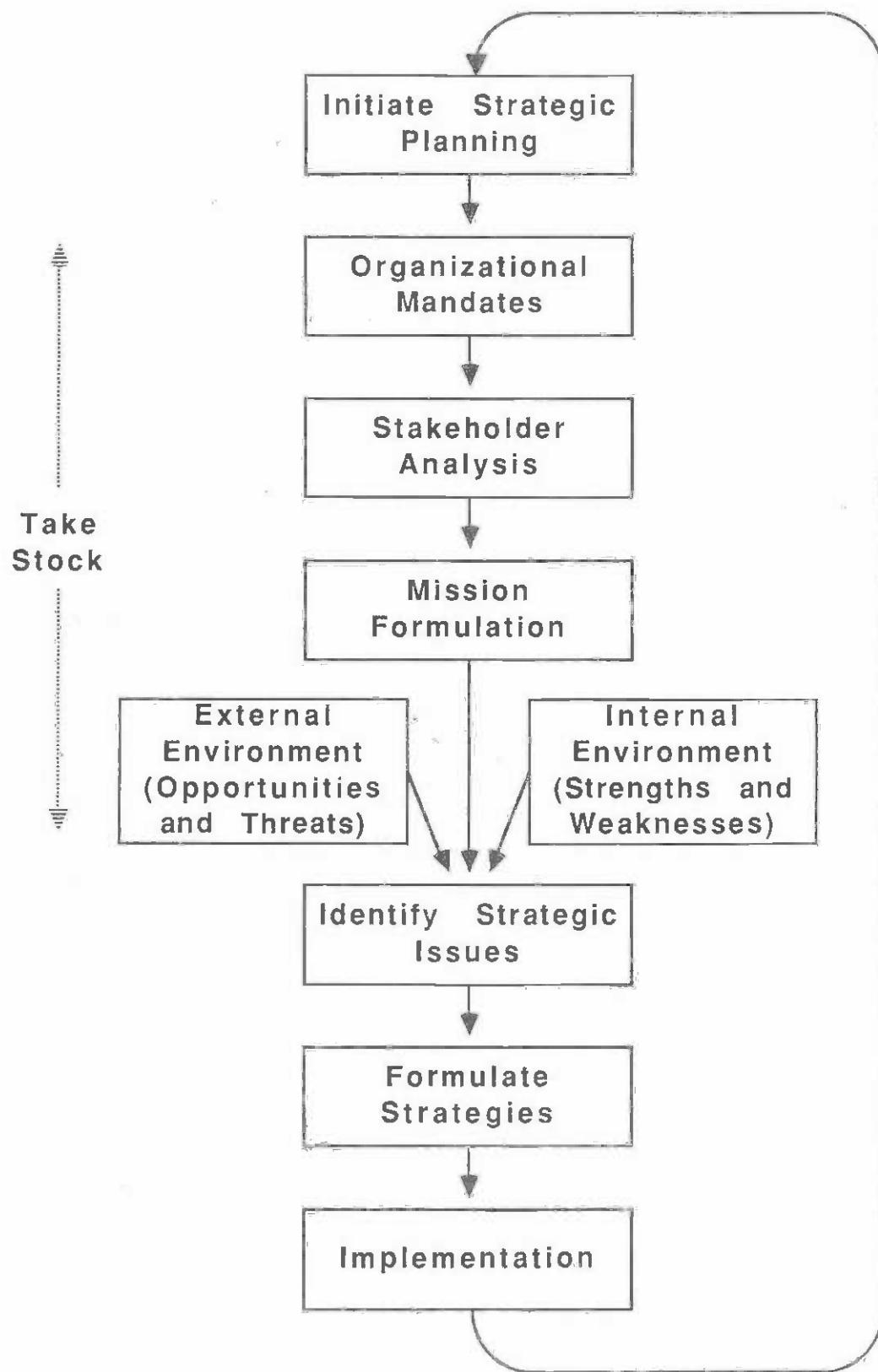


Figure 8.1. The strategic planning process.

Source: Adapted from Bryson (1988), Pfeiffer et al. (1989) and Barry (1986).

executive committee that does most of the actual work and makes recommendations to the larger group.

## *2. Identifying and clarifying organizational mandates.*

What is the research organization required to do and not do? Consideration should be given to **formal** mandates such as legal requirements and authorizations and government policy and appropriations, and **informal** mandates such as interest group reports, agreements and understandings with other organizations, social norms, etc., that are no less binding. The purpose of this step is to identify externally imposed mandates and clarify how they affect the research organization. By clarifying what is not ruled out by the mandates, the rough boundaries in which the organization may operate become clearer.

The process for identifying organizational mandates is straightforward. The strategic planning team (or several individual members) compiles a list of formal and informal mandates affecting the organization (exhibit A2, Appendix 8.1). This list is reviewed and modified by the entire planning team in order to clarify what the various mandates imply for the organization, i.e., What is required? What is allowed? Organizational mandates are one of the important inputs into developing a mission statement in step 4 below.

## *3. Conducting a stakeholder analysis.*

Stakeholders are defined as people, groups, or organizations that have a claim on the research organization's attention, resources, or output, or are affected by that output. Examples of stakeholders for a research organization include public officials, governing bodies, a wide variety of interest groups (industry groups, conservation groups, etc.), extension agents and organizations, future generations, small farmers, taxpayers, other public and private research organizations within the country, research organizations in other countries, educational institutions, international donor and technical assistance agencies, and employees. Important employee groups should be explicitly identified as stakeholders. Scientists are perhaps the most important employee group, because their own satisfaction is vitally important to the success of a research organization. Moreover, scientists tend to judge organizational performance based on standards of scientific research, and it is the scientists who hold the organization to exacting scientific and professional standards to a greater extent than other stakeholder groups.

A key to the success of a research organization and its ability to generate financial and political support is the satisfaction of key stakeholders. An organization that does not have a clear idea of who its stakeholders are, what they want from the organization, and how they judge the organization will have little chance of satisfying them. The stakeholder analysis can be structured around the following questions:

- Who are the organization's stakeholders?
- What do they want from the research organization?
- What criteria do they use to evaluate the organization?
- How is the organization performing against those criteria?

The first question can likely be answered through a brainstorming session of the strategic planning team. The second and third questions can be approached in two ways. One is for the planning team to make informed judgments about what stakeholders want and their evaluation criteria. The second approach is to ask the stakeholders, through interviews or

surveys, what their wants and criteria are. The first approach is obviously much faster and avoids any problems with stakeholders not being completely honest. For example, an elected official may be concerned primarily with whether the performance of the research organization enhances his prospects for reelection, but he would be unlikely to publicly state this criterion.

The fourth question to be answered in the stakeholder analysis concerns how well the organization performs against the stakeholders' criteria. For the purpose of prompting useful discussion on this question, it may be sufficient to indicate whether the organization's performance is poor, sufficient, or excellent relative to the various criteria. Exhibit A3 in Appendix 8.1 is a worksheet for a stakeholder analysis. Once the planning team has completed the stakeholder analysis, it should serve as a basis for discussion of exactly how the various stakeholders influence the organization and which are the most important stakeholders. It may be useful to order the stakeholders according to their importance to the organization.

#### *4. Developing a mission statement.*

A well-conceived mission statement can be a valuable management tool, providing future direction and a basis for decision making. A mission statement ideally should serve as a guide to what management wants the organization to be (Pfeiffer et al. 1989). It should remind and motivate researchers and other employees to identify with the goals and philosophy of the organization, and orient employees toward the national needs that the organization exists to fill. Mission statements also fulfill an important public relations role by concisely communicating to stakeholders what the organization is all about. Unfortunately, most forestry research organizations do not have mission statements--they are noticeably absent from annual reports and other key documents.

The stakeholder analysis provides information that is useful in developing a mission statement, but much more is needed. The mission statement should grow out of responses to the following questions:

- Who are we as an organization?
- What social needs do we exist to fill?
- What should our organization do to recognize or anticipate and respond to these needs?
- How should we respond to our key stakeholders?
- What is our philosophy and what are our core values?
- What makes our organization distinctive or unique?

Thoughtfully addressing these questions and developing a mission statement is a demanding process. The strategic planning team should answer the questions individually first, and then come together as a group for discussion (see exhibit A4 in Appendix 8.1). Following the group discussion, the task of developing a draft mission statement for further discussion should be assigned to an individual. The draft mission statement should be discussed and modified as needed throughout the remainder of the strategic planning process. Figure 8.2 is an example of a forestry research mission statement for the Forestry Research Institute of Malaysia (FRIM).

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Mission: FRIM shall develop appropriate knowledge and technology for the conservation, management, development and utilization of forest resources; and shall pursue excellence in scientific research, development and extension in the forestry sector.

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**Figure 8.2. Forestry Research Institute of Malaysia mission statement.**

Source: Cheah Leong Chiew, personal communication.

### *5. Assessing the external and internal environments.*

A major purpose of strategic planning is to identify external threats and opportunities that may demand a response in the foreseeable future. The idea is to prepare an organization to respond effectively before a crisis develops or an opportunity is lost. Assessing trends in the external environment for research is therefore an important part of strategic research planning. What are the recent issues and emerging trends affecting the research organization? This could include political, economic, social, technological, and environmental trends and issues that may be local, national, or worldwide in scope.

Some large public organizations use formal, institutionalized "external scanning" procedures (Pflaum and Delmont 1987). But elaborate and demanding procedures are generally less desirable than simple and practical approaches. Most research organizations rely on the knowledge of members of the strategic planning team and use group discussions to identify external threats and opportunities and assess their significance to the organization. Other approaches might include workshops involving stakeholder representatives to identify major issues, or various survey techniques (e.g., Milne 1988, Jakes et al. 1989).

The internal environment also should be assessed to identify strengths and weaknesses that help or hinder the organization in carrying out its mission. Categories of internal strengths and weaknesses include:

- the resources available to the organization (such as scientific and technical personnel; support personnel; scientific equipment, facilities, and supplies; library and information resources; computer resources; funding);
- the organizational structure (see chapter 6); and
- the organization's performance (outputs and the impacts of outputs on clients).

Using these categories, the planning team should develop a list of the major internal strengths and weaknesses of the organization. This list, along with the list of external opportunities and threats, should then be discussed and analyzed. Pfeiffer et al. (1989) note that scanning and assessing the external and internal environments should be a continual activity in an organization so that relevant information is always available to key decision makers. Exhibit A5 in Appendix 8.1 is a worksheet for assessing the external and internal environments.

### *6. Identifying strategic issues.*

The preceding steps of the strategic planning process lead to the identification of strategic issues facing the research organization and developing strategies to manage them. Bryson (1988) defines a strategic issue as a fundamental policy choice facing an organization. For

research organizations, strategic issues affect or call for a reexamination of the organization's mandates, missions and values, and the kinds, levels, and mix of research services provided. Strategic issues usually arise when:

- external events beyond the control of the organization make or will make it difficult to accomplish objectives with the resources available;
- choices for achieving organizational objectives change, or are expected to change (e.g., changes in technology, financing, staffing, or management); or
- new opportunities arise (Bryson et al. 1985).

Examples of strategic issues that might face a research organization include an increasing rate of deforestation, increasing conflicts among groups that utilize forests (Jakes et al. 1989), long-term decline in real research budgets or civil service salaries (Bengston 1989b), and privatization of research (Theron 1989). In identifying strategic issues, particular attention should be given to potential discontinuities which might have a major impact on the organization (Hanna 1985).

The process of identifying strategic issues involves first reviewing the mandates, mission, external threats and opportunities, and internal strengths and weaknesses. Each member of the planning team is then asked to individually identify strategic issues by answering for each issue three questions:

1. What is the issue? The issue should be described succinctly in a single paragraph and should be framed as a question that the organization can address.
2. What factors make the issue a fundamental policy question? How does the issue affect mandates, mission, internal strengths and weaknesses, etc.?
3. What are the consequences for the organization of not addressing the issue? If there are no consequences, it is not a strategic issue; if the organization will be significantly affected by failure to address an issue or will miss an important opportunity, the issue is highly strategic and should receive high priority.

Planning team members will need time to reflect on these questions, and at least a week should be devoted to individual identification of strategic issues. The entire planning team then convenes and develops tentative agreement on what the issues are. Each issue should be summarized on a single page, addressing each of the three questions posed above. Strategic issues are then prioritized to aid in developing strategies to deal with the issues. A worksheet for identifying strategic issues is shown in exhibit A6 in Appendix 8.1.

## *7. Formulating strategies to manage strategic issues.*

Bryson (1988) recommends a five-part process for development of strategies to manage strategic issues. For each issue that has been identified, the following questions should be addressed:

- What are the practical alternatives the organization might pursue to address a particular strategic issue?
- What are the barriers to realization of these alternatives?
- What major proposals might be pursued to achieve the alternatives directly or to overcome the barriers?

- What actions must be taken within the next year to implement the proposals?
- What specific steps must be taken within the next six months to implement the major proposals and who is responsible?

The purpose of these questions is to clarify exactly what has to be done and who has to do what in order to deal effectively with each strategic issue. For example, suppose a strategic issue facing a research organization (posed as a question that the organization can address) is: How can we best recruit and retain a highly talented and qualified research staff? Practical alternatives to address this particular issue might include:

- Better anticipate shortages of trained research personnel.
- Simplify hiring practices.
- Develop and maintain close ties with universities to identify potential researchers for recruitment.
- Improve the system of rewards and incentives for researchers to increase retention of researchers.

Using the last alternative as an example, potential barriers to realizing this alternative might include:

- Lack of funding to increase researcher salaries.
- The existing civil service system is rigid and limits possibilities for career advancement in research.
- Lack of funding to establish a program of financial awards for outstanding researchers.

Proposals to achieve the alternative directly (improve the system of rewards and incentives for researchers) or to overcome the barriers might include:

- Establish a program of nonfinancial awards and recognition to reward outstanding research productivity, quality, contributions to technology transfer, and other achievements.
- Provide opportunities for international travel (to attend scientific conferences or training courses) as a reward for productive researchers. Seek funds from international sources.
- Provide nonsalary benefits such as housing to productive researchers. Seek funds from international sources.

The last two questions of the five-part process involve identifying the specific actions that need to be undertaken and assigning responsibility for carrying out the strategy to an individual or ad hoc committee. Alternatively, the planning team may address only the first question--identifying practical alternatives to deal with a strategic issue--and a key staff member should then be assigned to follow up on one or more of the alternatives as part of the implementation of the strategic plan. Exhibit A7 in Appendix 8.1 is a set of worksheets to aid in formulating strategies.

The final written strategic plan should not be overly long--it should be a summary of the planning team's efforts, usually 10 to 15 pages. The simplest form for a written strategic plan consists of the final versions of some of the worksheets completed by the planning team, with the following components:

- Mission statement
- Organizational mandates (formal and informal)
- External opportunities and threats (factors that might affect the direction of future programs)
- Internal strengths and weaknesses
- Strategic issues facing the organization
- Strategies to manage the issues

A key staff person should be assigned the task of preparing the first draft of the written strategic plan. The draft is then reviewed and modified by other members of the planning team, key decision makers, and possibly by key external stakeholders. After a final review, the plan will be ready for formal adoption and implementation.

### IMPLEMENTING STRATEGIC PLANNING

The true test for any strategic planning process is the extent to which it affects the activities of the organization and the behavior of employees. The purpose of strategic planning is to develop a better road map to guide the organization. Unless this road map actually guides decisions and actions, the planning process is nothing more than an academic exercise (Pfeiffer et al. 1989). But implementation of the strategies developed does not follow automatically (Hanna 1985). Change will be threatening to some and almost inevitably faces resistance. Resistance to the implementation of strategies may take the form of procrastination, "paralysis by analysis," lack of implementation follow up, or even outright opposition.

The role of the Director General in implementing the strategic plan cannot be overemphasized. The Director General is closely involved in the process from the outset and must be totally committed to the strategic plan and lead the support. All managers need to be committed to the plan and should use it to guide decision making. Management must communicate the plan and its rationale to all employees, especially those that may be affected by it.

Periodic review and updating of the strategic plan and monitoring its implementation are vital. Every six months the specific steps to implement the plan should be reviewed. Every year or two the strategies to deal with strategic issues should be reviewed and progress evaluated. Every three to five years the entire strategic plan should be reviewed by the strategic planning team and modified as needed.

### LIMITATIONS OF STRATEGIC PLANNING

Strategic planning can be a powerful and practical tool in research, but it should not be oversold. The limitations and potential pitfalls of strategic planning should be clearly recognized. Barry (1986) and Rocheteau (1989) discuss the following limitations:

*Costs can outweigh benefits.* Depending on the scope of the planning effort, strategic planning may be costly in terms of money and human resources, especially the scarce time and efforts of high level research managers. The potential benefits of strategic planning should be weighed against these costs. If the planning effort is likely to be unsuccessful or to fall significantly short of expectations, resources devoted to planning would be used more productively for other purposes. The question, "Will the benefits of strategic planning outweigh the costs?" must be asked at the outset.

*Formal strategic planning may be unnecessary.* Some research organizations operate effectively by responding quickly to new opportunities and threats as they emerge, or "muddle along" without formal planning. A formal strategic plan may be unnecessary for small research organizations that operate effectively in this manner. In addition, some organizations have gifted leaders that instinctively think and manage strategically. Although such leadership is rare, organizations with unusually insightful and gifted leaders may not need to develop a formal strategic plan.

*Planning may become a bureaucratic exercise.* One of the main goals of strategic planning is to help research managers think and act strategically. But formal planning efforts sometimes become bureaucratic exercises that actually dampen initiative, creativity, and risk-taking. Some planners may focus excessively on the planning process and neglect strategic thinking.

*Planning may be over-emphasized.* The planning function is only one of the responsibilities of managers. Too much emphasis on planning may result in other vital areas being neglected. Development of a strategic plan should obviously be put aside when an organizational crisis develops, such as a severe cash shortage.

## Appendix 8.1: Strategic Planning Worksheets

Adapted from Bryson (1988) and Barry (1986)

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### Exhibit A1: Initiating and agreeing on a strategic planning process

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1. Who will be on the strategic planning team?
2. Are there others who should be involved in developing or reviewing the strategic plan?
3. Who within the organization will manage the strategic planning effort and lead the planning meetings?
4. List the benefits you expect from strategic planning:
5. List the concerns you have about strategic planning:
6. List the resources needed to proceed with the planning effort:
7. What should be the form and timing of reports, including approval of the final plan?

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## Exhibit A2: Identifying and clarifying organizational mandates

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1. List and briefly describe formal mandates for the research organization (e.g., legal mandates, government policies, etc.):
  - a.
  - b.
  - c.
  - d.
  - e.
  
2. List and briefly describe informal mandates for the research organization (e.g., agreements and understandings, interest group reports, social norms, etc.):
  - a.
  - b.
  - c.
  - d.
  - e.

**Exhibit A3: Conducting a stakeholder analysis**

Stakeholder	What do they want from our FRO?	Criteria they use to evaluate our performance	How is our FRO performing according to these criteria?
1.			
2.			
3.			
4.			
5.			

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## Exhibit A4: Developing a mission statement

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1. What social needs does our research organization exist to fill? What social problems do we exist to address?

2. What should our organization do to recognize, anticipate, and respond to these needs?

3. How should we respond to each of our stakeholders?

a.

b.

c.

d.

e.

4. What is our philosophy as an organization? What are our core values that provide direction and guidance to the organization and its employees?

5. What makes our organization distinctive or unique? (e.g., resources, mission, location, etc.)

**Exhibit A5: Assessing the external and internal environments**

---

External opportunities (list and briefly explain):

1.

a.

2.

3.

4.

External threats (list and briefly explain):

1.

2.

3.

4.

---

Internal strengths (list and briefly explain):

1.

2.

3.

4.

---

Internal weaknesses (list and briefly explain):

1.

2.

3.

4.

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### Exhibit A6: Identifying strategic issues

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1. What is the issue? (describe succinctly and frame as a question that the organization can address)
2. Why is this a strategic issue? (how does the issue affect mandates, mission, internal strengths and weaknesses, etc.)
3. What are the consequences for the organization of not addressing this issue?

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### Exhibit A7: Formulating strategies to manage strategic issues

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1. For each strategic issue, what practical alternatives might the organization pursue to deal with the issue?
2. What are the barriers to realization of these alternatives?
3. What major proposals might be pursued to achieve the alternatives directly or to overcome the barriers?
4. What actions must be taken within the next year to implement the proposals?
5. What specific steps must be taken within the next six months to implement the major proposals and who is responsible?

## Research Program Planning

### INTRODUCTION

#### WHAT IS PROGRAM PLANNING?

Program planning fills the large gap between strategic planning (which is long-term and broad in perspective, providing overall direction for the research organization) and annual planning (which is short-term, very specific, and closely tied to the budget process). The output of strategic research planning is a key input to program planning; the output of program planning is a key input to annual planning and budgeting. Program planning at the research organization level has been called "level 2" planning (Dagg and Haworth 1988), operational planning (Milne 1987), medium-range planning (Bengston and Kaiser 1988), and mid-term planning. Regardless of what it is called, developing the program of research that an organization will actually carry out is at the heart of planning at this level. A research program is the collection or aggregation of research areas (e.g., major problem areas to be addressed), the thrusts within each research area that the organization is pursuing or plans to pursue, and scientific and administrative support program areas such as library and information services, personnel services, etc.

The planning horizon for program planning is typically three to five years. It should be stressed, however, that if program planning is to be effective, it should be an ongoing process that is built into the structure and operating procedures of the research organization. Program planning should not be an isolated management activity. The ultimate responsibility for program planning rests with senior research management, but researchers, team leaders, and external stakeholder groups have important roles to play as well.

#### WHY IS IT NEEDED?

The impact of a research organization on society is largely determined by the relevance of its research program. If a research program addresses national development goals and high-priority problems in the forest-based sector, then the organization has the potential to make a significant contribution (given adequate resources, a favorable policy environment, and other factors that influence the effectiveness and efficiency of research). But without a relevant program of research, an organization has little or no chance for success. It is therefore worth spending a significant amount of management time and effort on developing a relevant program.

In addition to relevance, a program of research must be sufficiently focused, given the resources available for research and the capacity of the organization. Research organizations that spread their resources thinly over too many program areas and projects will be less effective than an appropriately focused organization. A lack of focus in forestry research programs relative to research resources has been repeatedly observed (cf., Wadsworth 1968, Brunig 1982, Lundgren et al. 1986). Iyamabo (1975) observed a tendency to spread limited research resources over a large number of tree species, rather than concentrating on carefully selected species with the greatest potential. This lack of focus

may be due to the fact that in many developing countries, a single government institute often has responsibility for research on all aspects of forestry, including silviculture, tree breeding, pathology, soils, ecology, wildlife, forest products, and the social sciences. The combination of broad research mandates and severely limited resources implies the need for careful planning to develop an appropriately focused program of forestry research.

## RESEARCH PROGRAM PLANNING: STRUCTURE AND PROCESS

Most public research organizations in developed and developing countries use a project-oriented approach to research planning and management. There are many variations of the project-based approach, depending on the size and complexity of the organization and other factors. This section briefly describes the structure and process of research program planning in a generalized project-based system.

### RESEARCH PROGRAM STRUCTURE

As illustrated in Figure 9.1, the structure of a project-based research program usually consists of three separate levels or components:

- a set of broad program areas,
- a set of research projects or units under each program area, and
- a set of individual studies within each project.

Research program areas are broad subject areas or topics for research that an organization is pursuing or plans to pursue. They are often defined along disciplinary lines (e.g., silviculture, plant pathology, etc.), although defining program areas by broad problems that cut across scientific disciplines may be a more desirable approach. The number of research program areas varies greatly between organizations: small research organizations with narrowly defined missions may have a single program area; large organizations with broad mandates may define ten or more program areas to pursue. Research program areas will also vary over time, as priorities and information needs change. Programs areas should be clearly defined, with goals and objectives explicitly stated and resource requirements (financial, human, and physical) specified to the extent possible. In addition to research program areas, Figure 9.1 shows two research support areas: scientific support services (e.g., library and information services, computing and statistical services) and administrative support services (e.g., personnel services, budget and finance). These support program areas are discussed in Chapters 16 and 17, respectively.

Research projects or units are often the building blocks of research programs. A project is defined as a self-contained area of investigation with specific goals and objectives which relate to a particular program area. Each research program area contains one or more projects. A research project or unit is defined by its goals and objectives, and by the individuals assigned to work within it: an experienced scientist designated as the team leader or project leader; from 0 to 10 or 15 additional researchers, depending on the scope of the project and availability of trained personnel; and technicians and other support personnel. The duration of a research project may be fixed (often five years), or it may be flexible, to be terminated or redirected with new objectives when the original objectives have been achieved.

Finally, each research project includes a set of individual research studies designed to generate specific information needed to fulfill the goals and objectives of the project. The

duration of studies within a project is highly variable, depending on the type of research and the nature of the experiments being carried out.

