

Research management in forestry

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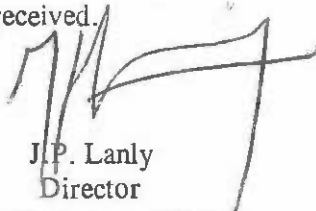
FOREWORD

This book is an abridged version of FAO Forestry Paper 96 "Planning and Management of Forestry Research: Guidelines for Managers", by Hans M. Gregersen, Allen L. Lundgren and David N. Bengston. It has been prepared specially for the busy manager. The original version will remain available for reference, and is recommended for those who wish to explore the subject matter in greater detail.

The preparation of FAO Forestry Paper 96 was spurred by the realization that forestry research throughout the world, but more particularly in developing countries, had to be strengthened, to improve the management, conservation and sustainable utilization of forest resources. In the foreword to the paper, the view had been expressed that "the distinguishing mark of sound research is in anticipating needs rather than responding to problems as they arise", and that "such anticipation must be followed by good planning and management if research is to be internally efficient and externally effective".

I trust that this book will provide busy managers with many useful ideas for improving their planning and management of research.

I wish to thank Francis S.P. Ng, Chief, Forest Research, Education and Training Branch, for preparing the abridged version, as well as the Director and officers of the FAO Research and Technology Development Division, and officers of the Forest Resources Division, for the helpful advice received.



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1. INTRODUCTION

"Research" in these guidelines covers scientific experimentation involving control and physical manipulation, as well as research in social science/economics involving controlled inquiry without physical manipulation (Ackoff et al., 1962).

Forestry research is defined here to include research on forest products. It covers research on the nature and functioning of trees, forests, their components and their products, on the role of trees and forests in land use and how that role can be modified, and on the interactions between people, forests, and forestry. The organizations involved in forestry research are here referred to as forestry research organizations (FROs).

A number of terms are used to describe various kinds of research. Basic research is done to understand basic processes and to provide knowledge that can be used in 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 priorities.

Resources for research

Three major types of resources are needed for research: human (scientists, technicians, other staff), financial (the funds to put manpower to productive use), and physical (the infrastructure, equipment, buildings, etc.)

Human resources

The results of an FAO survey (Table 1.1) indicate 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 the questionnaires).

In another study, of 39 institutions, about two-thirds were found to have between 0 and 5 Ph.D. and between 0 and 10 Masters level scientists. More than one-quarter of the researchers and administrators had degrees from outside their home countries.

Lack of trained personnel has been identified, in a survey among by research directors, as one of the most critical problems facing developing country forestry research organizations (see Figure 1.1). 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, more than one-quarter of existing researchers obtained their education and specialization outside their own country.

Many of the persons who go outside for training never return, thus their training does not directly benefit their home countries. Finally, of the researchers who do return, many 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 in their home countries.

