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Management information for agricultural research: Asian experience

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SUMMARY

Information is a crucial resource in decision-making. Structured information systems are required to support decision-making processes in complex organizations. This article discusses an information system for agricultural research organizations known as INFORM. This system aims to provide research managers and scientists with information essential for management such as planning, budgeting, monitoring and evaluation. The INFORM system integrates information on research personnel, programmes and finances in a single framework. Researchers' time allocated to specific research and non-research activities is the basis for estimating total resource allocations. INFORM is a flexible system with limited data requirements, which uses simple software on standard personal computers. Development of INFORM in Asia is outlined in this paper, following a discussion of principles and procedures. The final sections of the article present examples of results that can be obtained with INFORM and discuss important lessons and issues.

INCREASING COMPLEXITY OF THE RESEARCH MANAGER'S TASK

Research managers are paid to make decisions. The raw material for decision-making is data. It is, however, difficult to use raw data for decision making. Data need to be processed, analysed and presented in meaningful ways; in other words, data have to be transformed into pertinent, relevant and timely information.

Managers of small organizations that are not very complex may obtain necessary information without a great deal of data collection and analysis. However, when organizations grow bigger, as their structure and mission become more complex, managers need structured information systems to support decision-making.

National agricultural research systems (NARS) in developing countries have become much bigger and complex organizations in the past decades. The number of researchers employed more than doubled between 1961–65 and 1981–85 and research expenditures have almost tripled (Pardey *et al.*, 1991, p. 199). NARS are also becoming more complex organizations, mainly as a result of having to respond to new tasks and challenges.

There is a move from one person–one discipline projects in a departmental structure towards a situation where research programmes are organized around multi-disciplin-

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ary teams addressing specific problems. Obviously, such a set-up is more complex to manage.

The number of funding sources for agricultural research is increasing. Agricultural research may be supported by the government, the private sector and other national and international donors. Each of these usually has specific objectives as well as reporting requirements. Dealing with a multitude of budgets and special projects and programmes certainly increases the manager's workload. Parallel to this, many research systems are faced with budget cuts, privatization and similar changes that demand a more entrepreneurial attitude of the research manager.

It is necessary to address new concerns and issues in research programmes: ensuring, for example, that sustainability aspects are incorporated is a specific issue that a research manager may have to deal with in the design of the research programme and the allocation of resources. The incorporation of gender issues provides another example.

Increasingly, research has to satisfy the demands of different groups of clients and beneficiaries. The consensus is that it is important to target agricultural research towards the needs of specific clients and—in general—to incorporate the user perspective in the planning, monitoring and evaluation of agricultural research programmes.

Most research institutes have information systems, but few of these can address the issues raised above because of their limited scope and inflexibility. This article presents a discussion of principles and practice in relation to the development of management information systems in agricultural research. Special attention is given to INFORM, an information system for agricultural research managers, which integrates information on research programmes, personnel and finance in a single framework.

TOOLS FOR RESEARCH MANAGEMENT AND ADMINISTRATION

A wide variety of tools may be used in research management. They include personnel administration and management, accounting, budgeting and financial management. Before discussing the concept of management information systems (MISs) for agricultural research, it may be useful to highlight briefly three issues discussed in the literature relating to the use of 'tools'.

One problem, described by Siffin (1976, p. 61) in the general context of public administration, is that of 'seeking developmental outcomes from system-maintenance oriented tools and concepts'. Many tools such as personnel management and accounting can be seen as oriented towards maintaining the status quo. One of the most important *change-oriented tools* promoted in both developed and developing countries is programme budgeting. This has been advocated by researchers and administrators as a tool for change. Several authors have discussed the technical and institutional problems in the establishment of programme budgeting systems (PBS) (Schick, 1971; Caiden, 1988). One problem discussed relates to *excessive data and computing requirements*. Providing a variety of perspectives on budgetary information, it appears, was not practically possible before the age of affordable computers and flexible software.

Management information systems can be change oriented to a smaller or larger degree, depending on whether the emphasis is on the production of a limited number

of routine outputs or whether the system is flexible enough to generate a wide variety of different outputs tailored to the requirements of the research manager.

In a review of thinking on development administration, Esman (1988) describes changes from an emphasis on 'integrated systems' towards more modest approaches:

> 'The failure of ambitious programs for comprehensive administrative reform has generated a reaction against systems concepts and a renewed appreciation of sector specific problems ... in concrete administrative structures.' (Esman, 1988, p. 131).

Incremental improvements using tools specifically designed for a task are now considered more worthwhile than complex systems that promise to be all things to all people. To be practical and acceptable, management information systems need to follow the *incremental approach rather than that of systemwide change.*

It seems reasonable to conclude from the above that information systems should be oriented towards change, should take an incremental (step-by-step) approach and should not depend on large volumes of data.

The need for an information system that helps research managers in the tasks of programme and resource management may appear obvious. However, there are few practical applications in agricultural research. Often, MISs for research remain static, computer-centred systems. There are, however, also a number of practical approaches.