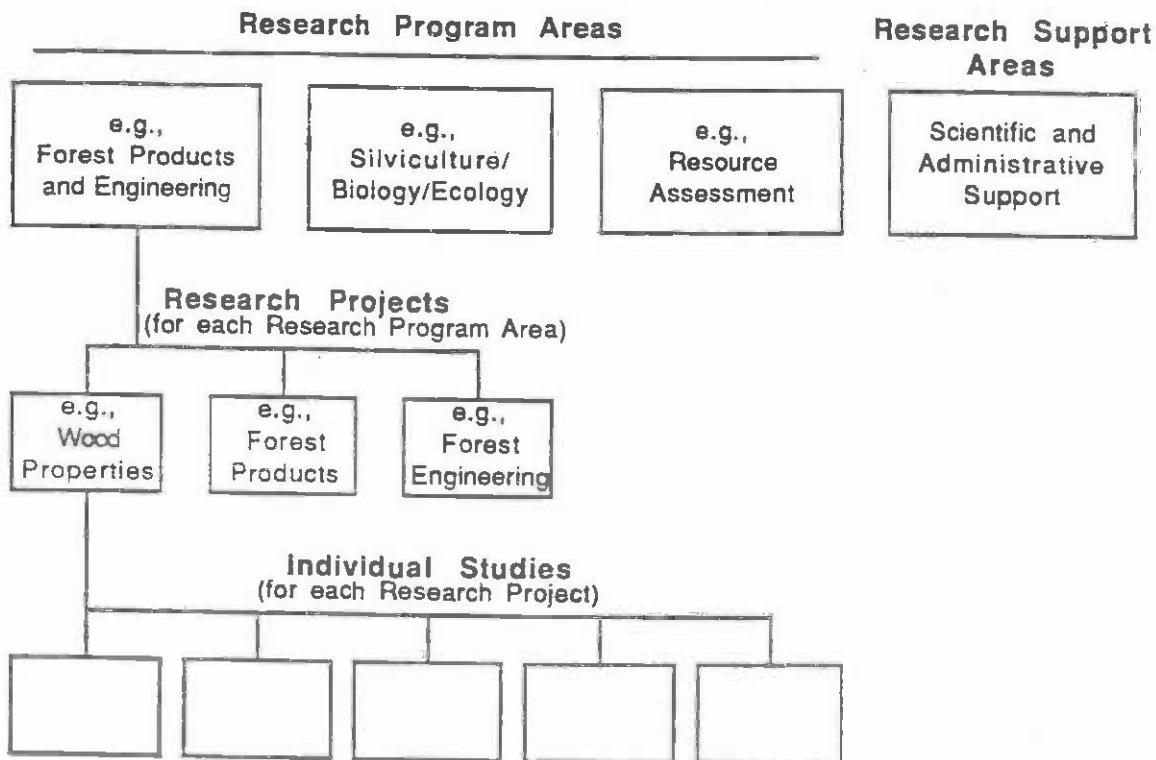


Figure 9.1. Generalized structure of a project-based research program.

#### RESEARCH PLANNING PROCESS

The planning of a project-based research program usually includes the preparation of three types of key planning documents that relate to the three program levels outlined above--program areas, research projects or units, and individual research studies. The three types of documents are: program plans, project descriptions, and research study plans.

Program plans summarize the specific research areas and projects included within each program area over the planning horizon (usually five years), along with the associated resource requirements for each program and project. A multi-year bar chart may be prepared and included for each project, depicting clearly defined objectives and timing for their achievement, plus a summary of resource needs. ISNAR (1987a) provides an outstanding example of this type of planning document. A key point about the overall program plan is that it should provide a solid basis for monitoring progress and evaluating performance of the organization, e.g., Have the specific objectives been accomplished on schedule? Have the anticipated impacts been achieved?

Project descriptions detailing each of the individual research projects also are important program planning documents. Project descriptions usually are prepared by a team leader, and should include:

- a statement of the project's mission
- the justification for the project
- identification of key problems to be addressed within the scope of the project and the approach to solving these problems
- objectives and planned outputs
- a plan of work that defines responsibilities of project members
- staffing and other resource needs
- a reporting schedule that identifies indicators or milestones that reflect progress

The third planning document is the highly detailed plan of study for individual research studies, prepared by the researcher and/or the team leader. A study plan should include:

- a statement of the research problem, and justification of the study in relation to the project in which it fits
- a clear statement of the specific research objectives
- importance of the work and previous work in the field
- a detailed description of how the work is to be carried out, including the scientific methods and procedures to be used in gathering and analyzing data
- cost estimates, including personnel needed and their skills, facilities required, duration of the project
- scheduling of the research and planned outputs
- planned technology transfer activities

#### PLANNING CONSIDERATIONS

Within this basic framework, the research program planning process should:

- include both external and internal input,
- be ongoing and iterative,
- incorporate monitoring and evaluation into the key planning documents.

*External and internal input.* Development of the research program should be influenced by both external and internal input. Figure 9.2 identifies key external and internal influences on program planning. Externally, input on research priorities and the nature of the research program should be actively sought from clients and other stakeholder groups. An assessment of the level of funding and the capacity of the organization anticipated throughout the program period is also required to set realistic constraints on the program.

Internally, team leaders and researchers submit proposals for research projects and studies, and advisory committees of researchers appointed by managers review and evaluate such proposals. (The vital role of researchers in program development is discussed further in the following section). The current capacity of the organization to initiate and carry out research may impose severe constraints on programs in the short-run, and may continue to affect organizational capacity for many years, since building up research capacity is a very slow process. The organization's strategic plan should be an important source of input concerning the overall direction and nature of the research program.

*Ongoing and iterative.* Planning and formulating the research program should be a continuous process. Research programs should evolve over time in response to changing information needs and other circumstances. There should be many feedback linkages built into the program planning process, and the entire process should be iterative. For example,

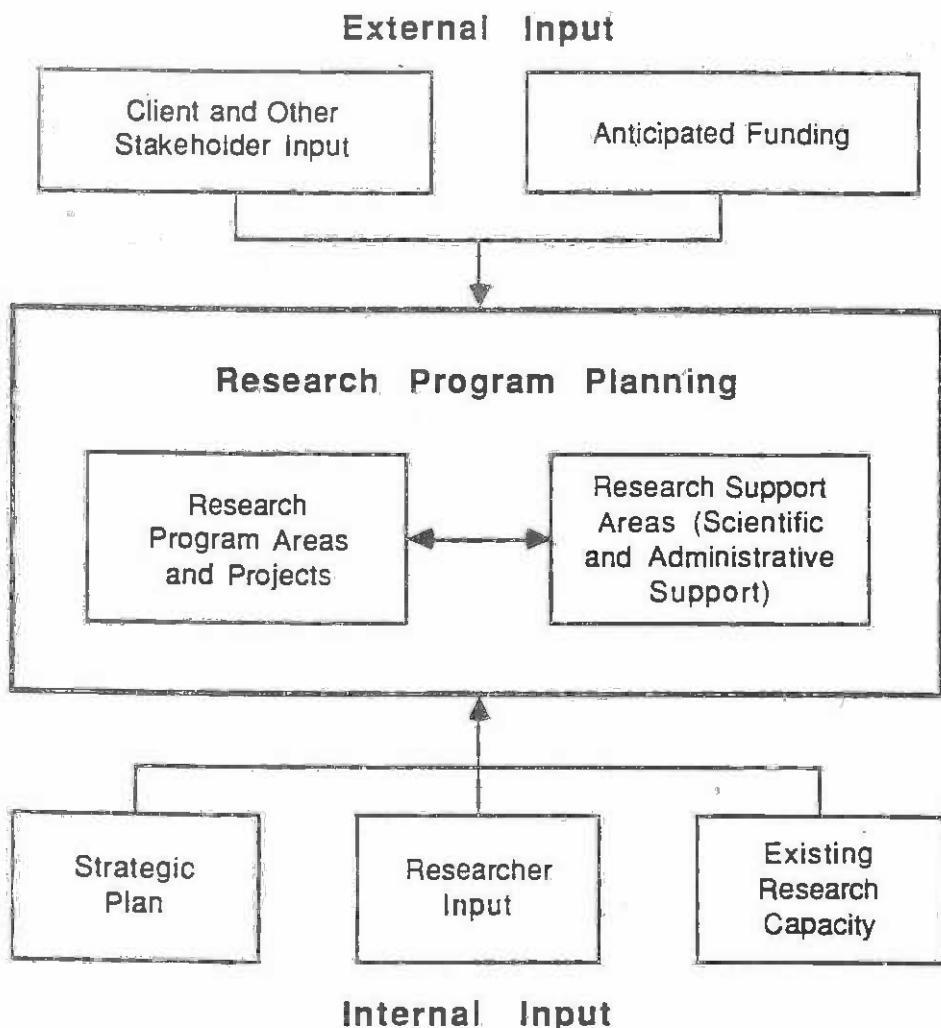


Figure 9.2. External and internal influences on research program planning.

the decision to initiate work on a new program area or research project should be preceded by repeated interaction with and feedback from policy makers, the research advisory board, external and international research organizations to help obtain access to the technology already available, scientists and team leaders to develop and evaluate proposals relating to the new program area, and other interest groups.

*Incorporate monitoring and evaluation into key planning documents.* Monitoring and evaluation of research programs should be ongoing and built into the key program planning documents described above.

If objectives and scheduling are clearly stated and refer to meaningful and observable achievements, project descriptions and study plans will be very useful in monitoring progress and evaluating performance relative to the stated objectives.

Monitoring and evaluation of research programs also should include external review teams on an as-needed basis (Ruttan 1978). These should be participatory reviews that include senior research management and monitor progress, identify problems, and evaluate alternative solutions. Action plans for needed follow up should be developed and tracked until all items are completed (usually within one year after the review). External review teams can provide useful insights in the evaluation of an organization's broad goals, objectives, and strategies, and its capacity to effectively carry out its proposed program of research. Members of such teams should resist the temptation of concentrating their review efforts on operational details such as performance appraisals of individual scientists and reviews of research methodologies used in individual studies.

In addition, a review of each research project or unit should be carried out by managers roughly every two years. These reviews serve as an important input into program formulation, and should include evaluation of research progress, staffing and training, program and budget development, support services, research facilities, and dissemination of research results (see Murphy 1985, Daniels 1987, McLean 1988a).

### **SPECIAL CONSIDERATIONS IN PROGRAM PLANNING**

Several aspects of research program planning warrant further discussion. This section highlights the important role of researchers, the role of other stakeholders, and human resource planning.

#### **THE ROLE OF RESEARCHERS IN PROGRAM PLANNING**

A certain amount of tension exists in program formulation between the interests of individual researchers and the need for publicly-supported forestry research organizations to be responsive to the most pressing needs of the forest-based sector and society. Researchers generally will have the highest morale and be most productive when they have a significant voice in selecting research studies to work on and projects to work within. Experienced researchers have invested a great deal of time and effort developing expertise in a particular area of research, and they may be reluctant to work on projects outside of their area of specialization. At the same time, research activities must be geared to forestry and national development goals. Unless research is responsive to social goals, it will become more and more difficult to mobilize the funds needed for research.

To minimize this conflict, researchers should be partners with managers in planning and program formulation. As researchers are actively brought into the planning process, the likelihood of a good "fit" between researchers' interests and organizational goals increases greatly. Several roles for researchers in program planning may be identified. First, researchers have a key role in proposing projects and topics for investigation. Researchers are generally in the best position to know which areas of research hold the most promise, based on their own experience, understanding of the needs in the forest-based sector, or knowledge of developments in research elsewhere in the world. Without good project proposals available, the most sophisticated methods for research planning and priority setting will be of little use. Moreover, scientists will be more interested and productive in pursuing research topics they have proposed. A certain amount of freedom in determining what to work on is an important internal reward for many scientists. Pelz and Andrews (1966) found that researchers are most productive when several people are involved in shaping research assignments, but the scientist retains significant input to the decision

process. Pelz and Andrews also found that performance was low where the chief alone determined scientists' assignments.

Managers, therefore, should actively seek the input of researchers on what scientific investigations could be carried out to address various goals of the organization. But rarely will there be enough resources to carry out all proposals received, and rarely will all of the proposals be relevant to national and organizational goals. Responsibility for ensuring that the research program is relevant rests squarely with managers, not with researchers. Managers must develop criteria for decision making and provide clear guidance on priority areas for research.

Second, researchers--especially top researchers and team leaders--should have a role in formally reviewing and evaluating proposed subjects for research, both project and study proposals. Researchers are in the best position to identify constraints and opportunities relating to improved practices, and they should have a good idea of what is already known nationally or internationally on proposed topics within their area of expertise. Information that researchers possess on the results of related research, expected costs of proposed research, and the probability of success is likely to be the main source of data on these important questions. Managers should form committees of scientists and managers to review and evaluate research that is proposed.

#### THE ROLE OF OTHER STAKEHOLDERS IN PROGRAM PLANNING

The importance of identifying and analyzing key stakeholders of an organization and possibly including them in the planning process was stressed in the preceding chapter on strategic research planning. (Stakeholders are people, groups, or organizations that have a claim on the organization's attention, resources, or output, or are affected by that output.) Forestry research stakeholders might include public officials, governing bodies, interest groups, small farmers, extension agents and organizations, other research organizations, educational institutions, and international donor and technical assistance agencies, among others.

It is equally important to involve representatives of key stakeholder groups in program planning. While strategic planning provides overall direction for a research organization, much more detailed input is needed to work out a specific program of research. In some countries, certain stakeholder groups are organized into research advisory boards, councils, or committees that meet periodically to develop recommendations to forestry research organizations on research priorities and programs. If a country has no forestry research council or similar advisory groups, it is important to actively seek input from key stakeholders and incorporate them into the decision making process. Input from end users of research (such as forest rangers and farmers) is particularly important in planning research programs that are responsive to their needs. The inclusion of stakeholders in the program planning process is a key to the long-term success of a research organization and its ability to generate financial and political support. Input from other forestry (and nonforestry) national and international research organizations is important to determine what technology is already available to be adapted to local conditions, and thus avoid wasting scarce resources on "reinventing the wheel."

**HUMAN RESOURCE PLANNING: AN INTEGRAL PART OF PROGRAM PLANNING**

Program planning and priority setting must be related to trained scientific and support personnel--human resource planning is critical at this level. In most developing countries, the research resource that is in shortest supply is trained and experienced researchers. In a survey of managers, the level of training of researchers was identified as the most important factor influencing the capacity of forestry research institutions in developing countries (Bengston and Gregersen 1988). Constraints imposed by lack of trained researchers are compounded by the fact that researchers cannot simply be transferred to wherever they are most needed the way other resources may be transferred. A person trained as a silviculturalist cannot fill a position for a forest products technologist. Moreover, the training of a new scientist to fill a particular position takes a long time. Therefore, the availability of human resources imposes severe limitations on program planning, and the availability of trained personnel is a key parameter in program planning.

## APPENDIX 9.1

### TOOLS FOR PROGRAM PLANNING: THE LOGICAL FRAMEWORK<sup>1</sup>

The Logical Framework (LF) is a tool for planning and evaluation that is often discussed in management training courses. Its purposes are to facilitate the systematic identification of the objectives for some activity, plan for required inputs and desired outputs, and define indicators for monitoring and evaluating performance. The LF is appropriate for any level of planning other than strategic planning, from the development of broad, long-term programs to individual research projects. It is often used by small groups of managers as a framework for brainstorming and planning.

The information required to plan and evaluate an activity using this technique can be summarized in a table such as Figure 9.A1 (Fig. 9.A2 provides a generalized example of applying the LF to a research program). The left-hand column in the table is a "narrative summary" of the four levels of objectives of a research project or program:

- the goal is the ultimate objective to which the research project or program contributes, e.g., a timber harvesting research program may contribute to the achievement of a national development goal such as self-sufficiency in wood products;
- the purpose of a research project or program is what it is expected to achieve upon completion, e.g., in the timber harvesting example the purpose might be to develop and disseminate new timber harvesting technologies for adoption by timber producers;
- outputs are the desired results of the research project or program derived directly from management of inputs, e.g., the timber harvesting research program would be expected to develop new harvesting systems with specific characteristics and within an estimated time frame; and
- inputs are the human, physical, and financial resources required to produce the desired outputs. The quantity and quality of inputs should be specified, e.g., the number of scientists and technicians and their level of training, etc.

These four levels of objectives are represented by the rows of the table and are referred to in the jargon of LF as the "vertical logic." The idea is to systematically think through why the project or program is being undertaken, how it contributes to broader social goals, and the inputs needed to achieve the outputs, purpose, and goals.

One of the key assumptions of the LF method is that a direct cause and effect relationship exists between input, output, purpose, and goal. Thus, the "vertical logic" (the items in the left-hand column of Figure 9.A1) characterizes a project as a set of linked hypotheses or IF–THEN relationships:

*If we provide the following inputs,  
then we can produce the outputs.*

---

<sup>1</sup>Adapted from Delp et al. (1977), USAID (1980), and McLean (1988c).

*If we produce the outputs,  
then the purpose will be achieved.*

*If the purpose is achieved,  
then the goal may be realized.*

As we move across the columns of Figure 9.A1, we see the "horizontal logic" of the LF, indicating how the achievement of the objectives can be determined. It lists verifiable indicators, means of verification, and important assumptions:

- verifiable indicators should demonstrate that the desired results are being accomplished and specify the type of evidence needed;
- means of verification specify where that evidence can be found and how it can be measured; and
- important assumptions qualify the other entries by listing those factors which may not be controlled by research managers but which influence the success of a project or program. The assumptions column should help to keep managers realistic in their expectations.

The recommended procedure for completing the logical framework is to begin by working through the vertical logic. For a proposed research program, managers must determine at each lower level the conditions which are necessary and sufficient to achieve the next upper level, i.e., the inputs that are listed should be necessary and sufficient to produce all of the outputs; the outputs should be necessary and sufficient to achieve the purposes, and so on. Next, the horizontal logic is completed by first identifying the indicators, then the means of verification, and finally the assumptions for each of the vertical logic levels (i.e., the rows of the table).

The advantages of the LF as a planning tool include its simplicity--it is simple to understand. The LF guides the planning process by providing a structure and ensuring that the manager thinks through the fundamental aspects of a project design (but it is not a substitute for the considerable effort that is required to plan effectively).

The framework also is a useful tool in monitoring and evaluating a project or program. Evaluation requires clear targets against which performance is measured. The Verifiable Indicators column should provide such targets. The Means of Verification column specifies the actual data to be monitored for each level. Assumptions concerning inputs, outputs, and purpose define what external factors necessary for project success should be monitored and evaluated. Finally, impact evaluations--which deal with the contribution of research to national development goals--are concerned with the types of indicators specified at the goal level.

The Logical Framework also has some important limitations: (1) it does not take uncertainty into account, (2) it does not consider potential alternative actions, and (3) the IF-THEN relationships assumed among the various project components and elements in the environment are an over-simplification.

Despite these limitations, the Logical Framework may be a useful tool for planning, monitoring, and evaluating research. For more detail on this tool, see Delp et al. (1977), USAID (1980), and McLean (1988c).

Project Design Summary		Life of Project: From Fiscal Year ____ to Fiscal Year ____ Total Funding ____ Date Prepared: ____	
Logical Framework		NARRATIVE SUMMARY	
Project Title: _____		VERIFIABLE INDICATORS	MEANS OF VERIFICATION
Goal (the broader objective to which this project contributes): _____	Measures of goal achievement: _____	Sources of information, methods used: _____	Assumptions for achieving goal: _____
Project Purpose: _____	End of project status (conditions that will indicate purpose has been achieved): _____	Sources of information, methods used: _____	Assumptions for achieving purpose: _____
Outputs: _____	Magnitude of outputs, planned completion date: _____	Sources of information, methods used: _____	Assumptions for generating outputs: _____
Inputs: _____	Type, level, and cost of inputs, planned starting date: _____	Sources of information, methods used: _____	Assumptions for providing inputs, initial assumptions about the project: _____

Appendix Figure 9.A1. The "Logical Framework." Source: Adapted from Delp et al. (1977) and McLean (1988c).

Project Design Summary		Life of Project:	
Logical Framework		From Fiscal Year _____ to Fiscal Year _____	
Project Title: _____		Total Funding _____	
Project Title: _____		Date Prepared: _____	
NARRATIVE SUMMARY	VERIFIABLE INDICATORS	MEANS OF VERIFICATION	IMPORTANT ASSUMPTIONS
Goal (the broader objective to which this project contributes):  Develop new technology that contributes to national development objectives	Measures of goal achievement:  Increased production Reduced erosion Increased incomes	Sources of information, methods used:  Surveys Government statistics Impact evaluation	Assumptions for achieving goal:  Favorable economic environment Stability Adequate roads, markets, communication system, etc.
Project Purpose:  Produce new knowledge that is of interest to research, extension, land managers, and policymakers	End of project status (conditions that will indicate purpose has been achieved):  Technologies or recommendations disseminated to target audiences	Sources of information, methods used:  Program/project records Extension reports	Assumptions for achieving purpose:  Prices favorable Extension services available Other inputs available
Outputs:  Preliminary research results Final research results Research capacity strengthened	Magnitude of outputs, planned completion date:  Data from experiments analyzed Publications produced Field demonstrations conducted Improved staff and facilities	Sources of information, methods used:  Research reports Annual reports External review	Assumptions for generating outputs:  Low staff turnover Scientific standards upheld
Inputs:  Human, financial, and physical resources Equipment and supplies Training Scientific leadership	Type, level, and cost of inputs, planned starting date:  Staff and facilities in place by end of year 1 Courses completed Senior:junior staff ratio 1:5	Sources of information, methods used:  Quarterly and annual reports Accounting and administrative records Personnel data	Assumptions for providing inputs, initial assumptions about the project:  Funds and staff approved will be disbursed and available Courses available

Appendix Figure 9.A2. Generalized example of applying the "Logical Framework" to a research program.

Source: Adapted from McLean (1988c).

## Annual Research Planning and Budgeting

### INTRODUCTION

Annual research planning and budgeting refers to planning for the upcoming fiscal year. The primary purpose of annual planning and budget formulation is to identify the immediate tasks to be accomplished--based on the direction provided by the strategic plan, the priorities established in program planning, and other factors--and translate these into concrete resource requirements (Goldsorthy 1987). If annual planning and budgeting is closely related to strategic and program planning, the end result will be a coherent research program with documentation for its justification and cost.

The short-term perspective of annual planning implies that it is concerned with the work that will be carried out with existing personnel, facilities, and other resources, because in the short-run research resources are basically fixed. At this planning level, programs and projects and their objectives, resource requirements (dollars and person years), and allocation of resources are very specific: "The annual work program is... the firmest statement possible of the aggregate of experiments and studies to be carried out during the year with the capital resources and budget available" (Dagg and Haworth 1988).

### FUNCTIONS OF ANNUAL PLANNING AND BUDGETING

Annual planning and budgeting fulfills several important functions (Arnon 1989). First, it is a key planning instrument. The budget is the main tool with which research is planned in the short-run. It is used to direct resources into those areas that conform best with research policy and the strategic and program plans. Budgeting requires that concrete decisions be made about the most effective use of scientific, technical, and support personnel, and research facilities and equipment. Managers are compelled to make hard decisions, such as striking an appropriate balance between basic and applied research, long-term and short-term research, and research on various problem areas. Strong guidance on these decisions should be provided in strategic and program planning, but specific monetary values are assigned in the annual budget.

Second, the budget serves an important function as an instrument for delegating authority. Expenditures for specific activities are approved in advance, so that team or project leaders are free to dispose of the funds allocated for their research without further approval unless there are deviations from the original budget requiring consultation with managers.

Third, the annual plan and budget are tools for: (1) monitoring and evaluating programs, projects, and studies (comparison of anticipated outputs, achieved outputs, and costs); (2) personnel appraisal; and (3) financial control. Careful budgeting and periodic review keeps expenditures in line with the approved allocations of financial resources. Reviews at fixed intervals can be used to compare expenditures to the performance of a research project.

Finally, careful research budgeting increases awareness of the scarcity of resources facing the organization, and increases concern over efficient use of resources throughout the organization.

## SOME COMMON PROBLEMS WITH ANNUAL PLANNING AND BUDGETING

Planning and budgeting research on an annual basis has serious shortcomings because of the long-term nature of research. Fluctuations in funding from year to year can destroy the effectiveness of the budget as a tool for planning. A productive research program requires continuity and stability of funding over several years, at a minimum. The productivity and morale of researchers will suffer greatly if projects are abruptly cut or terminated due to fluctuations in annual funding. Stability of funding from year to year is a major concern in many forestry research organizations in developing countries (Bengston and Gregersen 1988). Despite the problems with annual budgeting of multi-year research activities, annual budgets approved by legislatures or other government authorities are required in most countries. While annual appropriations are the rule, an unofficial commitment of management support for individual projects and studies over their planned duration should be given whenever possible.

The use of the budget as a planning instrument is often limited by a relatively large proportion of the budget being allocated to fixed costs, especially salaries, and by the need to maintain a minimum of activity in each program area. Inadequate operational or recurrent funding relative to funding for salaries is a widespread problem, resulting in a lack of travel funds, maintenance of equipment, fuel for vehicles, and many other items needed for research. In some agricultural research institutions, up to 90 percent of the total budget is spent on salaries (Elz 1984). An FAO (1984) survey of forestry research institutions in Africa found that inadequate operational funds--as indicated by operational funding falling below 100 percent of personnel costs--was a serious problem for the majority of countries.

Another problem commonly encountered is that the budget categories used for fiscal accountability and reporting often are not well-suited for project management. Thus, records kept for fiscal reporting and financial control may not be very useful for personnel management, monitoring and evaluation, and other management function.

Finally, excessive budgetary regulations and control may result in a heavy burden on researchers and team leaders: "It appears that a concern for fiscal responsibility has often been carried to the point where it becomes an excessive burden on research productivity" (Ruttan 1981). Arnon (1989) notes that professional support for financial management is often inadequate, resulting in the inflexible application of budget control and related problems.

## THE PROCESS OF ANNUAL PLANNING AND BUDGETING

Annual planning and budgeting is a continuous process. For the purpose of describing the process, however, we can say that annual planning and budgeting begins with the Director General and other research managers developing initial alternative budget proposals for the relevant fiscal year, usually a year or more in advance. These proposals are based on several factors, including:

1. Advice received from government budget authorities about what budgetary increases (or decreases) can reasonably be expected. If no such advice is received, the director must develop realistic estimates based on the prevailing financial climate, the level of political support for research, and other considerations.

2. The research organization's goals and needs, determined largely by strategic and program planning, plus unforeseen opportunities and threats that may arise. Budgeting involves hard choices, and the mission and goals of the organization should help guide those choices.
3. The existing budget and allocation of resources across programs and projects. The immediate program is determined to a large extent by work already in progress, so changes associated with preparation of alternative budget proposals are often confined to changes at the margin rather than drastic reallocations (Goldsworthy 1987).
4. Proposals for new research initiatives developed by team leaders and researchers or suggested by external stakeholders. New research programs, projects, or major new studies within an existing project must be budgeted. Ideally, this process works from the smallest units of research upwards, with researchers or team leaders preparing detailed estimates of budget requirements for each proposal (Arnon 1989). Managers and a technical review team then select the most important proposals for inclusion in one or more of the alternative budget proposals.