Table 1.1 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

Financial resources

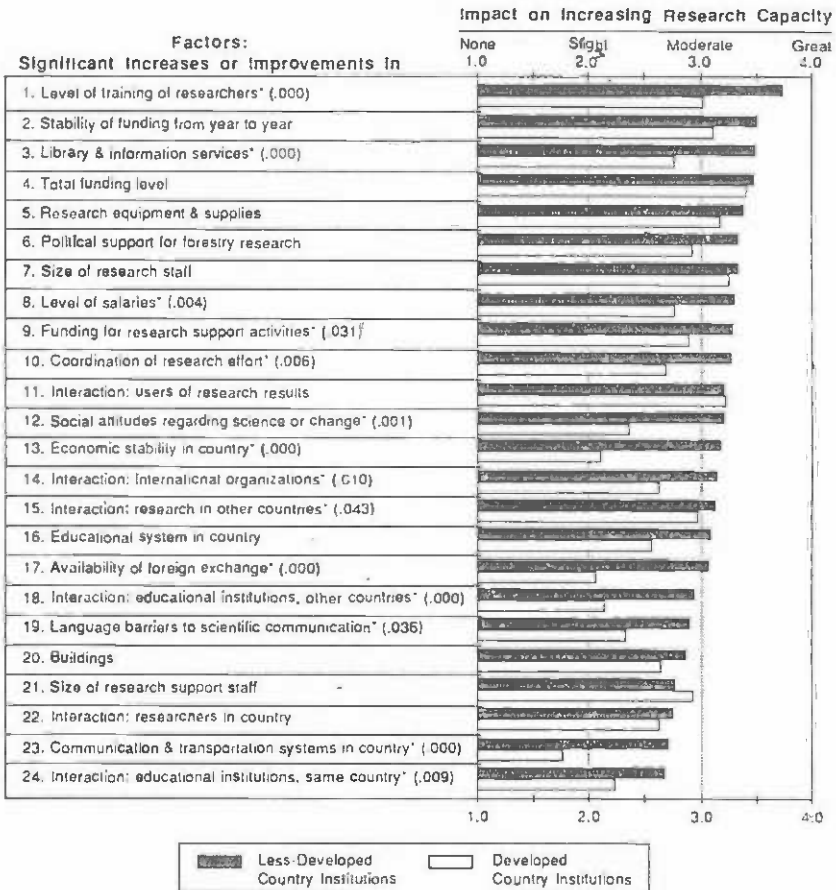
Expenditure on forestry research in 1981 for Africa, Latin America and Asia (excluding Japan) was about US\$186 million (see Table 1.2). This is up from an estimated \$107 million in 1975 and \$70 million in 1970. In comparison, the US Forest Service alone spent \$128 million on research in 1981.

Table 1.2 Forestry research expenditures by major geographical regions

Total expenditures in millions of 1980 US dollars

Region	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: Mergen *et al.*, 1988



*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 1.1. 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 & Gregersen, 1988

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

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 1.3). If the value of non-market 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.

Of the total expenditure on forestry research in developing countries in 1988, it is estimated that \$48.3 million came from international donors (FAO 1987). 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 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 understate 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.

Table 1.3 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

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 & 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.

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 infra-structural support (computer facilities, communications, transportation, etc.).

It is evident from Figure 1.1 that lack of adequate library facilities is a major concern of research administrators in the sample countries. 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, 1984a,b,c).

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.

Research organization and management

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.

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. 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. In a sample of 36 organizations, 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 & 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 1.1, 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.

However, caution is needed. 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.

2. THE PLANNING PROCESS

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.

Goals are broad statements of the intended outcomes of each research programme or major activity of the organization; such outcomes should be well-defined and achievable within a few years.

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 programme or project should be monitored and performance evaluated against a set of well-defined objectives.

Three planning levels

Three distinct types of research planning may be distinguished: strategic, programme, 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.

Programme planning uses the output of strategic planning as an important input. Proposed research programmes should be clearly defined in terms of purpose. Estimated resource requirements for each programme should be given, and individual research projects that fall under each programme should be specified. The time frame for programme planning is typically three to five years.

Annual planning and budgeting uses the output of strategic and programme planning as input. 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 programmes and projects (comparing planned and achieved outputs), personnel appraisal, and financial control. Budgeting is an integral part of annual planning.

Characteristics of effective 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 programme 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, programmes, 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. 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 (1981) states: "I am concerned about excessive administrative burden that stifles both routine investigation and research entrepreneurship." 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 programmes 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 programmes,

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 programmes 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.

3. STRATEGIC PLANNING

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?). The time frame is long-term, five to ten years, or longer in some cases. Strategic planning is the responsibility of senior research management.

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

Worksheets that may be used by the planning team to facilitate the process are given in Appendix 3.1. The following strategic planning process is adapted from Bryson (1988), Pfeiffer *et al.* (1989), and Barry (1986). 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
(Appendix 3.1 worksheet 1)

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? 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?

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.