As these four factors indicate, the process of developing alternative annual budget proposals should be both a top-down and a bottom-up process, similar to program planning (Chapter 9). Budget advice from higher authorities and the organization's strategic and program plans are the main sources of top-down input, and the current budget and research proposals for new projects and studies are the main sources of bottom-up input.

Based on these factors, the formal budget request is then developed and submitted, and budget negotiations with the ministry begin. The formal budget request should contain proposals for adjusting the research program in the event that resources are greater or less than anticipated (Goldsworthy 1987). The research organization receives an allocation of funds once they are appropriated, and, in turn, allocates funds to programs and research projects according to the annual plan.

Periodic financial reviews of research projects and the entire organization should be held throughout the year to review status and make adjustments as needed. A budget monitoring process should provide managers with up-to-date information on money spent, materials used, etc., in a usable form. This should provide managers with information they need to make informed decisions regarding program and project management. Team leaders should also receive budget reports for their individual projects at regular intervals.

It should be noted that managers are always concerned with several annual budgets at any one time: developing and justifying budgets for future fiscal years, administering the current budget, and reporting on previous budgets.

### **COMPUTERIZED PROGRAM BUDGETING SYSTEM**

Timely information is vital in planning and budgeting within a short time frame. Although annual planning and budgeting can be carried out using standard clerical procedures, a microcomputer-based Program Budgeting System (PBS) or management information system can greatly facilitate the process, particularly in a large research system. A PBS for research allows research activities, with well-defined program objectives, to be aligned with available resources (Marcotte 1987). Such a system must be tailored to: (1) the institutional context and decision making structure of a particular research organization; (2) the main users of

the program budgeting system and their information needs; and (3) the research planning cycle at higher levels. PBS is a project-based management tool that will (Goldsworthy 1987):

- help keep track of the division of resources between fixed and operating expenditures;
- encourage efficient management of resources;
- generate information about how staff time is used;
- indicate the allocation of resources between projects; and
- aid in monitoring and evaluating progress towards goals.

The International Service for National Agricultural Research (ISNAR) has developed a microcomputer-based program budgeting system that may be adaptable for use in forestry research organizations (Marcotte 1987, Sands 1988).

## Financing Forestry Research Organizations and Programs

This chapter relates closely to the previous one dealing with planning and budgeting of work programs. In the previous chapter, we talked about planning what needs to be spent in order to accomplish our objectives, i.e., the budget needed. In the present chapter we discuss how management goes about obtaining the needed budget. According to available survey results, some 10 to 15 percent of total administrative time in developing country forestry research organizations (FROs) is spent seeking funds. An additional 20 to 25 percent is spent developing and working with budgets (Gregersen 1984).

### DEFINITIONS

Funds are needed to maintain the basic operation of a forestry research organization. These are called "core" or "hard" funds. Additional funding is obtained to operate specific projects for limited periods of time; this we call "project" or "soft" funds. In either case, some of the funds are "tied," and some are "discretionary" in terms of the administrator's ability to shift them from one activity to another.

Tied funds are those that are earmarked for specific expenditure items, e.g., salaries of the permanent employees, building and construction monies earmarked for such purposes, and various types of basic operating costs. Discretionary funds are those which can be allocated by the research administrator at his or her discretion. They can be devoted to a variety of activities, depending on the needs and timing of such needs. Most managers maintain some discretionary funds in a contingency account to be used to meet unforeseen expenses, unanticipated increases in costs, damages, new opportunities, and other unexpected events.

### NEED FOR CORE FUNDING

All FROs need some long term core funding to secure their stability and sustainability through time. In most cases, core funding is obtained from the higher authority that governs the FRO, e.g., a ministry, the university administration, or some other national level decision making body in the case of independent research institutes.

A good rule of thumb is that core funding should not fall below 30 percent of total funding or the organization will find itself in a vulnerable position. Core funding around 50 percent is preferred and 60 percent or more can be considered to be comfortable in terms of organizational survival and long term operation. In fact, however, many FROs are forced to operate with only 15 to 20 percent core funding.

In some cases, as much as 90 percent or more of the core budget is tied to salaries and related fixed expenditures. Major adjustments can come only through retirements or resignations, or through separation of personnel.

Developing a sound, detailed funding plan is particularly critical for the FRO operating on a small core budget in relation to total funding. To keep the FRO running smoothly over time, advance planning of funding and projects is essential. The FRO governing body

needs to be fully informed about the ratio of core to soft funds, so it can make appropriate decisions concerning future budget allocations. Contradictions in policy may arise and have to be resolved. On the one hand, policy may encourage acceptance of new project funding when it becomes available from outside sources. On the other hand, policy may require core funding to be at some specified level in relation to soft funding, and that minimum ratio would preclude acceptance of more outside contract research. The governing body either can change policies or it can increase core funding to let the FRO grow.

### FUNDING PLANS AND BUDGETS IN RELATION TO FUNDING SOURCES

In almost all cases, a public FRO has to submit a budget "request" for at least part of its funding from some higher governmental authority. In some cases, the FRO's prepared budget is submitted in total to the appropriate authority (ministry, department, planning commission, etc.). That authority then decides on the funding level, given other budget requests. The budget is, essentially, the funding plan in this case. But in other cases, the FRO will have to prepare separate budget requests for a number of different potential sources of funding. In this case it also will need a separate annual budget which consolidates all sources in relation to their application to funding needs. A matrix with funding needs as row or line items and sources as column headings, can be a useful tool for keeping track of sources by needs.

Most FROs obtain some funding through sources other than a regular government budgeting process. As indicated in Chapter 3, in a typical situation the FRO obtains about 60 percent of its funding from regular budget appropriations, about one quarter from public grants or contracts for specific projects, about 10 percent or so from private grants and contracts and the rest from miscellaneous sources. Table 11.1 provides more detailed information on sources of funding for FROs, based on a survey of both developing and developed countries (Gregersen 1984).

Table 11.1. Question #9. Indicate the approximate percent of your organization's research funds that come from

	Regular budget Appropriations	Private grants or contracts	Public grants or contracts	Other	Number of cases
Government	76.0	3.9	16.8	3.3	65
University	40.1	18.5	40.4	1.0	45
Other	39.0	21.2	23.4	16.4	7
*Developed	59.4	10.7	27.3	2.6	70
Developing	59.3	10.8	25.6	4.4	44
Europe	55.2	9.6	31.5	3.7	48
Latin America	46.5	10.7	36.4	6.4	18
Asia (developing)	79.5	6.1	12.1	2.3	13
Asia (developed)	68.8	15.1	16.1	0	14
Africa	56.5	15.8	23.9	3.8	13
Mideast	86.9	1.8	11.3	0	3
North America	69.0	9.2	21.8	0	8

\*"Developed" includes: Europe, Asia-developed, Canada.

"Developing" includes: Latin America, Asia-developing, Africa.

Source: Gregersen 1984.

Often, research managers or administrators do not use imagination in finding funds for their projects and instead rely strictly on traditional sources of funding. In some cases, of

course, they have no choice: they are restricted by law or regulation to specific sources. However, in most cases there is some flexibility to go out and seek additional funding from nontraditional sources.

Table 11.2 provides a detailed listing of the potential sources of funding for forestry research. Out of this list, the administrator of a given FRO may find only five to ten sources that appear to have immediate potential. However, others can be worked on over time.

To develop a potential source into an actual source, the administrator needs to understand: the motivations and objectives of each source (proposals should be related to those objectives); the general magnitude of funds potentially available from the source (proposals should be geared to an appropriate request level); the restrictions and limitations associated with the source (proposals should be in line with such limitations); and the key decision points and decision makers associated with the source (FRO managers should, if possible, contact directly those who actually will make the decisions).

A key to success in obtaining support from most funding institutions is a well-written proposal. Appendix 11.1 provides general guidelines for proposal writing. Of course, many agencies have their own explicit guidelines. A number of means for gaining support from potential funders are listed in Table 11.3.

Since many sources are restricted to a single kind of activity, proposals have to be matched carefully to sources. A widespread danger is that FROs may develop proposals that fit the specifications and interests of potential source institutions, but not the real needs of the FRO nor the nation which it represents. Funding plans can be developed to fit the dimensions of a potential source, but without compromising the basic goals and needs of the FRO.

Of the potential sources listed in Table 11.2, the most likely ones for public forestry research are: public internal (to the country) sources, public external sources (both bilateral and multilateral), and private external sources such as foundations and other nongovernmental organizations. In many cases, there is joint funding of forestry research by several sources, including, for example, national public agencies and bilateral international donors. In such cases, a joint funding plan needs to be developed which specifies each funder's share of the total, and the responsibilities of the FRO in relation to each funder.

#### INTERNATIONAL MULTI- AND BILATERAL PUBLIC SOURCES

As indicated in Chapter 3, many FROs depend heavily on foreign sources of funding. Based on available surveys, percentages range from 40 percent international funding in the case of Africa to 5 percent in Asia. Overall, it is estimated that some 20 to 25 percent of public, forestry related research in developing countries is funded by international donors. The proportions vary widely among FROs, but the point still remains: international funding of forestry research is important, and some effort needs to be devoted to developing strategies for international funding.

Integrating internationally-funded research into the overall program of a FRO in a developing country can be a significant challenge. Quite often, the foreign research is much better supported than the domestic component of a program, thus leading to potential

Table 11.2. Financing sources and mechanisms for forestry research.

MECHANISMS FOR GENERATING FUNDS	MECHANISMS FOR FINANCING
<u>Public Internal Sources</u>	
– taxation and regular budget – public borrowing – forest funds, revenues	– direct government expenditure – grants and subsidies – government loans through development banks or other agencies – aid in kind – cofinancing with private sector, multinationals, etc.
<u>Public External–Bilateral Sources</u>	
– taxation and regular budget – public borrowing	– loans – grants – aid in kind (technical assistance, food, etc.) – cofinancing
<u>Public External–Multilateral Sources</u>	
– subscriptions from countries – borrowing in world capital markets – reinvested earnings	– loans – cash grants – grants in kind (food, etc.) – cofinancing
<u>Private Internal Sources–Industry</u>	
– equity capital – retained earnings, savings – borrowing (domestic and international capital) – endowments	– direct private investment – cofinancing with public or multilateral – lending/credit – private grants, gifts, etc.
<u>Private Internal Sources–Individuals, NGOs</u>	
– savings, labor, land – borrowing/credit – grants, subsidies, etc.	– direct investment on own land – investment on common lands – lending to others – cofinancing
<u>Private External Sources–NGOs</u>	
– endowments – grants, gifts – contracts	– lending – subsidies – direct investment – technical assistance – cofinancing
<u>Private External Sources–Industry, Multinationals, Banks</u>	
– retained earnings – borrowing/credit – endowments, gifts, etc. – contracts	– direct foreign investment – loans – grants – cofinancing

Table 11.3. Techniques for influencing potential funders of research.

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- a) Preparation of special, short, and easily readable material showing potential and actual benefits of research.
- b) Organization of special events with wide participation such as opening and inauguration ceremonies of new research units, release of new cultivars, and other public activities.
- c) Lectures given by researchers and research administrators during various public events.
- d) Organized visits and guided tours of research units with special emphasis on showing research results.
- e) Providing special advisory services to selected farms or whole regions.
- f) Undertaking joint research projects with the private sector.
- g) Special children or student programmes including specially selected schools from various neighbourhoods. In some cases, parents can be easily influenced through the creation of a good image among their sons and daughters.
- h) Organizing media programmes on television, on radio, through popular newspapers, through magazine articles, etc.
- i) Special efforts to establish good relations with the resource allocation and decision-making community such as: state and federal officials, legislatures, and others.
- j) Participation in academic activities, when possible, with University systems, particularly through graduate training programs.

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Source: Ruttan 1987.

jealousies among personnel. There also is the potential danger of isolation and lack of integration in the overall program, and pressures from outside to shape and direct the foreign-funded research in ways not particularly compatible with the FRO's overall research plan. The research manager has to face these challenges without compromising the overall strategic plan for the FRO. From a very early stage the manager has to start planning for a smooth transition once the outside funding terminates.

If managed appropriately, a foreign-funded research program can provide significant benefits, particularly if it includes provision of technical assistance and experienced expatriate researchers who can augment and complement existing national scientists. Foreign-funded research can provide an important means for strengthening national research capacity. Foreign involvement can lead to longer term opportunities for networking and contacts with the rest of the scientific community working on similar problems. It also can involve training abroad, which if properly handled can lead to eventual benefits. Often, the foreign funding agency will provide expatriate scientists to fill in during absences of key domestic scientists involved in training programs.

In seeking foreign funding and support for research programs, a manager with no prior experience with such sources is well advised to discuss a plan of action with others in the country who have had experience. Agencies, such as FAO, have experts with considerable experience in designing and managing research related programs, and they can be contacted for advice. Many forest services in developed countries have scientific expertise that is available at no cost on a short-term basis to advise developing country FROs on technical content of proposed programs. Such expertise should be utilized in designing funding proposals for foreign sources.

#### INTERNATIONAL NONGOVERNMENTAL SOURCES

While most international nongovernmental organizations (NGOs) are not in a position to provide funding for public forestry research organizations, there are opportunities to collaborate with many of them in joint research and development projects and thus obtain inputs of technical assistance and support in kind. Such groups as CARE, the Pan American Development Foundation, and various Canadian and European NGOs carry out applied forestry research in many developing countries. Developing relations with such organizations can further the interests of both the NGO and the domestic FRO.

Many large, nonprofit foundations fund significant amounts of research in developing countries. The Rockefeller Foundation, the Ford Foundation and others, have made major investments in forestry research in developing countries. Contacts with these groups are important in order to explore potential common interests. Consulates of major donor countries can provide information on the groups that are located in their countries.

#### DOMESTIC PUBLIC SOURCES OTHER THAN PARENT MINISTRY OR AGENCY

Quite often there are national level public agencies outside of the forestry and forest products sectors which could be tapped for funding specific types of forestry research, such as forest policy, agroforestry, watershed management, forest products, and forest utilization. Such sources should be sought out and contacts initiated. If the strategic plan for research has been prepared in the proper fashion, it should contain sections which relate the proposed research to broader national development and conservation issues such as those related to employment, energy, environmental protection, and food security. Such a plan thus provides a starting point for contact and discussion with agencies outside of forestry.

## APPENDIX 11.1

## WRITING RESEARCH FUNDING PROPOSALS

The ability to write well-crafted grant proposals is an important skill in obtaining project or soft funds. This appendix provides a brief introduction to proposal writing, focusing on the essential components that should be included in any proposal: title page, summary or abstract, problem statement, objectives, methods, budget, dissemination plans, and attachments. More detail about grantseeking techniques is given in books such as Bauer (1988) and Reif-Lehrer (1989).

**Title page.** Some granting agencies have standard formats for the title page. Whatever the format, the key to the title page is to include all required information and more. The title page should contain:

- the name of the program you are applying to;
- the address of the office that handles the program and the name of the contact person;
- your return address, phone number, and FAX number; and
- the title of your proposal.

The title for a proposal is very important, because it is read first. A poor title may result in your proposal not receiving adequate attention. An ideal title:

- describes the proposed research project or program;
- expresses the end result of the project rather than the methods;
- indicates the benefits to clients; and
- is short and easy to remember.

**Summary or abstract.** The summary should motivate the reviewer to continue. If the summary does not capture the interest of the reviewer, the rest of the proposal may not be read. It should be succinct, summarizing the key points of the proposal rather than repeating them. The summary should be written after the rest of the proposal is completed.

**Problem statement.** The problem statement should create a sense of importance and immediacy towards the proposed project. It is important not to assume that the funding agency has the same level of concern or sense of urgency about the project as the grant seeker. This sense of urgency should be created by documenting the need for the project rather than expressing your opinion about the need. Such documentation may include statistics from past research, quotes from experts in the field, and statements of need or statistics from the funding agency's own publications. At the end of the needs statement, the case can be made that your research organization is best suited to deal with this problem, that is, that you have the expertise, staff, and facilities needed to successfully carry out the project.

**Objectives.** Objectives are the specific, measurable results which the proposed research project or program is designed to achieve within a given time frame; they tell the funding source what will be accomplished at the end of the project and who will benefit from the research. Objectives are tangible outputs that address the problem identified in the preceding section. A common mistake is to discuss tasks or methods in the objectives section of a proposal, rather than emphasizing end results and outputs.

Methods. The methods section describes how the objectives will be accomplished. It should describe the activities that will be undertaken and how they fulfill objectives, research methods that will be employed, staffing and responsibilities for the various activities, and materials and equipment needed. In some cases, separate sections following the methods section may be desirable to describe the time schedule (sequence and flow of activities) and project staff (assigning responsibility to specific individuals for each part of the project).

Budget. The budget should be closely tied to the description of activities that will be undertaken in the methods that will be undertaken in the methods section. The funding source may provide guidelines for preparation of the budget. If not, the budget should include at minimum the following items:

1. Personnel

- salaries and wages (specify for each of the individuals involved)
- fringe benefits
- consultants/contracted service (specify)

*Personnel subtotal*

2. Nonpersonnel

- equipment (specify)
- supplies
- travel (specify)
- other nonpersonnel costs (specify)

*Nonpersonnel subtotal*

*Project total*

Each of the budget categories should show the total expenditure, the amount being contributed by the grantee (if applicable), and the amount requested from the funding source.

Dissemination plans. It is important to specify how the results of the project or program will be disseminated to users, i.e., research publications, technology transfer or extension publications, training courses, sponsoring a seminar or conference, presentation of results at regional, national, or international conferences, and so on. A separate line in the budget may be added for funds needed to carry out dissemination activities.

Attachments. Materials that back up your proposal should be included in the attachments or appendix. Attachments could include copies of your organization's publications that relate to the proposal, the vitae of key personnel, letters of endorsement, a list of other funding sources that will be approached for funding, and so on. A separate contents page should be included for the attachments.

Cover letter. The purpose of the cover letter is to reintroduce yourself to your contact at the funding agency. You should have had previous contact with a particular individual on the funding organization's staff, and you may want to remind them of this contact and the changes you have made in your proposal based on their input. Cover letters should generally be short, motivating, and point out the need for the proposed project or program.

Writing tips and style. It is important to follow closely any guidelines provided by the potential funder even if they are not logical. Your writing style should reflect what the funding agency wants and what the reviewers will be look for. This may require contacting

appropriate individuals at the funding agency to gauge their level of familiarity with your proposal area.

## PART IV

### Implementing and Managing Research Programs

The mission, goals and objectives of a forestry research organization can only be achieved by implementing the research programs developed through the planning process. The success or failure of a research organization depends in large part on how well research managers and their staff manage the personnel, funds, facilities, and other resources available to the organization in carrying out the planned programs of research. To do this successfully in the uncertain environment of research requires considerable managerial flexibility, and a willingness to adapt planned programs to changing conditions. Research managers must manage the researchers and other people in their organization in such a way as to stimulate a high level of performance. To do this requires:

- recruiting and managing researchers effectively;
- providing research leadership
- creating an appropriate environment and incentives for research;
- providing opportunities for training and education to increase the capabilities of people in the organization;
- providing adequate scientific support services;
- providing adequate administrative support services; and
- encouraging research networking to facilitate the exchange of information and skills among scientists within and outside of the research organization.

These requirements for the successful management of research are discussed in Chapters 12-18.

## Managing Researchers

People are the most important resource of any research organization. One of the most important tasks facing a research manager is managing and directing the human resources within the organization so as to achieve the goals and objectives of the organization. The challenge to managers is to recruit scientists and other staff who have the potential to carry out the planned research program, and then create an appropriate environment for them to do research, assign duties and responsibilities, delegate the authority required to carry out those duties, and reassign people as conditions warrant.

Managers are responsible for developing the capabilities of the scientists and support staff within the organization so they can carry out their work assignments effectively and efficiently. They must plan and provide opportunities for training and education to enhance performance of researchers and support personnel. They also must evaluate the performance of research and other personnel, and take whatever corrective action is indicated by this evaluation.

The creation of an appropriate organizational environment providing research leadership, and the training and education of personnel will be discussed in separate chapters (see Chapters 13, 14 and 15).

### RECRUITMENT

The key to developing a productive research organization lies in recruiting the right kind of people, including both scientists and support staff. Considerable thought and careful planning should go into every recruitment. One would not buy an expensive piece of equipment, or build an expensive facility, without careful planning and without comparing estimated performance with desired performance. One of the largest investments in any research organization is the investment it makes in people. Ultimately, recruitment will strongly influence the future capacity and capability of a research organization to do effective research. Thus, to the greatest extent possible the responsibility for recruitment should reside with research managers, and should not be left to an isolated manpower office at ministry headquarters (Sachdeva 1988).

Recruitment must fit in with the organization's mission, goals, objectives, and plans. But flexibility is needed here. At times scientists or technical personnel with the skills needed to carry out a desired research program may not be available. Because scientists tend to be specialists, with particular skills, expertise and knowledge, they generally are not interchangeable. Thus, the scientific talents on a research staff dictate to a large extent the realizable goals and objectives of the organization. The availability of special skills and interests at the time of recruitment may dictate a reformulation of objectives and plans, and strongly influence the program of research that can be carried out effectively by the organization.

In the discussion that follows, it is recognized that in many government organizations stringent rules and regulations govern the recruitment process, leaving relatively little

flexibility for the research manager in recruiting personnel. Nevertheless, the following may be of some help in guiding the recruitment of scientists and other personnel.

In recruiting scientists for a research organization, their potential quality as researchers is of critical importance. Scientists vary widely in their interests, abilities, and skills. Studies of scientist productivity in many fields have shown that the productivity of scientists is a highly skewed distribution--a relatively small percentage of scientists in any field produce most of the publications (Moravcsik 1986).

A great deal of care and attention should be given to ensure that people of high research potential are recruited. Wherever possible, recruitment should stress quality, not quantity. Otherwise, a research organization can become overloaded with people who contribute little or nothing to the research goals of the organization. Yet the recruitment of scientists usually is governed by the available supply. If a forestry research program is being developed in new directions, the supply of qualified candidates for any open position may be almost nonexistent.

One of the difficult decisions in recruiting is whether to recruit a more high-level experienced researcher with a proven track record, or a less experienced researcher at the apprentice level who shows considerable promise. Less experienced researchers generally are more readily available, will require considerably less investment in salary, and may have more flexibility in problem assignment with no long-term vested interest in a particular scientific subject or method. However, a younger scientist may require several years to gain the experience necessary to become an effective and productive researcher, and may lack the contacts within the profession that can facilitate research networking.

In contrast, the more experienced researcher can become productive in a relatively short time, recognize and be able to attack successfully important research problems, attract funding and other scientific talent, and provide recognition for the organization through an established reputation in the field. But such a scientist commands a higher salary, and may stretch the organization's budget to the limit. Further, the mature scientist may be responsible for a number of previous professional commitments that can take time away from a proposed research program.

In recruiting research personnel, public research institutes often face stiff competition from private industry in terms of salaries and other job benefits, especially for those scientific and technical disciplines where the supply is low and the demand is high. In many developing countries it is difficult to compete with private industry and other organizations for well-qualified researchers. Government salaries and advancement potential are often far below those available elsewhere. But scientists are not motivated solely by monetary rewards. If the research manager can create a dynamic research group that provides an exciting atmosphere to work in, it may be possible to overcome some of the competitive disadvantages in pay scales and promotion opportunities.

Recruitment of scientists must be closely linked to long-term strategic research program plans, the organizational structure proposed to carry out those plans, projections of the resources and facilities available, and expected future funding levels. Recruitment should be planned well in advance. It should be based on expected vacancies in positions that must be filled and on new positions that are to be created, and should be in line with detailed program planning (Bennel and Zuidema 1988). Systematic long- and short-term manpower

planning is essential. Because recruitment of scientists takes time, it must be planned carefully well in advance of actual requirements.

Forestry research often requires recruitment of people with a particular blend of knowledge, skills, and experience. Rarely are such people sitting around waiting to be hired upon demand. Finding the right person, gaining their interest in applying for a position, allowing time for them to terminate their present work and move to the new job location, and making proper arrangements for them to be employed, may take from several months to well over a year, even under the best of conditions. Top quality candidates for some specialties may become available only every few years. Such unavoidable delays can greatly disrupt recruitment and funding plans for new positions, and have a major impact on the attainment of the research organization's goals.

In some cases it may be necessary to plan for future staffing far enough in advance to allow for special educational or training programs to produce scientists with the desired qualifications. But some advanced education or training may take several years to complete. Thus, long-range planning is a necessary part of the future recruitment of scientists.

Funding considerations may dictate the area of research for which recruitment can be done, the entrance salary level and thus the qualifications of potential candidates, and the technical and operational support that can be given to the position being filled. In actual practice, funding limitations and the availability of qualified candidates severely constrain the research manager's options in recruitment.

In developing recruitment plans, the impact of recruitment on future funding obligations should be considered. If there is a provision for annual or periodic salary advancement and/or promotion of forestry research personnel, then in recruiting people, the future funding requirements to support future staff, including anticipated salary increases, should be compared to the expected availability of research funds in the future. The recruitment and retention of personnel in a growing organization must be governed by a realistic appraisal of the future budget outlook. It is easy to overlook the fact that as scientists and other personnel mature, they may become eligible for promotion or within-grade advances in salary.

A critical attribute to be considered in recruiting scientists in an expanding organization is their potential for becoming mentors for the younger scientists that will be recruited later (Wolff 1987). Learning how to do research is best accomplished by serving an apprenticeship under the guidance of a mature, competent scientist. A few experienced research scientists in a growing research organization can serve as a nucleus to attract other scientists seeking opportunities to work with a respected scientist. Mature scientists also develop considerable interaction with the world community of science and with scientists in other fields, thus increasing the potential for collaboration with other organizations.

Technicians, technical support staff, and administrative staff, provide essential services to researchers. Without adequate support, a considerable portion of a scientist's time may be lost to tasks that could better be carried out by specially trained technicians and clerical staff. Research planning should include estimates of the number and kind of scientific support staff required. In recruiting people for such positions it is important to choose qualified people. People who cannot or will not do the job become a drain on the financial resources and morale of any organization.

Managers often are reluctant to remove a person from a job because of poor performance. Under many government civil service rules and regulations reassignment or dismissal for poor performance is difficult, at best. Thus, once employed, many people remain with an organization for a large part of their career. The investment an organization makes in a person it has employed over a period of years can be very large, including the costs of salary, fringe benefits, training, travel, and other expenses. If the employee does not perform up to the standards expected, or performs unsatisfactorily, this large investment may provide no payoff to the organization.

### SCIENTIFIC PERSONALITIES

In recruiting and supervising scientists, research managers should be aware that scientists exhibit a variety of personality types. For example, Maslow (1970) differentiates between means-centered scientists and problem-centered scientists in approaches to research:

*"Means-centered scientists tend, in spite of themselves, to fit their problems to their techniques rather than the contrary. Their beginning question tends to be, Which problems can I attack with the techniques and equipment I now possess?, rather than what it should more often be, Which are the most pressing, the most crucial problems I could spend my time on?"*

In supervising scientists, research managers need to be aware of these differences in scientific approaches to insure that not only is the research being done well, but that the problems selected for research are meaningful and important to science and to society.

Young scientists, in particular, are likely to exhibit a means-center or tool-oriented approach to science. Their education and training has equipped them with the latest technology in measurement and analysis which they are anxious to apply. Formal education often leaves them less well-equipped to identify and analyze critical problems faced by the important clients of a research organization, and to develop effective research strategies for attacking these problems. Much of a scientist's competence in problem-solving, particularly in applied research, comes through experience in working with other capable scientists and with research clients.

People utilize both a rational and an intuitive approach in dealing with the world. For a long time a myth has persisted, among scientists and nonscientists alike, that science relies on only one aspect of human nature--the logical-rational side. What often has been ignored is the important role of intuition in solving problems of science (Brown 1977). Albert Einstein wrote:

*I believe in intuition and inspiration ... at times I feel certain that I am right while not knowing the reason.... Imagination is more important than knowledge. For knowledge is limited, whereas imagination embraces the entire world, stimulating progress, giving birth to evolution*  
*(quoted in Barry 1986, p. 14).*

Scientists use intuition to develop the leaps of imagination to break out of conventional modes of thinking about the world and develop new hypotheses to explain the world. Scientists utilize the rational mode of thinking to logically analyze and test proposed hypotheses. Successful scientists exhibit both a strong intuitive ability to imagine possible solutions to scientific problems, and a strong analytical ability to rigorously analyze and test

those solutions. In other words, they successfully integrate all of their capacities as a human being, both rational and intuitive.

Creativity is one of the key personality traits of successful researchers. In describing the creative personality, Austin (1978) states that successful scientists are always curious and "... intellectually restless, not satisfied with what is already well known." Austin suggests that the five most important personality traits of successful scientists are: curiosity, imagination, enthusiasm, discrimination, and persistence.

In recruiting and managing scientists, research managers should recognize both analytical and creative abilities in people. To enable research scientists to reach their full potential, research managers need to provide a working environment that encourages the full development of both the analytical and intuitive/creative traits of people.

### ASSIGNING DUTIES, RESPONSIBILITIES

In order to be effective, employees must have a clear understanding of their duties and responsibilities. It is the job of the employee's supervisor to ensure:

- that the employee has been assigned appropriate duties and responsibilities, and clearly understands them;
- that the duties and responsibilities assigned to employees are linked to the organizational mission, goals, and objectives.

Employees must have a clear understanding of what performance is expected of them in carrying out their duties and responsibilities. Preferably, they should participate in setting their goals and targets and the criteria by which their performance will be measured. Duties and responsibilities should be assigned based not only on the job the employee occupies, but also on the employee's abilities. People vary considerably in their ability to accept and make effective use of responsibility. In assigning responsibilities, managers must recognize that not all employees have equal abilities to effectively utilize the responsibilities that may be assigned to them.

Research managers can use the assignment of duties and responsibilities as a means of training an individual for career advancement. By increasing the level of responsibility and providing a new scope of duties, managers can challenge individuals to prepare for a move up the career ladder. But the performance of people with new duties and responsibilities must be monitored closely, and help should be provided when needed to assist people in better utilizing their new positions to achieve organizational objectives and their own personal goals.

According to Krebs (1971), the challenge facing research managers and administrators is:

*"... to see to it that those who have proved themselves as productive research workers and have shown qualities of leadership are given full scope, above all sufficient time for research, and that those who, after having been given the chance, have not proved productive, as well as those who have lost their productiveness after an initial spurt, should be gently but firmly directed towards activities appropriate to their talent and inclination ..."*

With a change in program emphasis or funding levels it may be necessary to reassign people to new areas of research or to new locations, with a change in duties and responsibilities. Such decisions are often difficult and may be resisted by the employees being reassigned.

### DELEGATING AUTHORITY

Assigning duties and responsibilities to employees is not enough to ensure their effective performance. To be effective, employees need authority commensurate with their responsibilities. Authority refers to the extent to which the individual has control over work planning, methods of doing the job, approval for purchasing and travel, control of resources, flexibility of time, standards for acceptable performance levels, the recruitment, assignment of responsibilities, and dismissal of subordinates, and many other factors.

The proper delegation of authority for carrying out responsibilities effectively was identified as an important component in developing an effective research organization at a recent conference of administrators of forestry research institutions in the Asia-Pacific region (Putti 1986). The research manager must delegate sufficient authority to each employee within the organization so that they can function effectively in fulfilling their responsibilities. A lack of authority may lead to employees refusing to accept assigned responsibilities in practice. Yet the delegation of authority beyond what is necessary may cause the manager to lose control of the organization.

Control over expenditures should be delegated to as low a level as possible. Blanket organizational restraints on travel, telephone use, supplies, personnel ceilings, use of computers, and other expenditures can lead to inefficiencies in research performance that can cost far more than the potential savings due to tighter control of expenditures (Brooks 1968). Some expenditure constraints may be imposed on the research organization by higher administrative levels or by funders, and may not be under the control of the research manager. But where they have the option, research managers should be wary of imposing such overall constraints as a way of controlling expenses. Rather, they can impose particular constraints on an individual basis where circumstances warrant, such as inexperience or abuse of expenditure privileges.

An effective way of delegating authority is to delegate a minimal amount of authority to new employees, closely monitor their use of the authority, and gradually delegate more authority as experience dictates. Under all conditions, there is a potential for the abuse of authority to gain personal ends. Research managers should continually monitor the use of delegated authority to control its misuse and abuse.

### DEVELOPING INDIVIDUAL CAPABILITIES

Managers are responsible for encouraging and providing opportunities for continued professional and personal development of all of the people within the organization. This is done not only to satisfy the basic needs of individuals for continued growth and development, but to increase the performance of the organization.

Effective research is more of an art than a science, one that is learned over time by doing, preferably under the direction and close supervision of a successful scientist (Bennell and Zuidema 1988). Having young scientists serve an apprenticeship under a more mature, competent, and productive scientist, who is able and willing to serve as a coach to help them

develop skills in identifying and solving scientific problems, is one of the most effective methods for developing competent scientists.

Most educational systems emphasize problem solving, and most young scientists are competent in using the latest methodologies and tools to solve particular types of problems. Yet one of the most important tasks in research is identifying or finding important researchable problems. For this task, the young scientist receives little or no training in formal educational courses (Dillon 1982). Young scientists may need additional training to become effective and self-motivated.

Scientific knowledge, technologies, and skills need to be enhanced continually throughout the working life of individual scientists. Science changes rapidly, and established fields of science often expand in new and productive directions. New technologies and new methodologies are being developed continuously. Keeping abreast of such developments, and developing the skills to utilize new developments in science, is essential for all scientists.

A major challenge to research managers is to find ways to encourage scientists to maintain and expand their research capabilities as they mature. Mid-career training and education are essential in providing new knowledge and capabilities to maturing scientists and, at times, to stimulate lagging careers. To avoid stagnation, continue their professional development, and increase their competence, scientists must be given regular opportunities to interact with colleagues and professional peers. This can be done through travel to make personal contacts with peers; attendance at seminars and workshops, short courses, national and international professional meetings and conferences; temporary reassignments to work with colleagues; and in other ways. Such professional development can be costly, but the alternative, stagnation of promising professional scientists and plateauing of careers, can be even more costly to the organization in the long run.

Many scientists, fearing change, fall into an unchanging routine approach to research. It is easy to continue to use the same problem-solving techniques that were successful in the past. For scientists, there are always endless loose ends to be attended to, additional tests of well-established principles to be made, additional trials to reconfirm previous findings, etc. Research on even the most limited subject can be endless. Yet, given the challenges facing forestry today, research managers cannot afford the luxury of having much of their scarce scientific talent addressing problems of limited importance to science and/or society. At times, to overcome individual inertia the research manager may have to prod scientists into accepting opportunities for continuing self-development and for tackling critical new problems, using incentives to stimulate participation. Often, research in a new area can have a stimulating effect on a scientist's career, even though at first it may be an unsettling experience to the individual.

Those researchers who have managerial or administrative talent should receive opportunities to develop those skills. In many developing countries, forestry research managers are young and lack experience in management, and thus could benefit from training in management skills (Bennell and Zuidema 1988). In those countries, a special effort needs to be made to provide research management training for promising management candidates in forestry research organizations. Training is discussed further in Chapter 15.

## MANAGING RESEARCH TEAMS

Although many scientists prefer to work alone on problems of their own choosing, they often are confronted by problems for which they have neither the knowledge nor the technical skills to satisfactorily resolve. To solve these problems they may have to seek out and collaborate with other colleagues who have the special talents or knowledge that they need. Teamwork among scientists is essential for many types of research (Hagstrom 1964). Teamwork is especially important when taking a problem-oriented approach to research, rather than a tool- or technique-oriented approach. A problem-solving, applications-oriented research approach often requires a team of researchers that represent different fields of knowledge, or that have different technical knowledge and skills. Managing multidisciplinary teams of scientists is difficult, particularly if the team assembled to work on a given problem has no experience in working together. Such teams often undergo considerable social strain in learning to talk with each other, in getting to understand each other's point of view, and in learning to work together (Hagstrom 1964). Conflicts arising among team members can require considerable managerial time to resolve.

The use of research teams introduces several problems into the management of research. Within a team, individual performance may be strongly influenced by the achievements of other team members. Thus, the evaluation of individual performance within a team may present more problems than evaluating the performance of individual scientists working alone, where research accomplishments are more clearly identified with a specific individual. One of the chief rewards in science is peer approval and acceptance within a particular scientific discipline. Peer recognition is typically given for accomplishments in advancing the frontiers of a scientific discipline. Those who work on teams to solve real-life problems may have less opportunity to gain stature within their discipline. Much of the team output may not be published in refereed scientific journals, and if it is, it may have multiple authorship. Since many performance appraisal systems rely on peer approval, those scientists working on multidisciplinary problem-solving teams may not get the recognition they deserve.

Another concern managers must face in managing multidisciplinary research teams is the continuity of job assignments for team members, once the job assignment is completed or the team project is completed and the team is disbanded. The International Service for National Agricultural Research (ISNAR 1984a) suggests that a long-term research capacity is best developed and maintained by having a research institution organized by scientific disciplines. This facilitates scientific networking, peer review, and personnel evaluation systems. Such a system is in common use among forestry research institutions today. Under such a system, scientists from a particular discipline are assigned temporarily to problem-oriented research teams for a specified period of time, with the knowledge that they will return to their discipline-oriented groups when the team project ends.

Although the management of research teams presents special challenges, such multidisciplinary teams can be an effective way to direct research towards solving critical problems in the management and use of forest and related resources.

## PERFORMANCE APPRAISAL

Performance appraisal of each employee is a fundamental part of management. It is the key to evaluating how each employee is performing his or her assigned tasks. Although often considered distasteful and resisted by managers and employees alike, periodic

performance appraisals provide one of the best means of monitoring and controlling employee performance in their assigned jobs. Such appraisals provide information useful for justifying promotions, identifying emerging problems, and developing training plans. The overriding concern in performance appraisal is to improve individual performance and productivity in a systematic and purposeful manner (Bennell 1988b).

The key to effective performance appraisal is for the manager to clearly enunciate well in advance what specific performance is expected of the employee during the forthcoming rating period. Working together, the manager and employee should develop a mutually-agreed-upon set of clear and realistic performance targets that are to be met during the rating period. This expected performance should be explained to the employee, and assurance sought that the employee understands and accepts the performance expectations. During the course of the rating period, such performance targets can be modified as conditions warrant, but again, it is important to involve the employee in any changes in performance standards.

Ideally, performance appraisal should be a continuous process throughout the rating period, and corrective action taken as needed. At the end of the rating period, a formal performance appraisal should be completed. Such an appraisal should be in reference to the performance standards and targets established at the beginning of the rating period by the manager and the employee. Performance ratings should be based on the manager's judgement as to how well the employee completed the agreed upon tasks. It is unfair to rate an employee on the basis of unspecified expectations.

Zuidema (1988) suggests six factors that are useful in assessing the performance of researchers:

1. Personal attributes - who they are;
2. Technical knowledge - what they know;
3. Professional skills - what they can do;
4. Professional activities, behaviors - what they actually do;
5. Outputs/results - what they accomplish;
6. Outcomes/impacts - consequences.

The first three factors are predictors of performance; the last three are more direct measures of actual performance. Criteria can be established in each of these categories to evaluate an individual's performance, but the evaluation of scientists poses particularly difficult problems.

Quantitative performance criteria can be readily established for routine, repetitive work. But much of scientific research is nonroutine, nonrepetitive, highly creative work, for which qualitative criteria are more appropriate. The danger of attempting to apply quantitative criteria for measuring scientific performance, such as number of publications produced, or number of studies completed, is that such criteria may lead scientists to avoid attempting high-risk research, and instead concentrate on safe, sure, pedestrian problems. Managers must balance the desire for quantitative criteria by which to measure scientific performance, with the need to encourage creativity and risk-taking among scientists.

In evaluating scientific research performance, a research organization should first of all be concerned that scientists are working on important and critical problems. Although the quality of scientific methodology is important, it matters little how good the methodology

is if it is being applied to unimportant problems. Yet, important problems are often difficult problems. Scientists who work on difficult problems run the risk of failure. Science is a risky business. Research organizations should not expect every research project to be successful. Some failures are inevitable. Performance evaluation standards that penalize scientists for research failures may doom an organization to a program of mediocre research. In evaluating scientists, managers must find some way to tolerate occasional failures when scientists tackle difficult problems.

In evaluating scientists, managers may be forced to rely upon peer review for judging the scientific aspects of their work, because only scientific peers in a particular field of science are capable of judging scientific performance in that field. Yet, peer review usually provides only a partial evaluation of a scientist's performance. Managers should be aware of the overwhelming tendency of scientific peers to critique scientific work only on the basis of scientific method, technique, or logic (Maslow 1970). Rarely are scientists criticized for working on unimportant or irrelevant problems. It is the responsibility of managers to ensure that an important part of a scientist's performance appraisal includes a judgement as to the importance of the individual's research contributions to science or to society. An equally important evaluation criteria is the extent to which an individual's research contributes to the goals and objectives of the research unit and of the research organization.

### **TAKING CORRECTIVE ACTION**

The results of performance appraisals should be discussed with the person being appraised. Such a discussion should emphasize the strengths of employee performance, so the employee knows what was done correctly and is given recognition for positive performance. Discussions of performance present an opportunity to plan for employee development through advanced education, training, or special work assignments. Both supervisor and employee need to discuss employee short- and long-term goals and training needs, and jointly agree on specific actions to be taken to develop employee skills and knowledge during the next rating period.

Appraisal discussions also should focus on deficiencies in performance, where future performance needs to be improved. For many managers, criticizing the performance of employees is the most difficult part of performance appraisal. An important reason for performance appraisals is to identify weaknesses in employee performance, communicate these to the employee, and suggest means of improving performance in the future. In appraising performance, supervisors should not focus on fault-finding, but on identifying what went wrong and what can be done to correct potential performance deficiencies in the future. The emphasis should be on finding ways to improve performance so that both the employee and the organization benefit. The exact approach taken in appraising performance and planning corrective actions may vary from one culture to another.

Supervisors should communicate to the employee specific deficiencies in performance in such a way that the employee recognizes the deficiencies. Performance appraisals by themselves may stimulate individuals to improve their performance on their own. However, managers must recognize that at times it may be necessary to take corrective action to force individuals to change their performance in desired directions, or to discipline employees for failing to improve up to expected standards.

Employees should be given a chance to correct observed performance deficiencies. Based on the performance appraisal, the supervisor should develop, preferably with the help of the

employee, a plan to correct deficiencies within a given period of time through a series of specific actions. Proposed actions to correct performance deficiencies must be closely monitored, and decisive action taken to ensure that each deficiency is promptly remedied.

Weaknesses in employee performance indicate the need to improve employee/supervisor communication and interaction. Supervisors must take the initiative in stimulating more frequent contacts with the employee to discuss job performance. Managers need to ensure that there is increased communication between the supervisor and the employee. Considering the investment an organization makes in training an employee for a particular job, every effort should be made to improve employee performance so that they can contribute more effectively to the organization's goals and objectives. However, it must be recognized that there will be times when, for one reason or another, the performance of an employee declines too far to be tolerated by the organization. At that point, reassignment or separation of the employee may become necessary.

For some research work it may not be necessary to recruit and employ research scientists within the organization. Other options, such as contracting with university or other research personnel to conduct the research, or providing competitive research grants to qualified researchers, may be more desirable. This is a particularly advantageous approach in utilizing soft funding that is available over a short period of time. The difficulty with such arrangements is that research managers lose direct control over the conduct of the research. In the case of grants, usually there is little control over the performance of the work once the grant is made on the basis of a proposal. However, contracts can be written so as to require close working relationships between those funding the work and those performing the work. Considerable skill is needed in selecting qualified researchers, in drawing up agreements that are effective in specifying the work to be performed, and in administering contracts and grants to ensure they are carried out according to the terms of the agreement. But carefully controlled, this is a viable alternative to the recruitment of additional personnel to the permanent work force of a research organization.

In seeking potential applicants for jobs, contracts, or grants, a forestry research organization should not overlook the considerable pool of talent that may be available in scientific fields other than forestry. In developing countries, and developed countries as well, considerable research that is directly related to forestry is carried out by scientists in disciplines other than forestry, and by nonforestry research organizations. Ecologists, wildlife biologists, anthropologists, hydrologists, agricultural economists, and many other scientific specialties often have expertise in research closely related to forestry. In the absence of qualified forestry personnel within a country, a forestry research manager should explore the use of scientists in allied disciplines that might be available, either through direct recruitment or through the use of contracts and research grants. This is especially important in considering research needs in the social sciences, because few forestry researchers have adequate training in these fields.

## Creating the Appropriate Environment and Incentives for Research

Organizations tend to develop a culture that reflects the past and current leadership and management of the organization, the mission and goals of the organization, formal and informal rules and regulations that have been established and have evolved over time within the organization, and other factors (Wilcox 1989). All these factors form an informal and formal environment within which the organization functions. This organizational environment can greatly affect employee performance. This is particularly true of scientist performance within research organizations. Managers of forestry research organizations, through their leadership and management style, affect the organizational environment within which all scientists and support personnel operate, and thus directly and indirectly affect the performance of the organization. Government and organizational policies establish incentive and career ladder systems that affect the motivation of scientists and other employees within the organization.

### THE INFLUENCE OF AN ORGANIZATIONAL ENVIRONMENT

Managers often develop a strong loyalty to the organization for which they work, and their actions are governed by their acceptance and adherence to organizational policies and procedures, by the norms arising from inside the organization. In many organizations managers can generate a similar sense of organizational loyalty and belonging among the employees they supervise. But scientists differ from other employees in ways that suggest the need for a somewhat different environment in research organizations.

Scientists are strongly influenced by the scientific community to which they belong and by other factors outside of the organization within which they work. Many scientists are driven more by the need to secure acceptance and approval by the community of scientific peers to which they belong than by organizational loyalties. Their actions are governed in large part by norms that arise from these external sources. Thus, scientists generally are not as strongly committed to the organization for which they work as managers and other employees may be. A scientific organization must create an environment that recognizes this dual allegiance of scientists to ideals and rewards that arise both outside of and within the organization, and that provides incentives for scientists to direct their work towards organizational goals.

By their training and education scientists have been encouraged to critically examine the world around them, and to question, test, and challenge generally accepted paradigms and authority. Thus, they tend to question, challenge, or sometimes ignore organizational rules and procedures which they think are unnecessary. This may create additional supervisory problems for research managers. Managers may have to take particular care to ensure that scientists understand and accept the need for particular organizational rules and procedures that other employees may take for granted.

Research requires a high degree of innovation and creativity. To be effective, a research organization must develop an environment that encourages innovation and creativity in meeting the goals and objectives of the organization. This requires flexibility in planning

research, and a willingness to change plans as new challenges and promising directions emerge from on-going research.

Research also requires operating funds to cover the costs of supplies, equipment, travel, technical support, maintenance of facilities, and other expenses. Many research organizations in developing countries expend from 60 to 80 percent or more of their appropriations just for salaries, leaving little available for operating funds (Mook 1988). This lack of operating funds to conduct research can act as a disincentive to researchers. Without adequate funds to pursue their work, they may become so discouraged that they leave research and seek employment elsewhere. Research managers can affect the working environment by providing sufficient operating funds to conduct desired research programs, perhaps by controlling personnel levels or by other means.

Research is a risky venture with no assurance of success, particularly if the research is addressing important emerging problems or pioneering new frontiers of science. Despite the best planning, experiments go wrong and end in failure to achieve any useable result. Yet, scientists learn from failures. Research managers must recognize the inherent chances of failure in any research project, and allow for this in planning research, evaluating research performance, and establishing reward systems. Requiring success from every research project attempted, and requiring a fixed research output every year from every scientist, will almost certainly condemn a research program to mediocrity as scientists respond by proposing and pursuing a pedestrian program of research where success is almost certain.

Research managers need to create an organizational environment that generates an incentive system to reward achievement of organizational goals, that encourages and rewards creativity, innovation, and risk-taking, and that tolerates a degree of failure in the risky business of research.

### **MOTIVATION THROUGH REWARDS AND INCENTIVES**

People must be motivated to achieve an organization's goals and objectives. Organizations cannot motivate people. People can only motivate themselves. But organizations can provide appropriate incentives to motivate people to achieve organizational goals. These incentives may be both monetary and nonmonetary. To provide appropriate incentives, managers must understand what incentives are likely to be required to motivate the different kinds of people they supervise.

The basic question in the minds of scientists and other employees is, "If I work harder and am able to improve my performance, will this improved performance be recognized and rewarded in a way that is meaningful to me?" Efforts to motivate scientists and other employees must address this basic question. Badawy (1988) outlines seven principles of effective motivation:

1. Desired performance should be clearly defined and stated.
2. A clear distinction should be made between a need for training and a need for motivation.
3. Reinforced behavior tends to be repeated.
4. Feedback on performance is an important form of reinforcement.
5. Rewards should be given for movement toward the desired behavior.
6. Reward is more effective than punishment in motivation.

7. Rewards should follow soon after the behavior to be reinforced.

A common mistake in managing R&D projects is to assume that scientists and engineers are driven to seek the same rewards that other people seek. Many employees are primarily oriented towards monetary rewards and organizational goals. Although scientists and engineers are motivated by these same goals, they also are driven by other incentives and career goals. Scientists are committed to advancing knowledge and gaining professional recognition by peers in their chosen field of science (Badawy 1988). These rewards come from outside of the research organization for which they work. Managers must recognize this difference between scientists and other employees, and in the factors that motivate them, and provide appropriate incentives for the various people working for them. According to Chaudhuri (1986), in developing countries "...national research laboratories cannot attract good technologists through material incentives but must retain them by inspiring them to achieve challenging goals."

Various types of incentives for researchers have been suggested (Badawy 1988). These include:

Organizationally Oriented Incentives -

- Merit salary increases
- Promotions within career ladders
- Improved office space
- Increased technical or clerical assistance
- Increased challenge in job assignment
- Special recognition and/or monetary reward for superior performance

Professionally Oriented Incentives -

- Encouragement to publish
- Time off and expenses to attend professional meetings
- Greater freedom to come and go
- Better scientific equipment
- Sabbatical leave for education
- Expenses and tuition for continuing education

Bengston (1989c) reported on the results of two mail surveys of 91 public forestry research institutions worldwide (46 from developing countries, 45 from developed countries). He concluded that although salary levels are important in motivating forestry researchers, other rewards also are perceived as effective in stimulating researcher productivity (Figure 13.1). The six categories of nonsalary awards include:

1. Financial awards for outstanding productivity, quality, etc.
2. Nonfinancial awards and recognition
3. Additional research funding
4. Other benefits such as housing or transportation
5. International travel
6. Career advancement in research

Although respondents from developing countries rated five of these nonsalary awards as having from moderate to great effectiveness in stimulating researcher productivity, most were used only occasionally in practice (Figure 13.1). Financial awards were perceived as one of the most effective methods, but were the least used.