2. Identifying and clarifying organizational mandates (Appendix 3.1 worksheet 2)

What is the research organization required to do and not do? Consideration should be given to formal mandates such as legal requirements and government policy, 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.

3. Conducting a stakeholder analysis (Appendix 3.1 worksheet 3)

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.

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. 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 (Appendix 3.1 worksheet 4)

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 fulfil an important public relations role by concisely communicating to stakeholders what the organization is all about. An example of an actual forestry research mission statement is as follows:

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. (Source: Cheah Leong Chiew, personal communication).

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?

5. Assessing the external and internal environments (Appendix 3.1 worksheet 5)

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 & 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;

- 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.

6. Identifying strategic issues (Appendix 3.1 worksheet 6)

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).

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.

7. Formulating strategies to manage strategic issues
(Appendix 3.1 worksheet 7)

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 retainment 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 programme 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 programme of non-financial 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 non-salary 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.

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 programmes)
- 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.

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 3.1

Strategic planning worksheets

Adapted from Bryson (1988) and Barry (1986)

1. Initiating and agreeing on a strategic planning process

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?

2. Identifying and clarifying organizational mandates

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.

3. 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.			

4. Developing a mission statement

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.)

5. Assessing the external and internal environments

External opportunities (list and briefly explain):

1.

2.

3.

4.

External threats (list and briefly explain):

1.

2.

3.

4.

**(Assessing the external and internal environments,
continued)**

Internal strengths (list and briefly explain):

1.

2.

3.

4.

Internal weaknesses (list and briefly explain)

1.

2.

3.

4.

6. Identifying strategic issues

1. What is the issue? (describe 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?

7. Formulating strategies to manage strategic issues

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?

4. PROGRAMME PLANNING

Programme 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 programme planning; the output of programme planning is a key input to annual planning and budgeting. A research programme is the collection 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 the scientific and administrative support programme areas such as library and information services, personnel services, etc.

The planning horizon for programme planning is typically three to five years. The ultimate responsibility for programme planning rests with senior research management, but researchers, team leaders, and external stakeholder groups have important roles to play as well.

Most public research organizations use a project-oriented approach to research planning and management. The following sections briefly describe the structure and process of research programme planning in a generalized project-based system.

Research programme structure

The structure of a project-based research programme usually consists of three separate levels or components:

- a set of broad programme areas
- a set of research projects or units under each programme area; and

- a set of individual studies within each project.

Research programme 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 programme areas by broad problems that cut across scientific disciplines may be a more desirable approach. The number of research programme areas varies greatly between organizations: small research organizations with narrowly defined missions may have a single programme area; large organizations with broad mandates may define ten or more programme areas to pursue. Research programme areas will also vary over time, as priorities and information needs change. Programme areas should be clearly defined, with goals and objectives explicitly stated and resource requirements (financial, human, and physical) specified to the extent possible.

Research projects are often the building blocks of research programmes. A project is defined as a self-contained area of investigation with specific goals and objectives which relate to a particular programme area. Each research programme area contains one or more projects. A research project is defined by its goals and objectives, and by the individuals assigned to work within it. 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 fulfil 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.

Research planning process

The planning of a project-based research programme usually includes the preparation of programme plans, project descriptions, and research study plans.

Programme plans summarize the specific research areas and projects included within each programme area over the planning horizon (usually five years), along with the associated resource requirements for each programme and project.

Project descriptions detail each of the individual research projects and may 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.

A plan of study for individual research studies should be prepared by the researcher and/or the team leader. A study plan may 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 description of how the work is to be carried out
- cost estimates, including personnel needed and their skills, facilities required, duration of the project

- scheduling of the research and planned outputs.

Monitoring and evaluation

Monitoring and evaluation of research programmes 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 programme 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 programme formulation, and should include evaluation of research progress, staffing and training, programme and budget development, support services, research facilities, and dissemination of research results (see Murphy, 1985; Daniels, 1987; McLean, 1988a).