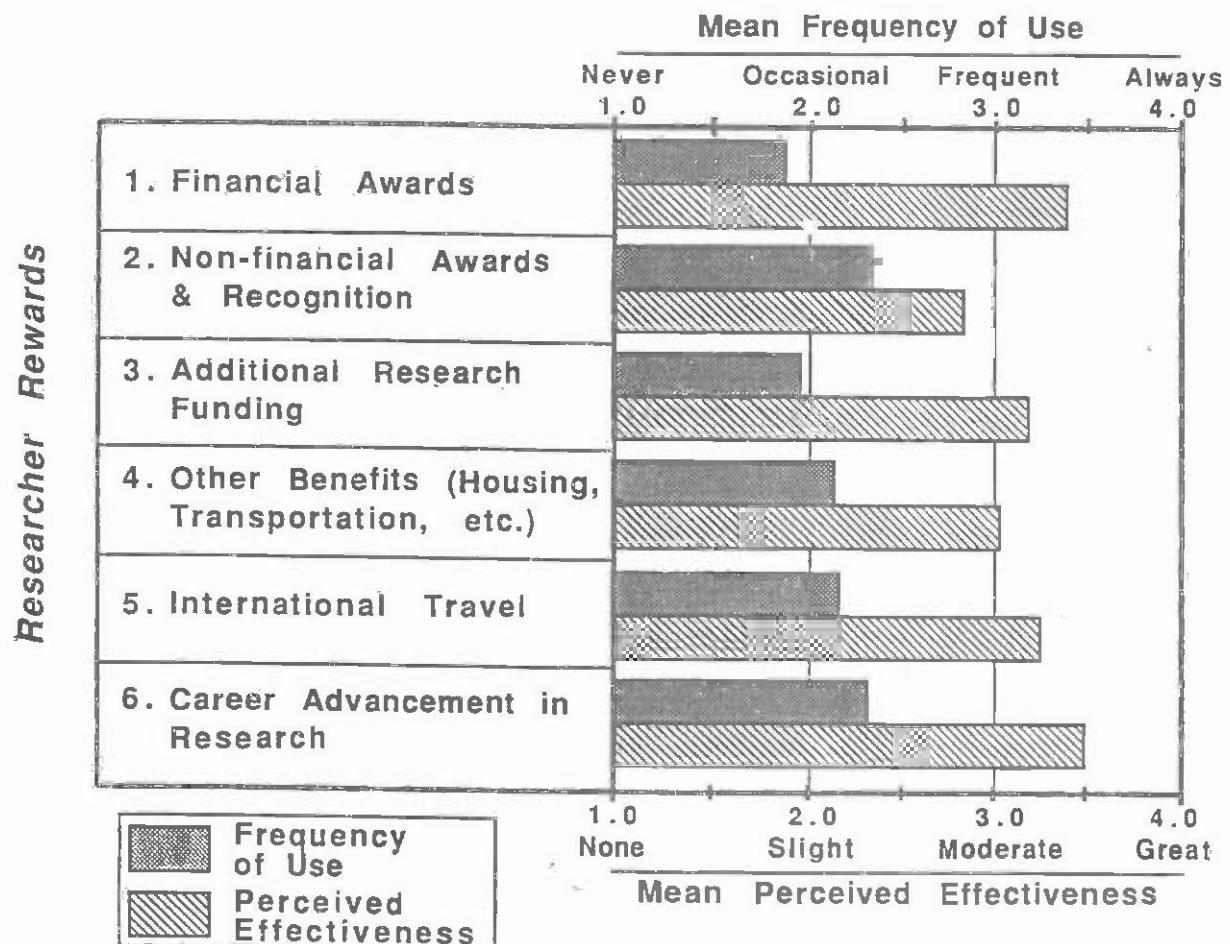


Figure 13.1. Mean frequency of use and perceived effectiveness in stimulating researcher productivity of six rewards for researchers in developing countries.

Source: Bengston (1989c).

Research managers should devote greater attention to the broad array of incentive mechanisms that are available to stimulate improved performance among research scientists and other employees. Above all, if the organization wishes to achieve its goals and objectives, then any system of rewards and incentives it develops and uses should be based on an individual's contribution towards those goals and objectives (Brooks 1968).

#### CAREER LADDERS AND TENURE CONSIDERATIONS

Scientists in many fields gain the knowledge and skills necessary to become an effective researcher in that field only after many years experience as a researcher. Thompson and Dalton (1976) identified four career stages in the life of scientists, engineers, and managers in large research laboratories:

**Stage 1** - In stage 1 the scientist serves as an apprentice to a more senior scientist. This stage is characterized by:

- the work is never his or her own;
- the assignment is part of a larger project or activity;
- much of the work is detailed and routine.

**Stage 2** - In stage 2, the scientist:

- assumes responsibility for a definable part of a project or process;
- works with relative independence and produces significant results that are recognized as his/her own;
- begins to develop credibility and a reputation for competent work;
- manages more of his/her own time and accepts more responsibility for outcomes.

**Stage 3** - In stage 3, the scientist:

- develops a greater breadth of technical skills and applies those skills in several areas;
- begins to deal with the external environment of the organization (clients);
- becomes involved in the development of people, and stimulates others through ideas and information (may become a mentor to younger scientists, or become a supervisor or manager).

**Stage 4** - In stage 4, the scientist:

- exercises a significant influence over the future direction of the organization;
- engages in wide and varied interactions both inside and outside the organization;
- sponsors and develops promising people who might fill key roles in the organization.

Not everyone is motivated to continue to advance through the four career stages described earlier. Some may remain in stage 1. Others may be content to remain in stage 2. If the research manager is to make effective use of people in the organization, he/she must identify those with the potential to advance further in their careers, and attempt to stimulate them to greater achievements.

As scientists gain experience and professional recognition, they expect to receive promotions and other organizational recognition for their growing competence. They expect to move from one stage in their career to another, steadily gaining more responsibility and authority.

Bennell (1988a) suggests that an optimal compensation scheme for agricultural researchers should:

- be simple and understandable;
- have grades based on job analysis and evaluation, and job comparison surveys;
- include career-long effective promotion and financial incentives;
- include job titles that identify seniority and competence among colleagues;
- have clearly specified promotion criteria based on demonstrated job performance;
- have provision for accelerated advancement for exceptionally competent and motivated researchers with a proven record of performance;
- provide for dual career ladders, with provision for advancement in both administration and research;
- provide for consistent increases in income over a career, based on demonstrated performance and achievement.

Such a comprehensive compensation scheme rarely exists in practice, but it does suggest an ideal to strive for. Many governmental research agencies have no career ladders for those choosing to stay in research. The only career ladders are for those in the more traditional administrative positions. Career ladders within government agencies often are determined by civil service or other departments of government, and are outside the control of the research organization.

A lack of research-oriented career ladders can lead to scientists abandoning research for administrative or other lines of work in order to advance professionally and obtain higher compensation. This is a valid option for many researchers who, after several years in research, discover that they would enjoy and do well in an administrative career. Without an open career ladder for research scientists, managers of research organizations will find it difficult to keep good research scientists and motivate them to a high level of scientific achievement. The lack of career ladders within research is one of the greatest barriers to be overcome in building an effective forestry research organization.

In the absence of a research-oriented career ladder, the challenge to research managers is to motivate researchers by structuring their research jobs so as to increase job satisfaction. Hall & Louis (1988) found that a high level of job satisfaction by engineering and technical workers in industry was linked to the following factors:

- high levels of recognition for good job performance;
- high job challenge;
- high psychological success;
- high job involvement; and
- a strong sense of being valued, both inside and outside the company.

These are factors that research managers have some control over. In the absence of a research-oriented career ladder, it is up to research managers to make the job situation challenging and rewarding to those who choose to remain in a scientific career. Managers can increase the level of job satisfaction among scientists by improving the organizational environment. They can:

- provide a high level of recognition within the research organization for good research performance;
- stimulate recognition by outside groups for outstanding research performance that contributes to solving important scientific and societal problems, and make it possible for employees to accept that recognition;
- assign increased duties, responsibilities, and authority, so as to increase the challenge of a scientist's job;
- provide opportunities to develop personally and professionally and acquire new skills and interests, so as to achieve a high level of psychological success that contributes to job satisfaction; and
- communicate to scientists the strong sense of being valued by the research organization for their contributions to organizational goals and objectives.

Above all, research managers can greatly affect the research environment by their style of leadership, which is the subject of the following chapter.

## Providing Research Leadership

The job of the research manager is to utilize the people, funds, facilities, and other resources at his/her disposal to achieve the goals of the organization and accomplish its mission. Ranftl (1986) suggests that a productive manager:

- Is competent at staffing;
- Directs the organization's efforts effectively;
- Is competent at handling complexities and problems, and in dealing with new concepts;
- Is a skillful communicator; and
- Supports and guides subordinates in their work and encourages their full participation.

To achieve these skills, the manager must develop an appropriate style of management and provide effective leadership to motivate people within the organization to carry out their jobs. The manager's style of management and leadership can greatly affect the effectiveness and efficiency of the organization.

### ALTERNATIVE MANAGEMENT STYLES

Several different styles of management are found within organizations. Two contrasting styles of management have been labeled Theory X and Theory Y (McGregor 1985). According Marcotte (1988), at the one extreme are managers with a Theory X style of management, who tend to believe that people:

- Lack integrity;
- Are fundamentally lazy;
- Avoid responsibility;
- Are uninterested in achievement;
- Are incapable of directing their own behavior;
- Are indifferent to organizational needs;
- Prefer to be directed by others;
- Avoid decision making;
- Are not very bright.

In contrast, managers with a Theory Y style of management tend to believe that people:

- Have integrity;
- Work hard to achieve objectives to which they are committed;
- Assume responsibility within these commitments;
- Desire to achieve;
- Are capable of directing their own behavior;
- Want their organizations to succeed;
- Are not passive and submissive;
- Will make decisions within their commitments;
- Are not stupid.

With these views, managers with Theory X beliefs will: exercise tight controls; not delegate; keep all information to themselves; not trust subordinates; and will drive, push, and shove people to achieve greater production. Managers with Theory Y beliefs will: relax controls with those who have demonstrated responsibility; delegate responsibility and authority; share information; put greater trust in subordinates; and will facilitate, encourage, and coach people to achieve organizational goals.

Some management styles appear to be more effective than others in leading research organizations. Bennell and Zuidema (1988) suggest that a participatory style of management has been found to be most effective in agricultural research organizations. This style is more in line with the Theory Y approach to management, and emphasizes a concern for both the researcher and the task to be performed. Researchers have the technical knowledge of what can be done and how it can be done. Managers have the strategic knowledge of what needs to be done. Working together and sharing their knowledge, managers and researchers can develop a research program that can be carried out to meet societal needs within the capabilities and resource constraints of the organization. Participation in managerial planning and decisions can generate greater employee commitment to plans and decisions of the organization.

### THE IMPORTANCE OF LEADERSHIP

Providing effective leadership is one of the most important tasks of management. Leadership has been defined as:

*"... a process by which one person attempts to influence the behavior of another (or a group) with the expressed purpose of achieving a goal (or goals)."*  
(Marcotte 1988, p.168 & 170)

Chaudhuri (1986) describes the importance of leadership in successfully developing the Swaraj farming tractor in India.

*"The success of the Swaraj project was to a very great extent due to leadership provided by the product champion who developed effective relationships with key persons, crusaded for the cause of indigenous technology and built a cohesive design team."*  
*"...the charismatic personality of the product champion ... was able to galvanize the members into a cohesive team."*

To inspire people, managers must have a clear vision of where they are going, what it will take to get there, and why it is important to fulfill the mission, goals, and objectives of the organization. Father Theodore Hesburgh, former president of Notre Dame University, has said (Peters 1987):

*"The very essence of leadership is [that] you have to have a vision. It's got to be a vision you articulate clearly and forcefully on every occasion. You can't blow an uncertain trumpet."*

### PRINCIPLES OF LEADERSHIP

Managers can provide more effective leadership by adopting the following principles (adapted in part from Peters 1987):

- Develop an understanding of the organizational mission, its goals and objectives and what it stands for. Research managers must accept this mission, and use it as a guide to their activities.
- Develop a clear statement of the organization's mission. Mission statements should be simple and easily understood by everyone. This mission should be communicated to all employees of the organization, so that they understand what the organization is attempting to do, and who it is serving. There is no effective leadership if employees do not know where they are going, how they are to get there, or who it is that they are trying to serve.
- Manage actively and visibly. Employees should be made aware that someone is in charge of their work, and cares about the kind of a job they do. A leader should be visible and approachable, so that all employees know who is in charge and have some personal contact with him/her. A leader should indicate by his/her actions the kind of work and level of performance they expect from their employees.
- Lead by personal example in carrying out job assignments. Employees are well aware of what their supervisors do, and on what issues, problems, and details they devote most of their time. What managers actually do reflects their priorities, and this is transmitted, consciously or unconsciously, to employees. Managers should determine what their top priorities are, and then devote most of their working time to those priorities. If managers devote little time to what they have declared to be urgent priorities, then employees are sure to interpret this as a sign that the other jobs on which the manager spends time are more important.
- Practice active listening. In today's rapidly changing world, managers must personally contact and listen closely to many different people to find out what is really going on in the world, to customers, employees, and others. For effective management there is no substitute for first-hand information.
- Delegate responsibility and authority to act. True leadership requires knowing when to "let go." Competent employees must be given a chance to develop to their full capability by being given increasing levels of responsibility and decision-making authority. It is the responsibility of the leader to provide employees with a clear understanding of exactly what responsibilities they have, and what authority they have to make decisions and take actions commensurate with that responsibility.

## TYPES OF LEADERSHIP

The style of leadership or management greatly influences the organizational environment. Marcotte (1988) describes four basic leadership styles, based upon the degree of direction and support given to employees by a manager. **Direction** refers to one-way communication from the leader to the subordinate to define the work situation and direct the subordinate. **Support** refers to two-way communication between the leader and the subordinate to communicate with, listen to, and encourage the subordinate. Marcotte suggests that different levels of direction and support may be appropriate in providing leadership in different situations:

1. High direction, low support - a directing style of leadership, where the leader defines roles, makes decisions, and closely supervises. This style is most appropriate in supervising an enthusiastic beginner, who has high commitment, but low competence.
2. High direction, high support - a coaching style of leadership, where the leader provides direction but attempts to incorporate the subordinate's input. This style is most appropriate where the subordinate has some competence, but lacks commitment.
3. Low direction, high support - a supporting style of leadership, where the subordinate engages in problem solving and decision making, and the leader facilitates work and provides recognition. This style is most appropriate where the subordinate has competence, but lacks confidence.
4. Low direction, low support - a delegating style of leadership, where the leader and subordinate jointly agree on problem definition, and decision making is delegated to the subordinate. This style is most appropriate where the subordinate has competence and is motivated to achieve a high level of performance.

Successful leadership requires leaders to be flexible in their leadership approach. They must know their staff well enough to know which style of leadership works best with each staff member to achieve the desired level of performance.

Leadership within a research organization faces special challenges. The research manager must motivate a diverse group of highly trained, potentially creative individuals to work together to achieve organizational goals and objectives. The style of leadership will depend on the personality, confidence, values, and motivations of the manager; on the researchers' motivation, education, experience, commitment, and understanding of organizational goals; and on the resources, mandate, and responsiveness of the organization itself (Bennell and Zuidema 1988).

Providing effective leadership for a research organization requires recognizing the special nature of scientists, who make up the most important element of research. Scientists require, and often demand, special treatment. The progress of science is uncertain and requires a great deal of creativity. There is considerable art in the pursuit of science. Because science is an uncertain, creative process, scientists cannot be managed as one would manage other employees. Managers of research organizations cannot rely upon tight control to direct scientists and enforce strict adherence to predetermined plans. There is little of the repetitive and routine in science that lends itself to clear, task-oriented job specification and measurement. Research does not lend itself to being governed by strong top-down direction. The job of leadership in a research organization is to provide a work environment and reward system that will motivate scientists to become self-directing and productive.

Managerial leadership is the most important factor affecting an organization's productivity (Ranftl 1986). Although admitting that leadership is difficult to define, Ranftl (1986) developed a profile of desirable characteristics of an outstanding leader (see Figure 14.1), based on a long-term study involving surveys of more than 3,500 managers in 59 major organizations in industry, government, and education.

Perhaps the most effective leadership of all is management by example (Peters 1987). Research managers, by the organizational vision they espouse, their attitude towards

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**An outstanding leader :****Sets a particularly positive example as a person**

- \* Is unusually competent
- \* Has quality and quickness of mind
- \* Is particularly creative, innovative, and nontraditional - a unique individual
- \* Is highly self-motivated, self-confident, and self-directing
- \* Has extremely high integrity, values, and standards - stands above organizational politics
- \* Has unusually high motives, and a firm sense of purpose and commitment
- \* Is dedicated, and never self-serving - avoids gamesmanship
- \* Has a strong positive orientation
- \* Displays total self-command
- \* Has a high level of deserved self-respect and self-esteem
- \* Is clearly accepted as a leader
- \* Accepts and enjoys role of leader, but with humility
- \* Is willing to work harder than other members of the team
- \* Has particularly high vitality, stamina, and reserve energy
- \* Is continually searching, learning, developing, expanding, evolving
- \* Is a "winner"

**Takes a dynamic approach to activities**

- \* Is action-oriented, with a compelling drive to accomplish and achieve
- \* Is quick to size up merit of people, ideas, and opportunities
- \* Uses a persuasive personality rather than force of power to get things done
- \* Is tenacious - perseveres in the face of obstacles
- \* Always sees things through to successful completion
- \* Makes decisions and does what has to be done, even if it is unpopular and may result in criticism
- \* Continually seeks new and better ways
- \* Is visionary, skilled at predicting future technological and operational needs and applications
- \* Always sees new challenges and new fields to conquer

**Brings out the best in people**

- \* Is strongly people-oriented
- \* Exhibits great respect for human dignity
- \* Is particularly skilled in dealing with and motivating people
- \* Has well-defined meaningful goals, and successfully inspires associates to help achieve them
- \* Has confidence in people and effectively communicates that confidence
- \* Brings about dynamic synergism within groups
- \* Is stimulating and catalytic - communicates a "can-do" attitude in all actions
- \* Maintains an exciting organizational climate and instills enthusiasm
- \* Helps subordinates achieve their full potential

**Demonstrates great skill in directing day-to-day operations**

- \* Conceptually integrates all facets of the operation
- \* Has a strong sense of timing and limits - accurately senses "when" and "how much" in each situation
- \* Has uncanny knack for cutting through complexity
- \* Sorts out irrelevancies and identifies real driving factors
- \* Provides practical solutions to difficult problems, and successfully communicates solutions to others
- \* Senses what might go wrong and develops contingency plans
- \* Maintains control of all situations
- \* Performs with relative ease during times of stress
- \* Displays and "elegant" simplicity in all actions

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**Figure 14.1.** Distinctive qualities of an outstanding leader (adapted from Ranftl 1986).

employees, their personal work habits, and a host of other practices, provide an example, whether intended or not, of what kind of person they want their employees to be. If research managers want to elicit a certain type of behavior on the part of their employees, then they should practice what they preach, and set an example for them to follow. How managers carry out their own work on the job will have a major effect on employee behavior.

Few people possess all of the traits of outstanding leadership, but some people possess more leadership traits than others. An important job of research management is to identify as early as possible those people within the organization that show leadership potential, so that they can receive training and experience to enhance their leadership ability.

## Training and Education

The term **education** is used here to mean acquisition of the base of knowledge that is needed by a competent scientist or by an effective manager. We most often associate education with formal programs in high schools and colleges. **Training**, on the other hand, is interpreted here to mean teaching specific functions and skills to those who will be, or already are, working with specific research activities or management and operational functions.

Forestry research managers have indicated in a number of surveys that lack of adequately educated and trained scientists is one of the key barriers to more effective research (Bengston and Gregersen 1988, Iyamabo and El Lakany 1988, ITFFR 1988). As indicated in Table 15.1, results of the ITFFR survey showed that, across all regions, and for both government and university research administrators, training of scientists was ranked most important, with training of technicians ranking second or third, along with development of networks.

Table 15.1. Priorities for increased investment in training and interactive activities.  
Where: 1 = most important; 5 = least important.

Training and Interactive Activities	All Developing Countries	Africa	Asia	Latin America	Institutions	Universities
Training of scientists	1	1	1	1	1	1
Training of technicians	2	2	3	2	2	3
Research networks	3	3	2	3	3	2
Travel, meetings and seminars	4	4	4	4	4	4

Source: ITFFR (1988) based on responses from some 85 countries.

Training is necessary for all employees to provide them with the knowledge and skills they need to function effectively. Such training may range from relatively informal instruction in office procedures and the use of office equipment by supervisors, to highly structured courses on scientific writing, the use of statistics in research design, word processing on computers, and similar subjects. The value of such training must be weighed carefully against the time lost from productive work during the training period. For such training to be effective, the manager must ensure that the organizational framework is designed to facilitate implementing new methods and technologies acquired by training. There is little point in expending human and capital resources in training if the results cannot be applied on the job after the training is completed.

### DEVELOPING A TRAINING PLAN

A research organization needs a training plan in order to determine training requirements, the best deployment of training resources, and the logistics of training activities. The first step in developing a training plan is to determine needs. These depend on: a) the skills and disciplines needed to accomplish the organization's research objectives and goals; and b) the scientists and skills currently available to the organization.

The second step is to assess what resources are available for developing and implementing training activities, and the types of activities which are most appropriate to accomplish the needs. Various types of training and education can be used. These include basic scientific education for researchers, technical training for technicians, general staff training for office personnel, and training in procedures for all personnel. In addition, of course, there is the basic education--both at the high school and the college and postgraduate levels--for the future scientists and managers of a country. All of these different options should be considered in developing the plan.

Figure 15.1 provides an overview of what should be included in a forestry research training plan. The following sections discuss each of the components.

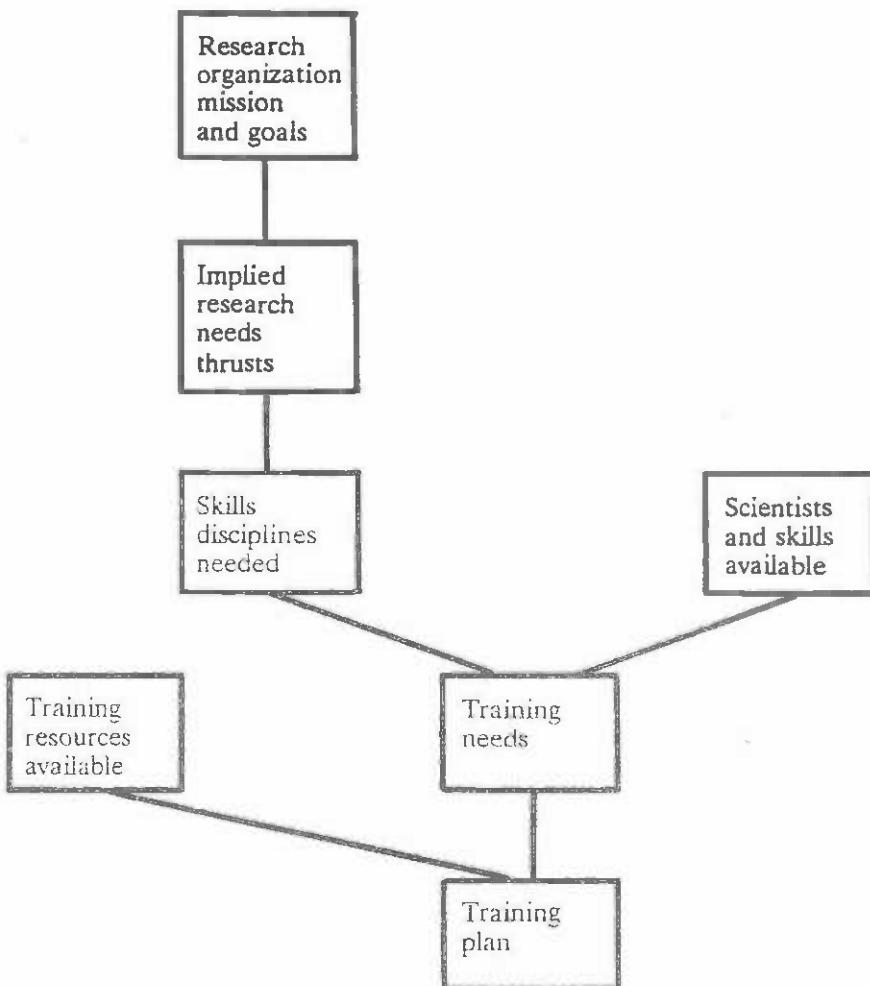


Figure 15.1. Developing a training plan.

## NEEDS ASSESSMENT

A training needs assessment is the first step in planning a formal training program. At the same time, of course, assessment of training needs should be an on-going process. For example, any time that new procedures are adopted, new equipment is purchased, new personnel join the organization, or some problem of performance is identified, there will be a need to reassess training requirements.

Training needs are determined by what the organization wants to accomplish, what it needs to do to accomplish its objectives, who it has available to accomplish its objectives, and what skills and abilities those people have. The gap between what skills it needs to accomplish its objectives and what skills and talents it has available provides an indication of potential training needs. We say "potential" in the sense that: a) the organization may be able to recruit people with the skills to do what needs to be done, or b) the gap between needed and available abilities may be caused by other factors influencing personnel performance and ability, such as inadequate incentives, work conditions, or supporting equipment.

A training needs matrix can be a useful tool in organizing training needs in relation to: a) topics of importance, and b) types of individuals within an organization. Table 15.2 provides an example of a training needs matrix for administrative and scientific staff. (A similar matrix is needed for technicians, office and other staff). The row headings are the basic elements in a "management by objectives" framework. The matrix has been completed, based on input provided by directors of research in some 16 African countries, at the 1989 IUFRO Workshop on Management of Forestry Research in Africa in Nairobi.

Prior to being given the matrix, the directors were asked to provide their views on which specific topics are important and the relative priorities that should be assigned to each topic in training activities. Table 15.3 provides the results. As indicated, training on program and project design and planning ranked first, with training related to budgeting and finance and training related to identifying research needs and priorities ranking a close second and third. Fourth and fifth were training related to internal relations and motivation, and training related to performance measurement and evaluation. As can be seen, the topics identified by the African research leaders fit in closely with those listed in the training matrix (Table 15.2).

## OPTIONS FOR MEETING TRAINING AND EDUCATION NEEDS

Once needs have been determined, the options for education and training programs are many. Which ones are chosen depends on, among other things: a) resources available, b) extent to which the organization can afford to be without key personnel while they are in training, and c) the training and education institutions available in-country. In most developing countries, all three of these factors present a challenge to the research manager attempting to develop an adequate training program.

Table 15.4 provides an overview of different types of training for researchers and other staff that can be, and have been, used in national forestry research organizations. It also suggests the types of objectives for which different types of training are appropriate, typical durations, targets, locations and expected results for different types of training activities.

**Table 15.2. Training for forestry research management: Information needs and skill requirements.**

needs by type of trainee: 1 = understanding and skill  
 2 = general understanding only  
 3 = none or awareness only

MANAGEMENT RELATED SUBJECT MATTER	PERSONNEL	Director	Research	Researchers
		General and other top administrators	Programme managers	
<b>1. Setting goals and objectives</b>				
external relations	1.0	1.5	2.5	
mission and goal formulation	1.5	1.5	2.0	
setting internal policies	1.0			
<b>2. Program planning</b>				
monitoring performance	1.0	1.0	1.5	
assessing research capacity	1.5	1.0	1.5	
assessing research needs	1.5	1.5	1.5	
identifying gaps in capacity	1.5	1.0	1.5	
program/project design	1.5	1.5	1.0	
financing	1.0	1.5	2.0	
<b>3. Implementation and management</b>				
procurement (purchasing/contracting)	2.0	1.5	2.5	
budgeting/accounting	1.5	1.5	2.0	
operational mgt. (equipment/facilities)	1.5	1.5	1.5	
people management	1.0	1.0	2.0	
training procedures	1.5	1.5	1.5	
networking	1.5	1.0	1.5	
research methodology	1.5	1.5	1.0	
<b>4. Dissemination of results</b>				
documentation and information	1.5	1.0	1.5	
extension and communication	2.0	1.5	1.5	

Note: This table deals with training for management; other types of personnel need training of a different type.

Source: Survey of 16 forestry research directors at the 1989 IUFRO Workshop on Management of Forestry Research in Nairobi, June-July 1989.

**Table 15.3.** Priority topics for management training in forestry research organization of Africa: The views of African research directors.

Topic for Training	Priority Ranking
Program and project design and planning	1
Budgeting and finance	2
Identifying research needs and priorities	3
Internal relations and motivation	4
Performance measurement and evaluation	5
Recruitment procedures	6
External relations	7
Planning	8
Specification of rules and regulations	9
Monitoring and control functions	10
Dissemination of research results	11
Training of staff	12
Management of facilities and equipment	13
Management of input supplies	14

Source: Survey of 16 forestry research directors from French and English speaking African nations, IUFRO Workshop on Forestry Research Management, Nairobi, June-July 1989.

Funding for training often is part of international technical assistance and investment programs. In this case, the manager should carefully weigh the advantages and disadvantages of foreign education, which may be required to be in the donor country. Such education programs may be good in an academic sense, but may not be relevant in terms of the problems facing the country. In the case of foreign supported programs, it may be possible to get temporary expatriate replacements for key people while they are in training. This has the double advantage of filling critical gaps and providing a ready source of in-house training, if the foreign replacement is an experienced researcher.

Continuing education of researchers is a key factor in forestry research success. Ideally such continuing education might involve a short period out of the country or in-country, but away from the home organization, coupled with seminars or workshops in the home organization.

### USING THE RESULTS OF TRAINING MOST EFFECTIVELY

A key problem arising time and again is the return of a newly trained, skilled researcher to a work environment where he or she will not be able to utilize adequately the newly learned knowledge and skills. This may be due to a lack of laboratory equipment and facilities, computer hardware and software or other technical facilities. Sometimes it is due to a reassignment to undertake administrative duties. A reluctance of supervisors or peers to accept the new methods or technologies may also present barriers to its use. The problem also arises from a lack of adequate support funding, or a lack of adequate incentives and an appropriate career ladder (related not only to promotion, but also to salary advances). These issues all have to be considered in looking at training needs. They are discussed in other chapters.

Table 15.4. Typology of training in research organizations.

TYPE OF TRAINING	OBJECTIVE	DURATION	TARGET	LOCATION	EXPECTED RESULT
1. Induction.	<ul style="list-style-type: none"> <li>To enable staff to become acquainted with organizational mandate, goals, roles, and regulations.</li> <li>To meet others and become more acquainted with the programs and activities within a short time.</li> <li>To facilitate socialization.</li> </ul>	Few days to one month	All new staff	In the organization	Faster integration and assimilation of staff into the organization.
2. On-the-job.	<ul style="list-style-type: none"> <li>To enable researchers to learn research techniques and methods.</li> <li>To coach young researchers on the scientific and research process.</li> </ul>	Continuous	All but emphasis on young researchers	Other institutions or at own institutes	Improved research productivity, job satisfaction, reduction in downtime of equipment, motivation and leadership role, etc.
3. Short-term. (e.g. short-term travel grants)	<ul style="list-style-type: none"> <li>To enable staff to acquire new skills, knowledge, and attitudes.</li> </ul>	Few days to six months	All, depending on topic		Improved research productivity.
4. Postgraduate. or Professional	<ul style="list-style-type: none"> <li>To increase knowledge and upgrade skills and research capability in general.</li> <li>To enable staff to achieve academic advancement.</li> </ul>	One year to 3 to 5 years	BSc or MSc degree holders	At local or overseas universities or leadership improved.	Enhanced research skills and knowledge. Research Better career prospects.
5. Postdoctoral. or long-term fellowships.	<ul style="list-style-type: none"> <li>To improve knowledge, skills, and professional contacts.</li> <li>To upgrade skills of researchers.</li> </ul>	Up to one year	MSc or PhD degree holders	At IARCs, other universities or institutions	Improved leadership, technical skills, and knowledge.
6. Agricultural. research management	<ul style="list-style-type: none"> <li>To improve capacity for management of resources, develop skills in agricultural research planning and budgeting, monitoring and evaluation, and improve supervisory and management leadership, etc.</li> </ul>	Few days to one month	Mid- to senior-level research managers	National training, international or regional seminars, conferences, and symposia	Improved managerial skills-leadership and motivational. Improved resource management skills.
7. Technical.	<ul style="list-style-type: none"> <li>To upgrade expertise of technical personnel.</li> </ul>	A few months	Technical staff	At polytechnics, international institutes, or other laboratories	Improved specialized techniques and methodology.

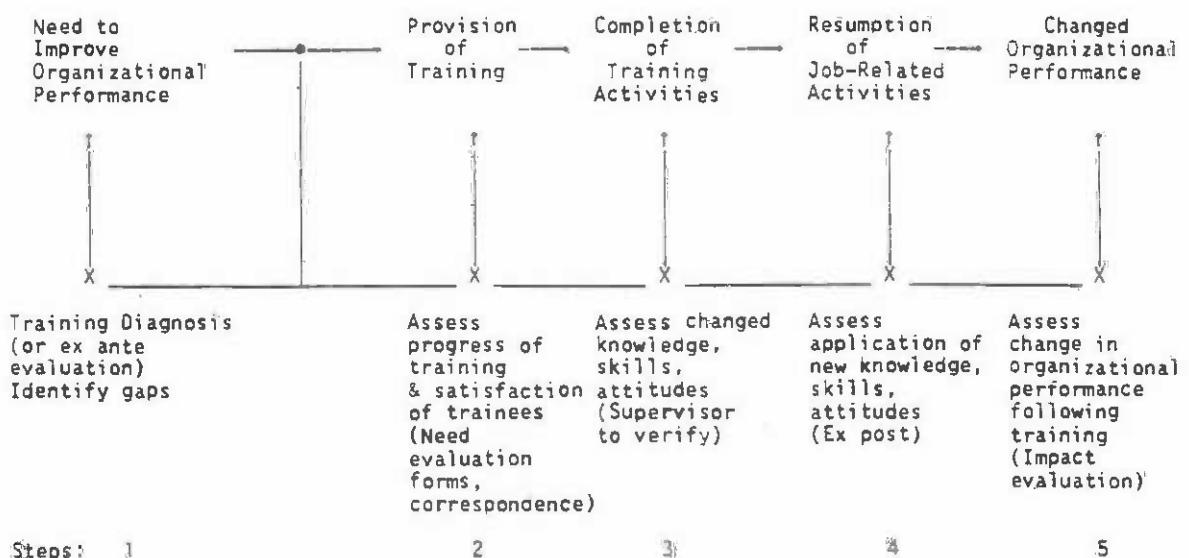
Source: Abe 1988

## EVALUATION OF TRAINING PROGRAMS

Evaluation attempts to show whether the training has achieved its stated objectives and to what extent it was effective, to what extent it has contributed to the organization as a whole, and to what extent it has influenced future training and training-related decisions and actions. In other words, evaluation attempts to establish whether the right (training) action was taken (Abe 1988).

All training activity should be subject to some form of evaluation, including evaluation of how well the results of the training activity have been applied in practice, and what effect the application had. Too often, evaluation stops when the training activity is completed. It needs to continue after the training is completed if one really wants to assess the effectiveness of training. After all, the purpose of training is to get people to change what they are doing or how they are doing something. The training can only be thought of as successful if the changes take place.

Evaluation should take place over time as the training activity progresses, and it should include evaluation by those involved in the training--both trainers and trainees. It should also involve assessments by supervisors or those who will be administratively responsible for the trainees when they return to their jobs. An overview is presented in Figure 15.2 of the stages in training where evaluation is needed.



**Figure 15.2.** Evaluation of five levels of management outcomes (adapted from K. Brethower and G. Rummel, 1979. Evaluating Training. *Training Development Journal*, May 1979:17); as reported in ISNAR, 1988.

## Scientific Support Services

In order to conduct effective research, scientists in a forestry research organization need access to a broad range of scientific and technical information, and to special expertise in statistics and computer technologies. No scientist has all of the scientific and technical knowledge and skills required to fully carry out his/her research responsibilities. In order to facilitate their research programs, research managers must identify and plan for meeting the needs for such specialized information and expertise. Most research organizations meet these needs by establishing special service groups within the organization. Such groups are referred to as scientific support services, to distinguish them from administrative support services (discussed in the next chapter).

### THE IMPORTANCE AND FUNCTIONS OF SCIENTIFIC SUPPORT SERVICES

Scientific support services exist to support the research program of the organization. Their primary goal is to facilitate and improve the quality of research by providing information and expertise to scientists and others in the organization. They also may contribute to other goals of the organization.

To avoid unwarranted duplication of research effort, to take advantage of the latest knowledge in a field of scientific research, and to identify the people working on a particular problem, scientists need access to the scientific literature. With the rapidly expanding literature on forestry-related topics in so many diverse fields of science, the research scientist must increasingly rely upon people skilled in library sciences. They need access to the literature in diverse fields of physical, biological, and social sciences. The information needs of forestry researchers frequently go far beyond the capabilities of a local forestry-oriented library established within a forestry research organization. Increasing, forestry research organizations must access the library resources of other organizations. The expertise required to locate and utilize these special information sources can be provided by a library support person or group within the forestry research organization.

It is not enough just to do research. Any research being done must be based on sound methodologies, so that the results obtained will provide answers to important questions in science or society. Sound statistical experimental design and analysis of data are important in achieving useful research results. Graduate training in forestry usually provides some training in statistical theory and application, but many forestry researchers lack the full understanding of statistics required to use it effectively. The application of statistics in practice is as much of an art as it is a science, and requires considerable knowledge, experience, and skill. Most scientists need some assistance at one time or another from knowledgeable, experienced statisticians in planning and conducting their research.

The use of computers in scientific research is rapidly changing the way in which research is being done in many fields. Computer technologies are changing rapidly over time, and it is difficult for the computer user to keep abreast of, and judge the capabilities of, the new computer equipment that becomes available. It is also difficult for the individual user to keep track of the new developments in computer software, and judge the usefulness of the diverse array of programs that become available. Most scientists need assistance in

evaluating the potential usefulness of computer hardware and software, in installing personal computer systems, and in learning how to use computer systems effectively in their work.

Research scientists also require assistance in preparing their research findings for publication. They may need assistance with editing, preparation of tables and graphs, photography, final typing, and in other ways. Research organizations may publish a series of research and technical papers in order to make research findings more readily available to users. To provide these services many organizations maintain a publications group as part of their research support services.

Research organizations need specialists to help scientists take full advantage of the available literature, statistical methodologies, and rapidly changing computer technologies. In small organizations, statistical or computer support services may be provided by individual scientists or others within the organization who are particularly adept or have had special training in statistics or computers. But as the demand for such help increases, those scientists who provide the help may find themselves devoting a large percentage of their time to assisting others in their research. In larger organizations, it may be necessary to designate special people or set up small groups to provide the necessary assistance to scientists.

The primary function of scientific support services is to provide information and expertise to scientists when needed. But some research support services also act as quality control groups for the organization. Statistical services provide a general quality control over the scientific work of the research organization by reviewing study plans, research reports, and publication manuscripts for their statistical soundness. Publication groups edit manuscripts and may oversee peer review of publications to assure that all scientific publications are well-written and scientifically sound.

Conflicts can arise when support service groups, such as computer services, provide services to both research scientists and to research administrators. Such groups become part scientific support and part administrative support. Because research support services groups are often administered by an administrative branch of the research organization, they can become so oriented to serving research administration that their support of research becomes a secondary consideration. That is, top priority is given to the demands of research administration, and meeting the needs of research scientists becomes a secondary priority. Although the primary reason for establishing and maintaining research organizations is to conduct research, in many research organizations when it comes to obtaining access to research support services, the doing of research appears to be assigned a priority far below the management and administration of the research organization. In computing services, top priority often is assigned to getting administrative reports out on time.

In practice, a proper balance must be struck between research and administration when conflicts in demands for scientific support services arise. Clear policies regarding work priorities must be established and communicated to the various research support groups.

The following sections discuss in turn each of the key scientific support services in more detail.

## LIBRARIES AND OTHER OPTIONS FOR ACCESSING SCIENTIFIC AND TECHNOLOGICAL INFORMATION

In order to play an effective role in science, forestry researchers must have convenient access to scientific literature and information about new technologies that is relevant to their particular field of research. They also must be informed about applied technologies related to their own field of specialization that can be used in practice. The acquisition, storage, and retrieval of scientific and technical literature is costly and time-consuming. Although many scientists maintain small collections of those publications of immediate interest to their work, for the most part they must depend upon more centralized libraries and other means of accessing information to fill their needs. For most researchers, libraries provide access to the world's scientific and technical literature.

The world literature is expanding rapidly in every area of science. Research related to forestry is being conducted by many disciplines outside of forestry, and is being reported in the literature outside of traditional forestry outlets. It is becoming increasingly difficult to locate literature that is relevant to the various fields of forestry research, particularly those interdisciplinary fields such as agroforestry and social forestry. To locate and obtain literature relevant to forestry, forestry researchers can use the help of professional librarians who are especially knowledgeable about this literature.

With the proliferation of scientific journals, books, and other sources of information, most forestry research budgets cannot provide individual scientists with enough funds to meet all of their information needs directly. To conserve funds and better meet the specialized needs for information, most organizations provide some form of centralized information service center, such as a library. The rising cost of acquiring books and journal subscriptions suggests the need to have fewer but better equipped and stocked libraries that can afford to maintain a more complete collection of literature relevant to the research programs of participating research institutions. Scientists must have improved means of accessing relevant literature from such centralized collections.

Library services within a research organization could be met in several ways:

- Each research project could develop out of its operational funds its own specialized collection of library materials to meet its own information needs.
- A research organization could maintain a central collection of books, journals, and other sources of information to meet the information needs of scientists and others in the organization, and either rely upon the scientists themselves to maintain and utilize the collection, or provide trained librarians to oversee the collection and help scientists use the collection and access other literature.
- A research organization could provide centralized librarian assistance, with a minimal book, journal, and pamphlet collection, but provide assistance to scientists and others in locating and obtaining information from other sources.

Providing library services to scientists is expensive, and with limited funding research managers must make some difficult decisions about how much of their funds should be spent on providing such services. This is not an easy decision to make. The impact on research of decisions regarding the provision of library services is likely to vary considerably, and is difficult to quantify. Some scientists rely heavily on libraries and library services, and their research could be affected to a considerable extent. Other scientists rely very little on library services, and their research may be relatively unaffected by such a decision.

Scientists who need to keep abreast of new developments in particular fields of science can do so in many ways. They can:

- subscribe to or obtain access to a few key journals;
- purchase or obtain access to key books periodically;
- subscribe to or obtain access to abstract journals and/or journals such as *Current Contents*, which reproduce title pages of key scientific journals;
- write for reprints from authors of articles of interest;
- get on the mailing lists (often free) of research networks to get newsletters, which often report on new literature;
- correspond with other scientists to exchange information;
- visit other scientists in other research facilities to find out about the latest developments;
- visit library facilities in universities and/or other research organizations;
- utilize computers to access information data bases.

These suggest some of the alternatives that could be used by scientists to locate scientific information in the absence of a library and/or a librarian at his/her research facility. Most research scientists maintain some sort of reference collection of books, pamphlets, and other materials directly related to their research and utilize several other options to access the scientific and technical literature. Research managers could provide funds to support some of the above activities in place of providing library facilities at a research installation.

#### STATISTICAL SERVICES

Statistical concepts play a key role in the planning of research and in the design of experiments (Berg 1980). Most scientists in forestry research with graduate training are aware of the importance of statistics in designing experiments and analyzing data, and have acquired some knowledge and skill in using statistics in research. But rarely is this enough to meet all of their needs. Furthermore, the majority of forestry and agricultural scientists in developing countries do not have advanced graduate degrees. A survey of national agricultural research systems in 79 developing countries indicated that 53 percent of the researchers had only a B.S. or equivalent degree (Bennell and Zuidema 1988). This closely corresponds to the situation in forestry research. Bengston et al. (1988) report that 54 percent of forestry researchers in developing countries of the Asia-Pacific region, and 60 percent in other regions had only a B.S. degree.

Without graduate training, many forestry scientists do not have the level of statistical expertise required to satisfactorily design scientific experiments, analyze observational data, and interpret the broader meaning of research results. Research managers should be aware of the importance of statistics in research, and should ensure that statistical expertise is available to scientists when needed through some form of statistical services within the research organization.

In many organizations, statistical services are responsible, in part, for the quality control of research. Statistics plays an important role in the design of experiments. Statistical analysis is widely used to establish the reliability of the data and conclusions obtained from observations and experiments. Many research organizations require that study plans and publications be reviewed by a statistician to ensure that the experimental design, data analysis procedures, and any conclusions drawn from the research are statistically valid. To

do this efficiently requires that statistical consultation and advice be readily available to the scientists of the organization.

Meeting the need for statistical services can present a challenge to the manager of forestry research. Statistical services can be provided in different ways. One option for a larger forestry research organization is to employ a full-time or part-time statistician to provide the necessary statistical services to scientists. However, the organization must have a fairly large number of scientists to justify the expense, unless some of the costs and services of the statistician can be shared with another organization. If other nearby related research organizations have or need statistical expertise, a statistician might be jointly funded among several organizations, with each organization sharing in the use of the expert.

If statistical expertise is available outside the organization, it may be possible to contract for statistical services. This might be an option for smaller research organizations, where a full-time statistician is not needed. The difficulty with this arrangement is that the services may not be available when needed, resulting in long delays for scientists in getting statistical advice and in the review of study plans and manuscripts. Also, statisticians from outside of forestry research may not have the special knowledge and understanding of forestry research problems and methodologies to be effective.

Finally, one or more scientists or other qualified professionals could be given special training to enhance their statistical talents, with the understanding that they would assist others in the organization as required, as part of their job for a period of time.

The way in which statistical services are provided will, to a large extent, determine what kind of services can be provided, and how effective and efficient they are likely to be in improving the quality of the research conducted by the organization. While statistical services are not the only influence on research quality, they do play an important role in many areas of forestry research, and should not be neglected.

On the other hand, statistics can be misused. Statistics is not the most important and critical factor in many areas of research. Where it is not relevant, statistical services should not be allowed to become the final judge of all research. The goal of much forestry research is to produce results that are useful in practice, and useful results do not necessarily imply a high degree of statistical reliability. Rough approximations can be useful in the absence of other information. Statistics always must be applied with common sense, and with an understanding of what practical goals research is trying to achieve.

#### COMPUTING SERVICES

*"Of all the changes that have taken place in recent years in how science is done, none is more fundamental and sweeping than the use of computers. Their increasing role shows no signs of abating; it is safe to predict that their use will continue to bring about startling changes in science." (Feinberg 1985, p.182)*

The widespread use of computers in many fields of scientific research is radically changing the way in which research is being done. Computers have greatly enhanced the ability of research scientists to conduct statistical analyses, and to process and analyze vast quantities of data. They make it possible to develop new ways to display data graphically that stimulate theoretical interpretations of research findings. Scientists are becoming increasingly dependent upon computers for word processing, data analysis, modeling, and

other tasks. The use of computers is becoming widespread throughout all fields of forestry research, and cuts across all disciplines.

Forestry researchers use computers for:

- Data recording and analysis, with the computer linked directly to measuring equipment to automatically record and analyze data as it is obtained;
- Data base management, so that data can be accessed rapidly and cheaply in many ways;
- Spreadsheet analysis for many different kinds of data manipulation and analysis;
- Statistical analysis, with many different kinds of programs to summarize, analyze, display, and report on data;
- Mathematical modeling, to simulate physical and biological processes taking place in the natural world;
- Analyzing the impacts of management alternatives on complex natural systems;
- Word processing, to prepare letters, reports, publications, and other documents;
- Graphics, to prepare graphs, pie charts, and many other forms of data presentation in talks, publications, etc.;
- Desktop publishing, to prepare newsletters and other printed materials, bypassing more expensive and time-consuming forms of publication;
- Communication among researchers, research installations, and others, linked electronically through telephone lines, utilizing satellites.

One of the options for providing computer services is to install a large central mainframe computer, under the direction and control of a computing services staff to handle all of the computing for the organization. This was the only option available in the early development of computers. Although some of an organization's needs for computing services can be met satisfactorily in this way, it is rarely satisfactory as a means of providing computing service support for research. In such a setting, serving research invariably becomes a secondary consideration. Priority is given to accomplishing the administrative and managerial tasks of those who supervise the central computing facility. Administrative reports, payrolling, accounting, and other administrative duties, which have firm deadlines, take precedence over research. Research computing can be delayed for days at busy times of the month or the year. Central memory on the computer may be limited, and inadequate amounts made available for use by scientists when they need it. Any apparent economies from centralizing computing facilities for research often are lost by the continual delays and long wait times for scientific work to be completed so further analysis can be done. Such disruptions in research work are rarely considered in analyzing the efficiency of computer use.

Much of the computer needs of scientists now can be met by the use of personal desktop computers. The personal computer has rapidly increased in capability, and currently exceeds the capability of many large computers a decade or two ago. The rapid decrease in price has put computers within the reach of many scientists around the world. A large number of excellent standard commercial programs now are available for personal desktop computers, including programs for wordprocessing, spreadsheet analysis, data base management, graphics, statistical analysis, and many other special applications. Most scientists can readily find programs that are easy to use in meeting a variety of their needs. In addition to this more general software, many computer programs specific to forestry have been developed, and are available for use (Rose 1987). While these forestry-related programs are not necessarily oriented to forestry research, they do indicate the wide range of uses for computers in forestry. An important source for information about

microcomputer applications in forestry is the Forestry Resources Systems Institute (FORS) (122 Helton Court, Florence, Alabama 35630, USA). FORS is a research support network that publishes a newsletter containing feature articles on microcomputers and their application in forestry, reviews of software, notices of meetings, etc., that is mailed to members throughout the world.

In many larger organizations, the increasing use of computers has led to a combined computer system that integrates a mainframe computer and desktop computers into what is termed a Local Area Network (LAN). The organization maintains a larger central computer system, which is tied electronically to a network of decentralized personal computers on the desks of staff members. The larger computer processing jobs, and the job of maintaining large files and data bases is carried out by the main central computer staff. The desktop computers are used by staff to meet their own personal needs, and allow access to files stored on the mainframe and to the computing power of the mainframe. This type of hybrid computing system is growing rapidly.

The establishment of a computer system to support research requires a considerable degree of knowledge and careful thought as to the uses computers are to serve in the organization. Regardless of the computer system adopted by a research organization, it must be recognized that the use of computers requires special skills and knowledge. Personnel will require training in the use of the equipment and the various software programs and their applications in forestry. Special provision must be made for obtaining technical help in the selection, installation, maintenance, and use of computer equipment.

In some cases, special needs for computing services may require skills in computer programming, which many scientists do not possess. To meet these needs, research organizations may have to provide for the services of computer programmers, either as staff members or on a contract basis.

### PUBLICATION SERVICES

Most research organizations maintain some form of publication service group that is responsible for publishing and disseminating research findings and for producing other publications needed by the organization. A publication service group provides many services to a research organization. They:

- assist scientists in preparing manuscripts for publication through editing, typing, preparing graphs, charts, and other illustrations, overseeing contacts with outside publishers, and other means;
- maintain quality control over publications to assure the editorial and scientific soundness of articles submitted for publication, by editing manuscripts and obtaining peer reviews;
- publish and distribute research, technical, and popular reports as an outlet for research findings;
- provide or obtain translating services to meet special language requirements of some publications;
- publish and distribute nontechnical informational material related to station administration and management.

A good editor, with qualified assistants, can do much to improve the quality of the scientific and technical publications coming out of a research organization. Such an editor should be

skilled in editing scientific publications in the language(s) in which they are to be published, and in preparing material for publication. An editor for a forestry research organization should be familiar with the subject matter being edited, either through experience as a forestry researcher, or through a systematic program of in-field and in-lab training designed to familiarize a nonscientist with the research being conducted by the organization. An editor should be familiar with potential audiences for the research results produced by the organization, and with effective outlets for disseminating research results to reach the intended audience.

Research managers should plan to provide adequate funds to finance the publication of research results and the dissemination of results to users. There is little justification for conducting a research program in forestry and forest products, if the results never reach potential users because of the lack of funding. In budgeting for forestry research programs, it is the responsibility of research managers to achieve an appropriate balance between doing research and disseminating research. One way to achieve this balance may be to insist that the budget in study plans for research projects include a cost component for the publication and dissemination of research results, which would be obligated for that purpose.

## Administrative Services

One of the key roles of the manager of a forestry research organization is to manage the resources under his/her control to achieve the objectives of the organization effectively and efficiently. The resources to be managed include people, funds, information, facilities, equipment, and supplies. To successfully manage these resources, research managers must develop and rely upon an administrative services staff who assist research management in administering the research programs of the organization, to ensure that its resources are managed according to the legal and regulatory mandates of the national government and others who provide these resources.

### THE ROLE OF ADMINISTRATIVE SERVICES

The administrative services of a forestry research organization serve two major functions: a control function and a research support function. Research managers must ensure that the personnel and activities of the organization comply with the laws, regulations and policies established to direct activities of national government agencies, and those established by other funding agencies. These constitute the institutional framework within which the organization must function. Research managers also must provide scientists and other staff with the special expertise necessary to carry out the many administrative details required by any organization.