APPENDIX 4.1

Tools for programme planning: the logical framework¹

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 programmes 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 by this technique is summarized in Table 4.1. Table 4.2 provides a generalized example of applying the LF to a research programme). The left-hand column in the table is a "narrative summary" of the four levels of objectives of a research project or programme:

- the goal is the ultimate objective to which the research project or programme contributes, e.g., a timber harvesting research programme may contribute to the achievement of a national development goal such as self-sufficiency in wood products;
- the purpose of a research project or programme is what it is expected to achieve upon completion, e.g., in the timber

¹Adapted from Delp et al. (1977); USAID (1980), and McLean (1988c).

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 programme derived directly from management of inputs, e.g., the timber harvesting research programme 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 programme 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.*
- 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 programme. 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 programme, 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 programme. 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 (1988b).

**PROJECT DESIGN SUMMARY
LOGICAL FRAMEWORK**

Project title:.....

Life of project: **From fiscal year** **to fiscal year** **Total funding:** **Date prepared:**

NARRATIVE SUMMARY	VERIFIABLE INDICATORS	MEANS OF VERIFICATION	IMPORTANT ASSUMPTIONS
<i>Goal (the broader objective to which this project contributes):</i>	<i>Measures of goal achievement:</i>	<i>Sources of information, methods used:</i>	<i>Assumptions for achieving goal:</i>
<i>Project purpose:</i>	<i>End of project status (conditions that will indicate purpose has been achieved):</i>	<i>Sources of information, methods used:</i>	<i>Assumptions for achieving purpose:</i>
<i>Outputs:</i>	<i>Magnitude of outputs, planned completion date:</i>	<i>Sources of information, methods used:</i>	<i>Assumptions for generating outputs:</i>
<i>Inputs:</i>	<i>Type, level, and cost of inputs, planned starting date:</i>	<i>Sources of information, methods used:</i>	<i>Assumptions for providing inputs, initial assumptions about the project:</i>

Table 4.1 The "logical framework". Adapted from Delp et al. (1977) and McLean (1988b).

**PROJECT DESIGN SUMMARY
LOGICAL FRAMEWORK**

Project title:.....

Life of project: From fiscal year to fiscal year

Total funding:

Date prepared:

NARRATIVE SUMMARY	VERIFIABLE INDICATORS	MEANS OF VERIFICATION	IMPORTANT ASSUMPTIONS
<i>Goal (the broader objective to which this project contributes): Develop new technology that contributes to national development objectives</i>	<i>Measures of goal achievement: Increased production Reduced erosion Increased incomes</i>	<i>Sources of information, methods used: Surveys Government statistics Impact evaluation</i>	<i>Assumptions for achieving goal: Favourable economic environment; stability; adequate roads, markets, communications etc.</i>
<i>Project purpose: Produce new knowledge of interest to research, extension, land managers, and policy-makers</i>	<i>End of project status (conditions that will indicate purpose has been achieved): Technologies or recommendations disseminated to target audiences</i>	<i>Sources of information, methods used: Program/project records Extension reports</i>	<i>Assumptions for achieving purpose: Prices favourable Extension services available Other outputs available</i>
<i>Outputs: Preliminary research results Final research results Research capacity strengthened</i>	<i>Magnitude of outputs, planned completion date: Data from experiments analyzed; publications produced; field demonstrations conducted; improved staff and facilities</i>	<i>Sources of information, methods used: Research reports Annual reports External review</i>	<i>Assumptions for generating outputs: Low staff turnover Scientific standards upheld</i>
<i>Inputs: Human, financial, and physical resources; equipment and supplies; training; scientific leadership</i>	<i>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</i>	<i>Sources of information, methods used: Quarterly and annual reports; accounting and administrative records; personnel data</i>	<i>Assumptions for providing inputs, initial assumptions about the project: Funds and staff approved will be disbursed and available; courses available</i>

Table 4.2 Generalised example of applying the "logical framework". to a research programme.. Adapted from McLean (1988b).