In most research organizations these administrative services are provided by a special group of people who are trained to interpret and administer the guidelines and regulations established by the research organization and the agency within which it functions. Such assistance usually includes the following functions: personnel management; procurement management; financial management; property management; and office management. Providing such administrative services is an important responsibility of research managers. In large research organizations it may be necessary to establish and manage a separate administrative group for each service function. In smaller organizations several functions may be handled by one person, or by the administrative unit within which the research organization is located.

Managers of the administrative services branch and their employees can have a major impact on the organizational environment, depending upon the way in which they view their job. As mentioned above, administrative services fulfills two important functions in a research organization: 1) controlling, to ensure that laws and regulations are followed; and 2) research support, to help researchers and their staff achieve the goals of the organization. An administrative services that concentrates its attention on the controlling function, and neglects its support function, can hinder the organization in achieving its goals. A research organization needs the support of an administrative services staff in carrying out its program of work to achieve its objectives effectively and efficiently. The research manager's job is to see that the administrative services under his/her control provide a balance of both controlling and support functions.

## PERSONNEL MANAGEMENT

The function of personnel management in the research organization is to administer the recruitment, training, and career development of the personnel in the organization, and maintain personnel records. They also may handle payrolling, labor relations, and the management of fringe benefits. Although personnel management is a responsibility of all supervisors within an organization, most organizations centralize many of the personnel management functions within a personnel management group.

The employment and personnel management policies of most government organizations are constrained by the laws, regulations, and policy guidelines established by higher authority within the government. These vary from one country to another, and may vary from one agency to another within a country, and cannot be reviewed here. The more general discussion here should be interpreted in light of the particular organizational constraints that each organization faces.

### LONG-RANGE PERSONNEL PLANNING

All organizations should have a long-range plan for future staffing that is closely related to the strategic and program plans of the organization. Such a plan should include a review of current staffing in the organization, future program directions, expected personnel needs to support such program directions, tentative schedules of promotions, transfers, reassessments, and retirements, and expected new personnel requirements over the next several years. Personnel requirements should include a description of what skills and knowledge are likely to be required, sources of future personnel, and the likely availability of people with the desired qualifications. If the expected supply of needed personnel does not meet the expected demand, consideration should be given to how this deficiency could be overcome.

A long-range personnel plan also should explore more than one option for future staffing. At least two scenarios for personnel needs may be outlined:

1. A minimum program size that describes the essential set of activities for the organization and related staffing needs; and
2. A desirable program size that describes a more complete or desirable set of activities and related staffing needs.

The desirable program should attempt to strike a balance between research needs and the realistic capacity of the organization to respond to those needs. Expansion of the research and support staff too rapidly beyond a certain point could change the character of the organization, and reduce the efficiency and effectiveness of the organization, given the existing management structure.

### RECRUITMENT

Authority to recruit personnel to fill position vacancies often is severely constrained by government laws, regulations, and policies. Nevertheless, within these constraints, every effort should be made to recruit the best qualified candidates for any vacant position. Considering the salaries, training, and other expenses of personnel, an organization's investment in people is one of the largest investments it will make in the future. Making a career commitment through the employment of a research scientist, for example, is a

major capital investment decision for any organization. It commits the organization to future large annual expenditures of funds for salaries and expenses that often greatly exceed other operating expenses.

Systematic thought and appraisal should go into any such large capital investment decision. The specifications of the job should be delineated as precisely as possible, and the qualifications of potential candidates should be evaluated carefully.

#### **CAREER DEVELOPMENT**

Research managers, supervisors, and staff in personnel management have responsibility for determining the interests and capabilities of employees so they can develop training and work experiences that increase employee skills and knowledge. Employees with improved knowledge and skills are likely to perform better in their job, and become more eligible for promotion to fill expected vacancies. Every organization needs a cadre of trained and capable people that can move to higher positions with a minimum disruption of ongoing operations. Every supervisor should be assigned responsibility for the career development of the employees they supervise.

#### **TRAINING**

Each organization has its own unique set of procedures for carrying out certain jobs, and special office, laboratory, and field equipment to be used. Every employee requires some training in organizational procedures, use of equipment, and safety, at a minimum. Employees also need training to develop new knowledge and improve their skills so they can contribute more effectively to the achievement of organizational and personal goals. The responsibility for training is shared by research managers, supervisors, and personnel management staff.

Research managers are responsible for:

- identifying training and development needs;
- developing employee training plans to meet needs;
- determining the best sources of expertise and opportunities to meet varying training needs;
- arranging for planned training activities;
- documenting training activities; and
- ensuring that employees have the opportunity to utilize and apply new knowledge and skills on the job after training.

Planning, needs, and options for training were discussed in some detail in Chapter 14.

#### **PROMOTION AND REASSIGNMENT**

As part of career development, employees within an organization are usually rewarded for good job performance by promotion and/or reassignment. One of the most difficult jobs in personnel management is supervising the promotion of employees. All employees expect to be rewarded for good performance with some form of job advancement. Personnel management includes establishing and administering qualification standards for promotion to ensure equitable treatment of employees. A fair system of promotion that rewards superior performance with career advancement provides an incentive to perform well in achieving organizational goals, and provides job satisfaction to employees.

A perennial problem in many developing countries has been the lack of promotion opportunities for research scientists. Many research organizations are small, which often limits opportunities for promotion. In many countries, employees can advance up the government career ladder only through the managerial and administrative ranks. Thus, ambitious competent researchers, who wish to advance their careers, must leave research and go into administration.

At times, the organization may require job reassignment for career development or to meet needs of the organization. This may present hardships for the employee, but it may be necessary to further the purposes of the organization. On occasion, employees may request reassignment for personal reasons. In order to retain a competent employee with desired skills and knowledge, the organization may decide to honor such reassignment requests whenever possible, as long as it does not interfere materially with the achievement of organizational objectives.

#### **PAYROLLING AND MANAGEMENT OF FRINGE BENEFITS**

Most governmental organizations have established relatively firm minimum qualifications for grade levels and pay levels for the various job positions within government service. One of the responsibilities of personnel management is to oversee the classification of positions to see that they comply with established policies, and to check on qualifications of the personnel being considered for particular positions. Another responsibility is to document and maintain reports of time worked for payroll purposes. Personnel management also may have the responsibility of managing employee benefit programs, such as health benefits, insurance programs, retirement plans, and other fringe benefit programs. They may be charged with handling labor-management relations, incentive award programs, and special programs affecting employee health and safety.

#### **SEPARATION AND RETIREMENT**

Personnel management is responsible for handling voluntary and involuntary separations of employees from the organization. Voluntary separations, where an employee leaves the organization at his or her request, typically requires documenting the service record of the employee, and determining what, if any, benefits from service accrue to the employee. Involuntary separations may require documenting poor performance, handling legal appeals by employees threatened with separation, and determining what, if any, service benefits are due. Personnel management may have to provide counseling for employees prior to retirement regarding retirement benefits and procedures, and administer the paperwork involved in retirement.

#### **PROCUREMENT MANAGEMENT**

Research organizations must purchase supplies and equipment and contract for services to carry out their mission. Often, the procurement of goods and services is severely constrained by legal and regulatory requirements. Although decentralized authority to obtain needed goods and services is desirable, on the grounds that those who are closest to the problem are best aware of what is needed, the special complexities of procurement and contracting argue for a strong degree of central control over the process.

In most government organizations, authority to purchase goods and services required for the operation of the organization tends to be centered in a special purchasing or procurement group, although individuals may be authorized to make limited expenditures

for clearly specified purposes. Procurement is centralized because special legal, business, and accounting skills and expertise are required in order to comply with the many laws and regulations that often apply to such procurement. Only people qualified through training and experience are given the authority to perform procurement and contracting duties. Procurement also is centralized to better control the potential for abuse where funds are disbursed. Another reason for the centralization of procurement is to take advantage of economies offered by the purchase of larger quantities of goods.

Some goods and services are obtained through special contracts with vendors and suppliers. The development and supervision of such contracts, which often require competitive bidding procedures, requires special legal expertise that goes beyond the competence of most research managers and researchers. This type of contracting usually is handled by a special centralized group, either within the research organization, or at a higher administrative level. The supervision of contracting usually includes the preparation and/or review of technical specifications, the development of legal contract documents, and the development of bidding procedures.

Procurement management must determine needs, determine best sources of supply to meet those needs, obtain the goods and services, distribute the goods and oversee the delivery of services, maintain records of financial transactions, and prepare reports of financial operations as required.

## FINANCIAL MANAGEMENT

A government agency, such as a research organization, is responsible for conducting its financial activities in a businesslike manner, complying with applicable laws and regulations. Responsibility for the proper financial management within a research organization usually is assigned to a special budget and financial management group under the control of the manager in charge of the research organization. The responsibilities of financial management may include:

- Assist in preparing financial plans, budgets, and other requests for funding;
- Maintain records and data to assist research management in determining future funding requirements;
- Distribute appropriated and other funds according to the applicable laws and guidelines;
- Administer the payment of financial claims by vendors supplying goods and services to the organization, and the reimbursement of legitimate employee expenditures;
- Establish financial controls to ensure funds are expended prudently and lawfully;
- Maintain records of fund allocations and expenditures to comply with existing laws and regulations;
- Prepare periodic financial reports as required;
- Assist research personnel in procuring the goods and services they need to conduct research, within the applicable guidelines and authority.

## PROPERTY MANAGEMENT

Any forestry research organization requires facilities and equipment to carry out its program of work. The facilities may range from rented office space to ownership and occupancy of a major scientific laboratory, from a few field plots established in collaboration with a land management agency to large experimental forests managed by the research organization.

itself. The tools and equipment required for its work may range from shovels and diameter tapes, to motor vehicles and sophisticated, expensive laboratory equipment. Adequate facilities and equipment are essential for carrying out programs of research. Research managers are responsible for ensuring that the needed facilities and equipment required for approved programs of research are maintained in good condition and are available when needed.

Managing research facilities and equipment, and providing the myriad of supplies and small items of equipment required by a program of research, requires special knowledge and skill. Facilities must be kept clean and in good repair. Laboratory and office space must be allocated among the various groups within the organization. Equipment must be made available, scheduled, and serviced when necessary. Supplies required to keep equipment in good working order and functioning effectively must be ordered and made available as needed. Plans for new facilities must be drawn up in time to meet the demand for them. New equipment must be ordered in time to meet expected needs.

The function of procuring and maintaining facilities and equipment for a research organization often is centralized within a research organization to ensure that legal and regulatory requirements are fully met in procuring and using facilities and equipment, and that they are used effectively and efficiently. The management of facilities and equipment may be assigned to one responsible staff member or administrative services group, or the responsibilities may be divided among several of the organizational staff.

The responsibility for those items commonly used by a large number of personnel, such as major buildings, motor vehicles, copy machines, etc., often is assigned to a special unit in the administrative services branch. The responsibility for items commonly used by only one person, or by one research unit, such as a desk calculator or adding machine, may be assigned to that person or unit. Even in this case, however, property records, the maintenance of that equipment, and the purchase of supplies required for that equipment may be centralized.

The upkeep of large facilities can become a major expense for any research organization. The gift of a completely outfitted laboratory to a small but developing research organization may become a major drain on the operating funds of that organization, and greatly slow down the development of an effective research organization.

#### SPECIAL SERVICES

In order to provide research scientists with the equipment and supplies that they need, research managers may have to provide for special services, which may be under the supervision of the administrative services branch. Such special services might include facilities and expertise to fabricate equipment, such as wood and metal workshops, glass blowing facilities, etc. They might include facilities and personnel to care for animals that are used in experiments or to provide work power. The special services might include draftsmen, cartographers, photographers, engineers, or similar specialists. Often, such special services as best administered centrally, unless they can be fully utilized by a single research project or facility.

## OFFICE MANAGEMENT

Office management is the responsibility of research management. The function of office management is to provide secretarial, clerical, and other services required by research scientists, managers, and other personnel in the research organization, and to maintain the records of organizational activities as required by law and by management needs of the organization. An effective and efficient staff of office personnel is required to carry out the necessary duties. To achieve this, the research manager must recruit competent personnel, develop their knowledge and skills through continued training, provide modern office equipment to enable them to utilize their skills to the fullest extent, and motivate people to a high level of performance.

Office management must be alert to determine the office needs of research personnel, determine how those needs can best be met, and then ensure that office services are provided in an effective and timely manner.

The records of a research organization provide a history of its operations. This includes the correspondence of the different groups within the organization, and records of plans, accomplishments, and other activities. The maintenance, retrieval, and eventual disposition of documents relating to research studies, data and information obtained by measurements and analysis, and records of publications and other means of dissemination are of particular importance to a research organization. The maintenance and disposition of some records are in many cases prescribed by law. It is the responsibility of research management to ensure that these laws are complied with. Careful thought must be given to preserving records in such a way as to maximize their potential usefulness in the future. Maintaining duplicate records of important documents and data sets on microfilm, while expensive, may be essential to preserve important records.

## Research Networking

Networking refers to the formal and informal ways in which scientists and research organizations contact one another and develop working relationships to exchange information, cooperate in research studies, and coordinate research programs and projects.

### THE ROLE OF RESEARCH NETWORKING

One of the chief ways of learning is through direct contacts with other people. This is as true within the scientific community as it is in society at large. Scientists learn and exchange information through contacts with other people. Moravcsik (1986) states that most of the important communication among scientists takes place through person-to-person contact, and by written forms of communication.

Science is a social activity. Frequent contact among scientists is essential for the progress of science. Through contacts with other researchers and organizations, scientists exchange ideas and information, collaborate on research studies, validate scientific discoveries, and disseminate research results. Organizations work with each other to coordinate research programs and to facilitate the sharing of expertise, equipment, and facilities. Contacts among scientists are stimulated through the development of informal and formal networks of scientists and organizations.

To make effective use of the available human and other resources, managers of forestry research organizations should encourage, facilitate, and promote research networking.

### IMPORTANCE OF RESEARCH NETWORKING

Communication and exchange of information among scientists is essential for the functioning of scientific research. Science, as we know it today, would not develop in the absence of communication among research scientists. To be effective, scientists must make their work known and seek constructive peer review to establish a mutual consensus regarding scientific knowledge. The exchange of ideas and information during the progress of research, and the collaboration among scientists in solving critical problems of science and society, can accelerate the finding of solutions.

Many of the forestry research problems facing the world today go far beyond the administrative boundaries and exceed the financial and human resources of any national forestry research institute. Modern science is truly international. Much can be gained by cooperative research among forestry research institutes in several countries, and by sharing expertise and exchanging information among scientists working on common problems in many different areas of the world. No single research institution has a monopoly on research expertise for all fields of forestry. Each can gain by interchanges of information among scientists, and by fostering some form of research collaboration through research networking. Organized collaborative research often can produce far more than the sum of what would be produced by individuals working in isolation.

Most of the major problems in the world relating to the management and use of forest and related resources cut across many disciplines, often involving the physical, biological, and social sciences. Work on such problems requires the exchange of information and cooperation of scientists from many disciplines. Yet much of science is organized by scientific disciplines. Universities are organized by scientific disciplines, with departments of botany, soils, forestry, economics, etc. Forestry research organizations have a similar organization, with research units in forest hydrology, genetics, entomology, silviculture, wood technology, and others. This type of organization, built around scientific disciplines, facilitates work within disciplines to advance the frontiers of science. However, to address major problems in forestry, there is a need to encourage multidisciplinary research. The development of problem-centered research networks can facilitate the interaction of scientists from many disciplines and many organizations.

### **FUNCTIONS OF RESEARCH NETWORKING**

Scientists form professional organizations to facilitate the exchange of information and contacts among scientists. They form collaborative relationships with other scientists to better pursue research programs. Research organizations coordinate research, develop working relationships, and share equipment and expertise with other organizations. Voluntary organizations promote the exchange of information and experimental materials, such as seeds, for special areas of research. These and other types of social relationships among scientists and research organizations are examples of research networking.

Research networking:

- promotes the sharing of scientific information and expertise;
- provides opportunities for the development of staff skills and the exchange of technologies;
- provides access to knowledge and skills outside of forestry research organizations;
- reduces research costs and makes more effective use of scarce research talents and skills;
- reduces unnecessary duplication of research effort;
- coordinates research programs for a more effective problem-solving approach; and
- links researchers and educators and trainers to facilitate the transfer of updated information in the classroom and the field.

Although research networking includes the development of common research designs and the pooling of research data, it encompasses far more activities and interests. Moravcsik (1986) points out that sharing facts is a relatively unimportant part of communication among scientists, and thus computerized information bases play a relatively unimportant role. He states that scientists in the developing countries need to share not only technical information, but also information about scientific methods, the management of science, and the philosophy of science.

### **TYPES OF RESEARCH NETWORKING**

Research networking can be done informally, through infrequent, casual, spontaneous contact with other scientists or organizations, without any formal agreement among those who participate. It also can be done on a more formal basis, sponsored by some organization which has networking as one of its functions, or through formally approved

agreements, drawn up between research organizations, that spell out the terms of cooperation.

Networking can be done by individual scientists who participate in networks on an individual basis. Networking also can be done by organizations, where the networking is carried out among organizations through their designated representatives.

There are many ways in which networking of individual scientists and research organizations can be carried out:

- *"Invisible colleges"* - Scientists develop many informal contacts with their peers as a means of keeping abreast of the latest work in the field, and to exchange ideas with each other. Linked together by an interest in a common research area, these informal, loose-knit groups of people are said to form an "invisible college" (Ziman 1976). Scientists visit each other, seek each other out at scientific meetings, communicate by telephone, letter, or other means. These "invisible college" networks are not organizations; they have no officers, no charter, no set meeting time, and publish no newsletter. They simply consist of a number of scientists who are bound together by an interest in communicating with one another in order to further their research in some particular field. The motivating force behind such networks is the initiative of individual scientists who want to be on top of things in their chosen field of research.

Many of the latest developments of science, and much technology transfer among scientists, take place through such informal contacts among individuals. Such contacts are usually made through travel to visit other scientists at their locations, and by telephone, mail, and other forms of communication. Because these loose-knit associations of individual scientists lack a sharply defined identity, and are not easily seen, they tend to be overlooked in considering research networking. Nevertheless, they can be one of the most effective forms of research networking, and deserve the strong support and encouragement of research managers and funding organizations.

- *Professional societies* - Scientists join national and international professional scientific societies, and participate in the activities of these societies, to meet other scientists and exchange information. Membership and participation in a scientific society is a form of research networking. By attending and presenting papers at meetings and conferences sponsored by the society, scientists are assured of meeting many other scientists who share a similar interest. A scientist who serves on committees or becomes an officer in such a society often develops close working relationships with fellow members. Scientists should be encouraged to participate in professional scientific societies, and be supported with some travel funds to the extent possible so as to make active participation possible.
- *Information networks* - Information networks are set up to facilitate exchanges of information among scientists and practitioners with a common interest, typically through newsletters. These networks often are supported as part of some other ongoing program, or are funded by a special grant. Typically, they publish and distribute newsletters to those interested in being on the mailing list. Examples of such networks include: Social Forestry Network; Common Property Resource Network; ICRAF Newsletter and Agroforestry Review; and International Society of

Tropical Foresters, among many others. Becoming a member of such a network ensures the scientist of keeping abreast of new developments in a particular field of interest, at little or no cost to the individual scientist. Some networks maintain and publish a list of members and their addresses, to facilitate members getting in touch with one another. Research managers should ensure that the research scientists on their staff are familiar with the various information networks that exist.

- *Research project networks* - Some networks are established to coordinate research efforts in a particular problem area. Research project networks may: develop, publicize, and provide training in a commonly accepted research design; develop and provide a centralized data processing and analysis service; maintain an aggregate data bank to be shared among members; publish newsletters; hold periodic workshops and meetings to exchange information and develop plans for future activities; and secure and distribute research funds. Not every network engages in all of these activities, and some have other activities. Most research networks are established in response to the initiative of some outside funding agency that wishes to initiate and coordinate research activities on a relatively large regional or international scale. Establishing and maintaining such research networks requires considerable funds to support networking activities over a relatively long period of time.

Scientists and research institutions who become members of such networks may gain access to special expertise, training, funding, information, and special services that otherwise would not be available. To gain these advantages they must commit personnel and resources for research studies that are strongly influenced and/or controlled by outside sponsors and members of the network. Membership in research networks usually means making a commitment to support some part of the network research program, often for a period of several years.

Examples of research project networks include: Nitrogen Fixing Tree Association; Oxford Forestry Institute Tropical Pine Provenance Research Network; Central American and Mexican Cooperative in Conifer Resources; MADELENA network at CATIE; IDRC bamboo/rattan network; World Wildlife Fund Network; F/FRED Forestry and Fuelwood Research and Development Network; and ASEAN-US Watershed Network.

- *Organizational networks* - Forestry research organizations maintain informal contacts with other research and nonresearch organizations, both inside and outside of forestry, to become better informed about activities that may influence forestry research. They develop formal agreements with other institutions to promote the interchange of information, exchange of personnel, sharing of equipment and facilities, research collaboration, and coordination of research programs. They participate in formal research networks among forestry research institutions to coordinate research projects. They become members of organizations such as IUFRO (the International Union of Forestry Research Organizations) to provide research scientists and managers with the opportunity of joining one or more of the many subject working groups of IUFRO and engage in world-wide networking with scientists of similar interests. They enter into formal twinning arrangements with other research organizations in order to facilitate the exchange of information and personnel. All of these are examples of organizational networking to further the objectives of a forestry research organization.

Active scientists in any field of research often belong simultaneously to several different scientific networks, both informal and formal. They may have informal contacts with peers in their discipline, be active in special interest groups or as officers of one or more professional societies, and be on the mailing list for one or more networks publishing newsletters. They may take part in some form of research project network. They also may have contacts with other scientists through networks linking their own research organization and other organizations. All of these networking activities can have an important influence on scientist's work and on professional and peer recognition given to his/her work.

Networking among research organizations can have an influence on program direction, and can positively influence research accomplishments of forestry research organizations. But unless organizational networking is actively supported by research management and the scientists involved, it can become just a paper network, with little activity or influence on actual research activities. There is little reason to establish a research network among forestry research organizations unless it will have an influence on the kind of research being done and on research accomplishments.

#### **NETWORKING WITH NONFORESTRY RESEARCH ORGANIZATIONS**

A substantial amount of research directly related to forestry is conducted by agricultural and other nonforestry research organizations (see Bengston, et al. 1988, for examples from the Asia-Pacific region). Research in watershed management, hydrology, and soils is conducted by university departments of agronomy, soils, and engineering, and by government agencies representing agriculture, water resource development, and other nonforestry programs. Much basic biological research related to forestry is conducted by university departments of botany, ecology, genetics, zoology, and other biological sciences. Much of the research related to agroforestry is conducted by university departments of agronomy, animal husbandry, soil science, and others, and by special agricultural and other institutes. Much of the social science research related to forestry development is conducted by anthropologists, geographers, sociologists, and other social scientists outside of forestry research organizations. Research directly related to forest products is conducted by forest products industries, other industries, and by engineering and other university departments, among others.

Nonforestry research organizations throughout the world possess considerable knowledge and expertise and conduct research that is directly relevant to forestry research. Managers of forestry research must develop closer working relationships with those nonforestry research organizations that are most relevant to their research programs. By encouraging and supporting the establishment of research networks with such nonforestry research organizations, forestry research managers can more effectively utilize available scientific expertise and coordinate research programs to make more efficient use of their research funds.

#### **LINKAGES BETWEEN RESEARCHERS AND EDUCATORS/TRAINERS**

Educators and trainers utilize basic and applied knowledge about science and technology in their education and training activities. Many educators and trainers are themselves researchers, and keep abreast of current developments in their field. However, some simply do not have the time or resources to conduct research on their own. Because educators and

trainers are the ones who train the scientists and resource managers of the future, it is imperative that there be close contact between research scientists, educators, and trainers. By sharing information and ideas, all can have the benefit of the most recent knowledge of science and technology, and ensure that this is passed along to young professionals in the field.

Networks that facilitate the interaction of scientists, educators, trainers, and field professionals should be strongly encouraged and supported by research managers in forestry. It is the educators and trainers who will produce the research scientists of tomorrow. It is in the self-interest of research managers to ensure that the information on which the training of future scientists will be based is the best available. Further, such networks provide access to a considerable pool of scientific expertise and managerial knowledge that can benefit research programs of the forestry research organization.

### FACILITATING AND ENCOURAGING NETWORKING

Burley (1986, 1989) suggests several principles for success in research networking related to research projects:

- The problem should be:
  - clearly defined with a specified research agenda;
  - common to several countries.
- Participants and collaborators should:
  - have a strong self-interest in participating;
  - contribute some resources to networking activities;
  - be sufficiently trained and have expertise to make significant contributions to networking efforts;
  - be willing to share results of activities with other participants through a variety of activities;
  - develop mechanisms for the extension of research results to intended users.
- Networks should:
  - be guided by strong leaders who have the confidence of the participants;
  - acquire outside funding to facilitate the birth and early functioning of the network;
  - not be considered permanent institutions, but be flexible in adapting to the skills and requirements of participants;
  - have local institutional continuity and commitment.

Burley (1986, 1989) has identified a number of problems that have been experienced in existing networks. These include:

- Disagreements and/or competition among participants as to:
  - topic or species;
  - appropriate experimental design;
  - comparable assessments and appropriate analysis;
  - leadership.
- Inadequate:
  - activity and resources;
  - amounts of test materials;
  - communications and feedback;
  - national government commitment.

- Difficulties experienced in:
  - identifying participants;
  - exchanging plant material because of international controls and lack of facilities;
  - identifying and preparing adequate documentation for donors;
  - obtaining finance for coordination and supporting activities.

If research networking is to succeed, it must have the support of those who manage and fund research programs. Every effort should be made to ensure that those who fund research are aware of the importance of networking in scientific research, so that adequate funding to support this activity will be provided.

## PART V

### Communicating Research Results to Users

One of the most important jobs of research managers is to oversee the dissemination or communication of research results to potential users. For the purposes of this discussion, the dissemination of research results encompasses not only the transfer of research results from research to users, but also the interaction between research and users in this process of technology transfer. Thus, we speak of communicating research results to users, implying a two-way process--from research to users, and from users to research. This process includes the adoption and utilization of technology, and the feedback from users as to their information/technology needs and the suitability of the research results provided.

Research that does not reach the hands of intended users, or is not utilized by either scientists or practitioners, has little or no impact on science or on society. That is not to say that every research study or project must produce useable results. Researchers can learn from failures, and improve future research from what they learn. But to learn from research failures, the results of that failed research must be communicated to others, or at least used by the scientist doing the research to improve future projects.

Forestry and forest products research produces data, information, knowledge, and things (improved seeds, plant materials, etc.), with two main audiences in mind. One audience is composed of scientific researchers, who will use research results to conduct further research. Research that produces knowledge and other outputs that is intended for and/or is used primarily by scientists to advance scientific understanding and to conduct further research is often termed basic research. The concern here is that the research results intended for scientists not only reach those scientists, but also are used by them in some way to further scientific research. The effectiveness of basic research is measured by the effect it has on the advancement of a field of science through its adoption and use by other scientists.

A second audience for research results is composed of people who use research results to change the way things are done in practice. This audience may include land managers, farmers, forest products industries, forest resource users, and others. Research that produces knowledge and other outputs for this audience is often termed applied research. The concern of research managers with applied research is that the results not only reach the intended users, but are also used by them in some way to change the way things are done.

For both audiences, the forestry research manager is concerned not only with doing appropriate research, but also with disseminating research results to the intended users, and facilitating its adoption and use so that it brings about changes in the way people do things. The manager also is concerned with obtaining feedback from both groups of research users to improve the way in which research is planned, managed, and conducted, thus ensuring that future research will meet the needs of both science and society.

Research seldom fits exclusively into one or the other of these categories of basic and applied research. Most research falls somewhere in between, along a broad spectrum of research, ranging from basic to applied. Nevertheless, these two categories, basic and applied, are useful in distinguishing between two fundamentally different types of research

clients. As described in the following two chapters, each of these two client groups require different approaches in disseminating research results.

Most scientific journals are devoted to a particular field of science. However, some strive to be interdisciplinary with respect to particular problem areas, and encourage submission of manuscripts from any discipline that relates to the subject matter of the journal.

Because of the proliferation of scientific journals, and their increasing expense, most forestry research organizations cannot subscribe to more than a fraction of those that would appear to be relevant to the various fields of forestry. Access to the literature in scientific journals is a problem to all scientists, but particularly to those in developing countries. Finding out what has been published in the various journals is difficult. Some of the best sources of information about what is available in older publications are the citations in published articles on a particular subject area. Such citations often provide excellent clues to relevant journals and articles. When they are available, review articles in journals are often excellent sources for obtaining older references to a subject matter area.

For more current information about the literature available in scientific journals, scientists turn to special journals, such as *Forestry Abstracts*, that publish abstracts of publications. Abstract journals list and briefly describe publications relevant to their subject matter area. The journal *Current Contents* attempts to meet this need in another way, by publishing reproductions of the table of contents of the major scientific journals, and by listing research institute reports.

Scientific journals are an effective, but imperfect, way to disseminate research results to other scientists. The publication of an article in a scientific journal is only the first step in the dissemination process. There is no guarantee that an article published in a particular scientific journal will ever reach the desired audience. To achieve dissemination through a scientific journal, the article must be accessible to the scientist, the scientist must be aware that the article is available, and the scientist must read the article to obtain the information contained therein.

Many forestry researchers, particularly in developing countries, lack access to all but a few scientific journals. Few, if any, scientists have ready access to all scientific journals published. Articles published in journals that are not widely distributed, or that are out of the mainstream of forestry research, are likely to reach only a limited audience of forestry researchers. A proposal to publish an article in a scientific journal should be analyzed to determine whether publication in that journal will, in fact, reach the intended audience and, if not, what can be done to achieve a more desired distribution of the article. An attempt could be made to get the article published in a journal with a wider distribution to the desired audience. Or, an effort could be made to obtain reprints of the article, and make them available to a wider audience. Achieving an effective dissemination to scientists through scientific journals may require more effort than simply ensuring publication in a journal.

#### **OTHER OPTIONS FOR COMMUNICATING RESULTS TO SCIENTISTS**

An effective way to disseminate research results to a relatively limited audience is through the presentation of papers at scientific and technical conferences. Presentations and written papers prepared for the conference quickly reach those who attend, and enable researchers to get immediate feedback. A larger audience is reached at a later date if the proceedings are published. One of the difficulties with depending upon conference proceedings for disseminating research results is the relatively limited audience reached in the distribution

of conference proceedings. It is often difficult to obtain copies after a year or two following their initial publication. Publicity about the availability of conference proceedings is often incomplete, and those who have a need to know may not find out such publications are available. Libraries have a difficult time obtaining copies of all relevant proceedings. Retrieval of articles published in conference proceedings may be difficult, because coverage of such publications in abstract and other reference journals often is incomplete.

Scientific and technical reports published by forest research organizations are another important means of disseminating research results to scientists. In addition to reaching scientists, such reports often achieve a wider distribution among field practitioners and other nonscientists than do articles published in scientific journals. Many of these publications are reviewed by peers before publication, but some are not. Because of the large number of forest research organizations that publish such reports, knowing what has been published by each organization, and what is available, becomes a difficult job for any scientist. Often, they have relatively limited and local distribution. Complete collections of such publications are likely to be available in only a few of the major forestry libraries. Few forestry scientists have access to more than a small fraction of the publications from forestry research organizations around the world.

Technical, general scientific, and popular publications are aimed more at nonscientists, including the general public, than at scientists. However, scientists also read these publications, and articles written for them provide another option for disseminating research results to scientists. Trade journals, which are aimed at a specific segment of industry, or other groups in society, provide a good outlet for some applied research findings. Scientists working in various fields of forestry and forest products often find in such publications information about trends in industry and new product developments and uses that is useful in their research. Thus, publications such as these do provide a means of disseminating research findings to scientists. General science publications that cover a wide range of scientific topics, (for example: *Nature*, *Science*, *Science News*, *New Scientist*), are a good way to reach scientists in other disciplines, who may not have the desire to read some of the more narrowly focused articles published for professional peers in scientific journals.

Demonstrations of research studies, results, methodologies, and equipment, in the field, laboratory, and office, are a good means of presenting research findings to professional colleagues, as well as to nonscientists. A surprising amount of the most recent scientific information is often passed among professional scientific colleagues in this manner. Demonstrations to visiting scientists of the latest scientific instruments, a new plot layout, a useful computer program, the latest tables and graphs being prepared for a new manuscript, all play an important role in disseminating information among scientists.

Field tours conducted during training sessions, or as part of scientific conferences and annual meetings of professional societies, all help to disseminate information about research programs and research findings. They also help to identify and/or demonstrate special resource management problems of particular interest to scientists.

Workshops and training sessions that address special problems in forestry and forest products, or that discuss methods and techniques for solving particular problems, provide a good opportunity to exchange ideas, information, and knowledge among those scientists who attend. Working together in a workshop environment can be an especially effective way of disseminating information among scientists in different disciplines. Learning to

communicate effectively with scientists from different disciplinary backgrounds can be a frustrating, but rewarding experience.

Research managers should be aware of the variety of ways available for communicating research results for scientific use. To the greatest extent possible, they should encourage and facilitate such exchanges of information between the scientists on their staff and the rest of the scientific community. A major responsibility of research managers is providing quality control over publications and other means of disseminating research results. This can be done by providing high quality editorial services, and insisting on some form of technical review to ensure scientific validity. They also should ensure that their staff are adequately trained in scientific writing, public speaking, and other methods of scientific communication.

### IMPROVING SCIENTIFIC WRITING

The importance of publications in communicating research results for scientific use suggests that researchers should be encouraged to develop their skills in scientific writing. Scientists must not only "do" science but must "write" science. Excellence in written communication is, therefore, an important responsibility of scientists. But the education and training of scientists focuses overwhelmingly on science to the point that both written and oral communication are often neglected or ignored. As a result, poor writing often prevents or delays the publication of good science.

Several useful books on writing and publishing scientific papers are available, and these should be on hand in every research institution (e.g., van Leunen 1986, Day 1988). Following the basic principles of good scientific writing will increase the probability of a manuscript being accepted for publication and of being understood when it is published. Day (1988) emphasizes that good organization is the key to good scientific writing, and that a scientific paper should contain several distinctive component parts in the proper order. The essential components of a scientific paper include the following:

- *Title.* A good title for a scientific paper has been defined as the fewest possible words that adequately describe the contents. Abstracting and indexing services rely on the title to accurately convey the content of a publication, so a misleading title may result in a paper never reaching its intended audience.
- *Abstract or summary.* The abstract or summary requires particular attention because this is all that many people will ever read. A well-prepared abstract enables readers to quickly and accurately determine the content of a publication and its relevance to their interests, and thus helps them decide whether they need to read the entire document.
- *Introduction.* The introduction should supply the reader with background information needed to understand the study and its rationale--why was this subject chosen and why is it important? The introduction should include the nature and scope of the problem, a review of previous literature and a brief description of the method of the study and its principle results.
- *Materials and Methods.* The materials and methods section provides detail on the data and experimental procedures. This section must be written clearly and provide enough detail for a competent colleague to reproduce the results. The potential for

reproducibility is critically important in good science, even though it is very unlikely that the experiments and other scientific procedures will actually be repeated.

- *Results.* The results section is the core of a scientific paper. It contains the new knowledge that the investigation is contributing to the particular field of research and, therefore, needs to be written with great care. Clarity and simplicity should prevail. The temptation to include everything in the results section should be avoided--representative rather than exhaustive or repetitive findings and data should be presented.
- *Discussion.* Day (1988) suggests the following guidelines for the discussion section:
  - discuss the principles, relationships, and generalizations that follow from the results;
  - point out exceptions or lack of correlation and discuss;
  - show how your findings relate to previously published findings;
  - discuss both theoretical and practical implications of the research;
  - state your conclusions and summarize the evidence for each conclusion.

# Communicating Research Results for Application

## INTRODUCTION

Research organizations will make no contribution to a nation's development goals or to solving social, economic, and environmental problems if research results are not successfully communicated to final users and put to use. Moreover, the users of research results are organizational stakeholders who should play an important role in research planning and priority setting. In other words, communication with users must involve the flow of information in both directions: communication of research results from scientists to users, and communication of needs and feedback from users to scientists. One of the key functions of research management is therefore to ensure that research results are successfully communicated to end users and that strong linkages are established and maintained between researchers and the various users of research results, including extension agents, farmers, landowners, forest products firms, policy makers, educational institutions, and the public.

*FAO Forestry Paper 66* (1986) deals specifically with the organization of forestry extension. The present discussion complements that paper by focusing on linkages between researchers, extension organizations and users.

The major functions of communication between research organizations and end-users are as follows:

- *Improve planning and priority-setting.* The perceived needs of users are a vital input into research planning and priority-setting and should be regularly communicated to researchers. Feedback on new technologies and management practices is also important.
- *Facilitate testing and adaptive research.* On-the-ground testing of research results and adaptive research are both important parts of the research process. Effective researcher-user communication can provide information needed to successfully test research results and adapt new technologies developed elsewhere to local conditions. Users can, in some cases, become part of the research.
- *Facilitate the transfer of research results.* This is the function of researcher-user communication that is most often emphasized--the one-way flow of research findings from scientists to extension workers and on to final users. This flow will be greatly enhanced if well-developed communication channels are in place.
- *Strengthen research capacity.* In general, research organizations with high levels of communication with users will function more effectively and efficiently than organizations with poor communication. This translates into greater research capacity, and often also greater support.

Despite the importance of communication with users, lack of interaction between forestry researchers and users of research results has been identified as a significant problem (cf.,

Iyamabo 1975, Dada 1984, Gregersen 1984, Temu et al. 1987). Table 4.5 (in Chapter 4) summarizes the type and frequency of interaction between a sample of public forestry research organizations in developing countries and seven types of organizations. This table deals only with formal interaction, e.g., through written agreements, contracts, and other administratively approved agreements. Perhaps the most striking feature of Table 4.5 is the relatively low frequency of interaction of all types and with all types of organizations. Of the three types of interaction (cooperative research, training or staff exchange, and information exchange), information exchange was used most frequently on average across all types of organizations. However, the frequency of information exchange with users of research results was surprisingly low. It was roughly the same as the frequency of information exchange with international institutions and with research organizations in other countries. The fact that 18 percent of the organizations surveyed report that they never formally exchange information with users, and 54 percent only occasionally interact in this manner strongly suggests the need for improving communication with users of research results.

Temu et al. (1987) identified several factors that may have contributed to the lack of interaction between forestry researchers and end-users in many developing countries:

- researchers and managers often tend to emphasize writing technical and scientific reports without putting the research results contained in them in a form suitable for application by various end-users.
- many research institutions have overlooked the importance of dissemination of research results.
- dissemination and implementation of research findings tends to receive low priority in terms of funding.
- there is a lack of trained forestry extension personnel in most forestry research institutions.
- the shift in emphasis from industrial forestry to social forestry has broadened the spectrum of end users of research results, and many forestry research organizations have not fully adjusted to this change.

This chapter examines the problem of communicating research results to end-users for application, including identification of users and their information needs, effective channels of communication with users, types of researcher-user linkages, and management options for strengthening researcher-user communication.

### **IDENTIFYING USERS AND THEIR NEEDS**

Important questions that every research manager must address include: Who are the users and potential users of our research results? What are their information needs? Identification of the end-users of research results should not take place after completion of a particular research project or program. Rather, identification of and interaction with potential users should take place early in the planning stages of research. Research that has been designed with input from users and with their needs in mind will be much more likely to be adopted and implemented.

It may be helpful to conduct a simple "user analysis," similar to the stakeholder analysis discussed in Chapter 8 in the context of strategic research planning. The users of research results are easily the most important stakeholder group for a research organization. (Recall from Chapter 8 that "stakeholders" are defined as people, groups, or organizations that have

a claim on the research organization's attention, resources, or output, or are affected by that output. Examples of stakeholders for a research organization include public officials, governing bodies, special interest groups, employees, other research organizations, and the full range of end-users of research results).

A user analysis should ideally be carried out for every major research project or program, since different types of research will often have different sets of potential users. The user analysis can be structured around the following fundamental questions:

- Who are the potential end-users of the type of information to be generated by the proposed research project or program?
- What are the specific information needs of these potential users that relate to the proposed research project or program?

The first question can be answered adequately in most cases through a brainstorming session involving research managers, scientists, and, if possible, extension specialists. The second question requires directly contacting the potential users and user groups to determine their needs and request their input. Pearce (1987) notes that input and feedback from users does not arise automatically, but must be specifically invited.

### CHANNELS OF COMMUNICATION WITH USERS

Once users of research results have been identified, what are the most effective channels for communicating with them? A recent Canadian survey sheds some light on this question (Cayford and Riley 1986). This survey of users' opinion regarding the usefulness of various communication channels produced the following ranking:

1. field demonstrations
2. informal and personal communications
3. audio-visual presentations
4. publications
5. seminars and meetings
6. other forums, newsletters

The relatively low ranking of publications as an effective communication channel with users is noteworthy. Publications are the primary means of communicating research results to other scientists, as discussed in the preceding chapter, but they are viewed as relatively ineffective in communicating with users. Moreover, communication by way of publications provides no input and feedback from users, but only a one-way flow of information. The effectiveness of publications would likely rank even lower for developing countries. It is interesting to compare the results of the user survey by Cayford and Riley to a survey of forestry research managers in developing and developed countries carried out by Gregersen (1984). In this survey, research managers were asked to rate the frequency with which they used various channels to disseminate research results. Based on average ratings of frequency of use, the following ranking of communication channels was found for forestry research organizations in developing countries:

1. reports to research contractors
2. professional journals and meetings
3. response to inquiries
4. lectures

5. direct demonstration
6. popular media

The fact that printed matter is viewed as a relatively ineffective communication channel by users and yet is the most frequently used channel by forestry research organizations suggests the need for change. Communication with users should focus on two-way channels of communication that users perceive to be effective.

### TYPES OF RESEARCHER-USER LINKAGES

In addition to the concrete examples of communication channels discussed above, researcher-user linkages in a more abstract sense may take a variety of forms. Five major types of linkages are discussed here. Stoop (1988) notes that each type of linkage relates to either different ways of communicating (informal vs. formal, top-down vs. bottom-up), or to different communication channels (internal vs. external, up-stream vs. down-stream). These five linkages are not mutually exclusive, e.g., formal linkages may also be top-down linkages.

*Formal vs. informal.* Formal researcher-user linkages typically involve administratively approved, written agreements. Formal, structured linkages may be formed through research councils, working groups, job assignments, and by other means. Informal linkages involve personal contacts that are not institutionalized. Informal linkages typically arise spontaneously from a perceived need for interaction between individual researchers and research clients, and sometimes function as a substitute for ineffective formal linkages (Stoop 1988). Many of the strengths of formal linkages are the weaknesses of informal linkages, and vice versa. For example:

- formal linkages are stored in the "institutional memory" of the research organization, while informal linkages are much less likely to feed into an institutional memory;
- information resulting from formal linkages is more likely to be passed on to decision makers than informal communication;
- informal linkages are typically a lower cost means of interaction than formal linkages;
- informal linkages are often more direct than formal linkages;
- informal linkages may be less threatening to certain users than interaction through formal channels.

Thus, formal and informal linkages are complementary, and scientists should be encouraged to develop and maintain both types. Because informal communication is less likely to be passed on to managers, scientists should be encouraged to report regularly to managers and other scientists the results of interaction with users.

*Top-down vs. bottom-up.* The distinction between top-down and bottom-up linkages refers to the direction of the flow of information. Top-down linkages involve the flow of information from scientists to extension agents and on to final users. This is a one-way flow of information that often is reinforced by a hierarchical structure in the research organization and society. Top-down linkages between researchers and users are too often the only type of communication that takes place between researchers and users. Bottom-up linkages, involving a flow of information in the opposite direction, recognize the practical knowledge base of farmers and other potential final users of research results, and their

information needs. Both top-down and bottom-up linkages are clearly required for effective research.

*Internal vs. external.* Internal linkages facilitate communication among researchers, either within an organization or across different research organizations. Pearce (1987) has referred to this in terms of the lateral transfer of information to fellow researchers. External or vertical linkages facilitate communication between researchers and user groups outside of the scientific community. The distinction between internal and external linkages is important because scientists are often neglected as an intermediate user of research. Moreover, the level of interaction among scientists both within and between research organizations is positively related to the productivity of researchers and the capacity of a research organization (Pelz and Andrews 1966, Barnowe 1973).

*Up-stream vs. down-stream.* Another way of looking at researcher-user linkages is to divide them according to the type of user. Thus, some users are "upstream" (policy makers, donor and technical assistance agencies, etc.), while others may be considered "downstream" (extension agents, farmers, firms, etc.). Discussions of communication types and channels in research sometimes neglect the upstream users, who are vitally important in securing adequate political support and funding for research.

*Direct vs. indirect.* A critical factor affecting the communication of information is the organizational level at which it occurs between the research organization and the user organization. Direct linkages involve person-to-person communication, usually between individuals at the same level in their respective organizations, e.g., linkages between top research managers and top managers of a forest products firm, or linkages between scientists in a research organization and engineers in a firm. Indirect linkages exist when information is communicated through an intermediary, e.g., from scientist to extension agent to farmer.

### MANAGEMENT OPTIONS FOR STRENGTHENING RESEARCHER-USER COMMUNICATION

Two general responses for strengthening researcher-user communication may be distinguished:

1. Maintain the current structure of the organization but adjust research strategies and management of researcher-user interactions to strengthen linkages; and
2. Modify the organizational structure and assignment of responsibilities to establish and strengthen researcher-user linkages.

#### MAINTAIN ORGANIZATIONAL STRUCTURE

Some management options under this first approach include the following (ISNAR/SPAAR 1987, Temu et al. 1987):

- *Post subject matter specialists from the extension service in research organizations.* Extension specialists should be involved in pre-extension work (i.e., interpreting research findings in ways that are appropriate for users) and serve on research planning committees.

- *Provide better career opportunities for extension agents.* Career ladders should exist in the extension service, just as they should in research. Training should be provided to help qualify extension workers for promotion to higher grades.
- *Collaboration with extension.* Research organizations and extension organizations should collaborate on verification trials, demonstrations, on-farm research, field days, radio broadcasts, newspaper and magazine articles, and other means of disseminating research results to users.
- *Reward researchers for interaction with users.* Linkages with extension and other research clients and participation in technology transfer activities must be part of the formal reward system for researchers. Research-user linkages will be neglected if researchers are not formally recognized and rewarded for such activity through promotions, cash awards, nonmonetary awards, and other rewards. Researchers should be rewarded for translating research results, using simplified language easily understood by farmers and land managers in pamphlets, posters, small seminars, and other forms of presentation.
- *Training.* Research-user linkages can be strengthened through various types of training programs, such as seminars and workshops. Training can serve as a tool to achieve more effective interaction among researchers, extension workers, and various users. Also, training may be a very effective means to transmit research results.
- *Monitor and evaluate research-user linkages.* Monitoring and evaluation can signal insufficient research-user interaction and point out appropriate actions to strengthen them. Ruttan (1978) recommends separate review and evaluation of the "outreach" component of a research program.
- *Involve users in planning and evaluation.* Both users and researchers should be involved in the early stages of research planning. Users also should be involved to the extent possible in the implementation and evaluation of research activities.
- *Organize field days.* Field days or open days should be held periodically. End-users should be invited to visit various research stations and demonstration plots to learn about research findings and ongoing research. Such events should be structured so as to encourage dialogue between researchers and users.

#### MODIFY ORGANIZATIONAL STRUCTURE

Some management options under this second approach to strengthening research-user communication include:

- *Create a unit to produce extension documentation.* A new, central unit may be set up in a national research system to produce and distribute documentation intended specifically for use in the extension service. A need that is often overlooked in research organizations is the production of simple, short reports that summarize and interpret research results in a way that is practical and understandable by managers who have little or no interest in research per se.
- *Establish a research-extension liaison unit.* Dada (1984) reports on a research-extension liaison unit established in the Forestry Research Institute of

Nigeria to form a link between research and users, including most importantly the state forestry departments. "The Unit is expected to bring results of research to the state foresters, and forestry problems from state foresters back to the research institute" (Dada 1984). Unlike most extension organizations, this research-extension liaison unit was set up as a division equal in status to the research division, giving it more authority to carry out its mission.

Temu et al. (1987) describe a similar extension and research liaison program. The staff and advisory committee of such a program would consist of a senior liaison officer, a few senior research officers, senior extension and planning officers, and a support staff. The senior liaison officer must be able to translate scientific and technical jargon into simple terms for laymen, and should be conversant with all the operations, programs, and personnel of the research organization in order to be an effective go-between.

The key tasks of the extension and research liaison advisory committee would be:

- to identify end-users of various research results;
- to provide critical evaluation of research results;
- to link the research organization and users.

■ *Establish research advisory committees.* Local and regional research advisory committees which include representatives from important user groups should be formed if such committees are not part of the current organizational structure. Advisory committees provide input from users on planning and priority setting.

## Further Information

The preceding chapters have presented an overview of the key dimensions of forestry research management. The essential components of a strong research organization have been identified and discussed. Coverage of each topic has been brief out of necessity--a complete and in-depth treatment of each area of research management would have resulted in a very lengthy document. Future FAO documentation will examine key topics related to research management in greater detail.

In addition to the FAO Forestry Department, a number of valuable resources are available to forestry research managers interested in enhancing managerial capabilities. IUFRO Subject Group S6.06 is dedicated to "The Management of Forestry Research." This group has provided an excellent forum for forestry research managers and researchers to discuss research planning, management, evaluation, and related topics (see Burns, 1986, Lundgren 1989). Also, IUFRO Subject Group S6.08 is concerned with "Applying the Results of Forestry Research" (see Moeller and Seal 1984).

IUFRO's Special Programme for Developing Countries (SPDC) has been active in forestry research planning and management training since its creation in 1983. The SPDC has a mandate to work in six major areas:

1. planning for forestry research
2. training for management of forestry research
3. training on methods of forestry research
4. facilitating the flow of information to researchers, e.g., through the encouragement of networks and the publication of an information bulletin
5. fostering twinning arrangements
6. establishing an international fund for forestry research training.

As part of its activities, the SPDC has conducted a number of regional workshops on identification of high priority research topics and on research conduct and management (Coordinator, IUFRO/SPDC, A1131, Wien-Schonbrunn, Austria).

Another important resource is the International Service for National Agricultural Research (ISNAR), part of the Consultative Group on International Agricultural Research. ISNAR's mission is to assist developing countries improve the effectiveness and efficiency of their agricultural research systems through enhanced capacity in the areas of research policy, organization, and management. This is accomplished through three complementary programs: advisory service, research, and training. The ISNAR staff has produced many outstanding publications that deal with various aspects of agricultural research management. Much of this material is applicable to forestry research. A list of ISNAR current publications is available (P.O. Box 93375, 2509 AJ, The Hague, The Netherlands).

Many national organizations in developed countries support research management and planning activities and training for researchers and administrators from developing countries. Such countries as Canada, France, the United Kingdom, Finland, Japan,

Denmark, Sweden, the Federal Republic of Germany, and the United States have a long history of such support.<sup>1</sup>

The urgency of strengthening forestry research organizations in developing countries is indicated by two factors. First is growing recognition of the importance of indigenous research capacity in the process of economic development. A country lacking the capacity to create new technologies and to screen and adapt imported technologies is at a substantial disadvantage in its development efforts. Second, the forestry sector in many developing countries faces a set of critical problems requiring a strong response from forestry research organizations. Substantial efforts to increase forestry research capacity are required if these problems are to be successfully dealt with. Hopefully, this document will help research managers in their efforts to strengthen their research organizations and will stimulate further efforts in this important area.

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<sup>1</sup>For example, one of the authors of this paper works for a research unit of the U.S. Forest Service that deals with forestry research planning and evaluation. A list of publications from that unit and its cooperators is available by writing the Project Leader (North Central Forest Experiment Station, 1992 Folwell Avenue, St. Paul, MN 55108, U.S.A.).

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