5. ANNUAL PLANNING AND BUDGETING

The primary purpose of annual planning and budgeting is to identify the tasks to be accomplished in the upcoming year, based on the direction provided by the strategic plan, the research programme, and other factors, and to translate these into concrete resource requirements.

Annual planning is concerned with the work that will be carried out with existing personnel, facilities, and other resources, because in the short term, resources are basically fixed. At this planning level, objectives, resource requirements (dollars and person years), and allocation of resources are very specific.

Planning and budgeting research on an annual basis has to be reconciled with the long-term nature of much research. A productive research programme 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. Hence, stability of funding from year to year is a major concern in many forestry research organizations in developing countries (Bengston & Gregersen, 1988).

Another problem commonly encountered is that the budget categories used for fiscal accountability and reporting often are not well-suited for research project management.

The process of annual planning and budgeting

Annual planning and budgeting begins with the director and other research managers developing initial 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 programme planning.
3. The existing budget and allocation of resources across programmes and projects. The work already in progress, often needs to be carried forward, so changes associated with annual 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.

As these four factors indicate, the process of developing annual budget proposals should be both a top-down and a bottom-up process, similar to programme planning. Budget advice from higher authorities and the organization's strategic and programme plans are the main sources of top-down input, and the current budget and 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 programme 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

programmes 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 the information they need to make informed decisions regarding programme 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 programme budgeting system

Timely information is vital in planning and budgeting. Although annual planning and budgeting can be carried out using standard clerical procedures, a microcomputer-based Programme 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 programme 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 programme 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 programme budgeting system that may be adaptable for use in forestry research organizations (Marcotte, 1987; Sands, 1988).

Fund-raising

The use of the budget as a research planning instrument is often limited by a relatively large proportion of the budget being allocated to fixed costs, especially salaries, resulting in a lack of funds for travel, maintenance of equipment, fuel for vehicles, and other items needed for research. In some agricultural research institutions, up to 90 percent of the total budget is spent on salaries (Elz, 1984).

The managers of research organizations can do various things to improve the funding of research, and some of these are listed in Table 5.1.

Where the regulations permit, research managers and scientists may also be able to obtain research funds from non-governmental funding agencies. A key to success in obtaining support from most funding agencies is a well-written proposal. Appendix 5.1 provides general guidelines for proposal writing. Many agencies also have their own explicit guidelines.

Table 5.1 Techniques for influencing potential funders of research

- 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 children.
- 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 programmes.

Source: Ruttan 1987.

Integrating internationally-funded research into the overall programme of a FRO can be a big challenge. Quite often, the foreign research is much better supported than the domestic

component of a programme, thus leading to potential jealousies among personnel. There also is the potential danger of isolation and lack of integration in the overall programme, 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. Also, from a very early stage the manager has to start planning for a smooth transition in anticipation of the termination of the outside funding.

If managed appropriately, a foreign-funded research programme 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 programmes.

In seeking foreign support for research programmes, a manager with no prior experience with such sources should seek advice from others in the country who have experience.

APPENDIX 5.1

Writing research funding proposals

The ability to write well-crafted grant proposals is an important skill in obtaining project funds. This appendix provides a brief introduction to proposal writing, focusing on the essential components that should be included in any proposal. More detail about grant-seeking 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 programme you are applying to
- the address of the office that handles the programme 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 programme
- 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 programme 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 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 (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. Most granting agencies require salaries to be contributed by the grantee's own organization.

Dissemination plans. It is important to specify how the results of the project or programme 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 personal history 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 programme.

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.

6. MANAGING RESEARCHERS

It is the responsibility of a research manager to manage and direct the human resources within the organization so as to achieve the goals and objectives of the organization.

Recruitment

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. 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 programme may not be available. 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 programme of research that can be carried out effectively by the organization.

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.

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.

In recruiting research personnel, public research institutes often face stiff competition from private industry in terms of salaries and other job benefits. Government salaries and advancement potential are often 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.

A critical attribute to be considered in recruiting scientists in an expanding organization is their potential for becoming mentors for the younger scientists (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.

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 programme 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 & 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.

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.

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, 1984) 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 multi-disciplinary 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.

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.

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. 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.

7. PROVIDING 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. Leaders should indicate by their 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 & Zuidema, 1988).

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 Appendix 7.1) 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 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.

APPENDIX 7.1

Distinctive qualities of an outstanding leader (adapted from Ranftl, 1986)

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 an "elegant" simplicity in all actions

8. SCIENTIFIC SUPPORT SERVICES

Scientific support services exist to support the work of the scientists in the organization. They also may contribute to other goals of the organization.

Libraries and other options for accessing scientific and technological information

For most researchers, libraries provide the main access to the world's scientific and technological literature. Many researchers also maintain small collections of publications that are of immediate interest to their work.

In order to keep abreast of new developments in particular fields of science, libraries can:

- subscribe to or obtain access to key journals
- purchase or obtain access to 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.

Researchers can:

- 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.

The world literature is expanding rapidly in every area of science. 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. Also, 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.

The rising cost of acquiring books and journal subscriptions suggests the need to have fewer but better equipped and stocked libraries.

Where funding is limited, research managers must make some difficult decisions about how much of their funds should be spent on providing library 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.

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.

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. 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. 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. 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 effort. Statistics always must be applied with common sense, and with an understanding of what practical goals research is trying to achieve.

Computing services

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 programmes 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, payroll, 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 programmes now are available for personal desktop computers, including programmes for wordprocessing, spreadsheet analysis, data base management, graphics, statistical analysis, and many other special applications. Most scientists can readily find programmes that are easy to use in meeting a variety of their needs.

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 programmes 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
- maintain quality control over publications to assure their editorial and scientific soundness, 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 non-technical information 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 programme 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 programme in forestry and forest products, if the results never reach potential users.

9. ADMINISTRATIVE SERVICES

Administrative services usually include the following service functions: personnel management, procurement management, financial management, property management, and office management. In large research organizations it may be necessary to establish a separate administrative group for each service function. In smaller organizations each function may be handled by one person, or several functions may be combined and handled by one unit.

Personnel management

The function of personnel management is to administer the recruitment, training, and career development of the personnel in the organization, and maintain personnel records. It also may handle payrolling, labor relations, and the management of fringe benefits. Although personnel management in a broad sense is a responsibility of all supervisors within an organization, many organizations centralize at least some of the personnel management functions.

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 programme plans of the organization. Such a plan should include a review of

current staffing in the organization, future programme directions, expected personnel needs to support such programme directions, tentative schedules of promotions, transfers, reassignments, 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.

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.

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.

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.

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 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. 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. Such contracts often require competitive bidding procedures, which usually include 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

The responsibilities of financial management may include the following:

- 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 research organization requires facilities and equipment to carry out its programme of work. The facilities may range from rented office space to ownership and occupancy of a major scientific laboratory. The tools and equipment may range from shovels and diameter tapes, to motor vehicles and expensive laboratory equipment.

Managing research facilities and equipment, and providing the myriad of supplies and small items of equipment required by a programme of research, requires special knowledge and skill.

Facilities must be kept clean and in good repair. 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 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. 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 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

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

The function of office management is to provide secretarial, clerical, and other services required by the research organization, and to maintain the records of organizational activities as required by law and by the management needs of the organization.

The records of a research organization provide a history of its operations. These records include the correspondence of the different groups within the organization, and the records of agreements, obligations, plans, accomplishments, etc. The maintenance, retrieval, and eventual disposition of documents are of importance to a research organization. The maintenance and disposition of some records are in many cases prescribed by law. 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.

10. COMMUNICATING RESULTS TO SCIENTISTS

Science is a social endeavor (Storer, 1966). The body of knowledge developing within a scientific discipline is not the work of a single individual, but of a multitude of scientists, interacting with each other. Scientists depend upon the work of other scientists in a field of research as a basis for their own work in the field. Thus, all scientists have a responsibility to ensure that the results of their research are made available to other scientists, and research managers have a responsibility to ensure that each scientist spends some time communicating research results.

Scientists communicate with each other by many means, including scientific publications, personal contacts and attendance at professional meetings.

Importance of research communication in science

In order to become part of a scientific community, scientists must interact with other scientists by utilizing research results of other scientists to further their own research, submitting their work to peer review, and communicating their results to other scientists. Such scientist interaction provides a means of sharing new ideas, methods, and research results, and contributes to quality control of scientific findings by the scientific community. If managers of forestry research wish their organization to play an active role in the development of science, they must provide opportunities for their scientists to interact, in one way or another, with other scientists to further the communication of research results.

Although there are many means of communicating with other researchers and disseminating research results, scientific research is considered incomplete without publication (Price, 1980). For scientists, scientific journals, books, and other

publications are a primary source of information about the status of science in any given field. They provide one of the chief ways of documenting and verifying research findings, and of communicating those findings to other scientists. Publication of research results in scientific journals is one of the most visible, easily accessible, and lasting contributions to science.

Scientists publish and communicate with their colleagues not only to disseminate research results to the scientific world, but also for more personal reasons: to establish a professional reputation, gain access to professional colleagues, gain invitations to professional meetings, and to gain promotion (Maguire & Kench, 1981).

Overview of the research communication process in science

Scientists always have used informal systems for exchanging information and disseminating research results. Scientists who share a common interest in a particular research subject often form what has been referred to as "invisible colleges," an intricate network of personal contacts, where the exchange of ideas, information, and draft papers occurs, often far in advance of more formal publication (Gray & Perry, 1975). Those at the forefront of a rapidly expanding field of science find it essential to maintain a close contact with others in the field in order to keep their own research on track, and to share in guiding the new developments. They do this through personal visits, attendance at meetings, letters, mailing lists, exchange of preprints, telephone, and more recently by facsimile or fax machines.

In many fields, a large part of new scientific findings are first distributed to interested colleagues through these invisible colleges and by other informal means, and only later find their way into print. One should not underestimate the power of such informal networks of scientists in disseminating information

about current research in progress. Research managers should encourage scientists in their organization to become part of such invisible colleges wherever possible in order to tap into the latest scientific discoveries and gain access to those active scientists who make up these informal networks.

However, such informal exchanges of information are not substitutes for the more formal communication of research findings to scientists through publication in journals, research reports, and books. Scientific journals provide a verified record of research achievements over time. Journals are the basic scientific information bank that is accessed by scientists in planning and conducting their research. Books provide a synthesis of an accumulated body of knowledge and provide an overview of a subject matter area. Such overviews are especially helpful to students and to those not intimately familiar with a particular subject area.

Access to the various means by which research findings are disseminated is essential to the conduct of research. Those lacking access to scientific information are severely handicapped in their research.

The role of scientific journals

Scientific journals are one of the major publication outlets for disseminating research results to other scientists. The publication of research results in a scientific journal provides public documentation of scientific findings, and makes such findings accessible to a wider scientific audience. It provides a permanent record of research results that is available over time for the use of future researchers.

The informal exchange of information, while playing an important role in communication among scientists, lacks the formal verification that a publication in a refereed scientific

journal is forced to undergo. Peer review provides a necessary verification of research work before it is widely disseminated, and can improve the quality of scientific writing.

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.

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.

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 programme, 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 programmes 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

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.

11. COMMUNICATING RESULTS FOR APPLICATION

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, it is important, in forestry research, to obtain feedback from the users to the 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-to-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).

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.

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 programme. 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" for every major research project or programme, 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 programme?
- What are the specific information needs of these potential users that relate to the proposed research project or programme?

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 & 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 & 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 programmes, 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 programme.
- *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 programme. The staff and advisory

committee of such a programme 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, programmes, 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.

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