The Division of Water Resources of the Commonwealth Scientific and Industrial Research Organization (CSIRO) in Australia has developed a system called REMISS (Research Management Information SyStem) (Sumner and Curtiss, 1988). The system provides comprehensive information on research projects. It includes detailed cost data for the projects including the cost of participating researchers and technical staff and the cost of equipment. It includes information on objectives, work plans and progress and uses keywords. The system is computerized using IBM-PC-compatible hardware and a relational database program called RBase.

The Agricultural and Food Research Council of the United Kingdom has developed a current research information and costing system for agricultural research known as ARCIS (Agricultural Research Current Information System) (Corbett, 1989). The system aimes to describe research in manageable units, to apportion the costs of research, to list principal researchers involved, to report progress in research and in spending, to allow retrieval of information aggregated in different ways and to provide some measure of output (publications).

At ISNAR, work on information systems for agricultural research started in 1986 with field work in Indonesia and in Sri Lanka in 1988. The following sections describe the INFORM system that grew out of this work.

INFORM—CHARACTERISTICS AND DEVELOPMENT

Mook (1988) describes the main elements of a management information system for agricultural research. The elements are summarized in a matrix (Figure 1). The rows show the four components in a research information system:

- *Research programme information* deals with projects or experiments. Questions

include the number and type of activities being carried out, their discipline, commodity, etc.

- *Information on research personnel* deals with two main questions: who they are and what they do. The first question involves information on age, degree and specialization. The second relates to staff participation in the institute's activities.
- *Information on finance* helps answer questions on the costs of different projects and programmes, for example how much is spent on rice research and how much on crop protection projects related to rice.
- *Information on equipment and facilities* deals with the use of these in research and the corresponding costs.

Figure 1. The INFORM matrix

Decisions / Information	Planning and programming	Monitoring and evaluation
Research projects Experiments	Strategy Tactics	Output Impact
Personnel	Recruitment Careers Training	Performance
Finance	Budgeting	Accounting Auditing
Equipment Supplies Facilities	Utilization Procurement	Stock control

Source: Nestel (1991a), p21.

The two columns on the right-hand side of the matrix refer to the types of decisions a research managers needs to deal with. Looking ahead, they face questions of planning and programming. In reviewing current or completed work, managers both monitor and evaluate. All of this is required for the research programme, the personnel, the funds and the facilities used in programme implementation.

INFORM was designed as a practical, flexible and modular system. Its development was guided by the following principles:

- Outputs should be of value to different classes of users, including policy-makers, national research managers, research institute directors, programme leaders and individual researchers. The system should be suitable for individual institutes as well as national systems.
- Information-gathering requirements should be limited. Most information should be readily available at agricultural research institutes.
- The system should focus on essential information for management and planning purposes in order to keep it small and practical.
- Hardware requirements should be limited. The necessary equipment should include no more than a standard microcomputer and a printer.

- Software used should be simple and easy to learn and use. It should be flexible in the production of outputs such as reports, tables and graphs.

The system is described in a series of training materials and guidelines (Gijsbers, 1991; Nestel, 1991a). Several features of its methodology are considered innovative for many national agricultural research systems (NARS).

Information on projects, personnel and finance is integrated. This central theme, illustrated in Table 1, forms the basis of INFORM. So far, INFORM has not included information on equipment and facilities used for research because much of that information relates to capital rather than recurrent expenditure, which is considered to be of more importance for management purposes.

Costs are estimated at the research activity level. A research activity is the smallest discrete unit of research such as a project, an experiment or a study. INFORM develops a budget for each experiment. At big institutes this may involve collecting information on several hundred experiments. The alternative—conducting the analysis at the level of broad-programme categories—is usually unsatisfactory, as it does not provide sufficient detail.

All revenues and recurrent costs of research are included in the analysis. This is an important principle, generally accepted in the private sector, but not always appreciated in public-sector research. Managers often take a narrow view of the cost of research and consider only variables such as travel, per diems, physical inputs (fertilizer, chemicals, seed) and temporary labour. The most important element in the cost of research—the scientific and technical personnel involved—is often excluded from the estimation of project costs. These are considered fixed costs as paid centrally by the government rather than the institute. For the purpose of INFORM, the cost of a researcher's participation in a research activity is considered a direct variable cost. INFORM is a change-oriented tool and, to reflect changes in resource allocation to projects, all costs that can be traced directly to research activities are considered variable. The time frame of change is important. In the short run, the activities (and costs) of a legume breeder may be shifted from soybean to cowpea. However, more time may be needed to train a sufficient number of entomologists if priorities shift to integrated pest management.

Researchers' time and cost are allocated to activities and programmes. Because the cost of researchers is included in the research cost and because the analysis is undertaken at the research activity level, the cost of a researcher participating in an experiment has to be calculated. This is done by estimating the percentage of time a researcher spends on each project and allocating a corresponding share of total annual cost to that activity. Data are collected through a researcher questionnaire on which each researcher indicates the time spent, or to be spent, on different activities. If a researcher spends 10 per cent of time on a project, 10 per cent of his, or her, cost is charged to that project.

Budget costs are grouped into meaningful categories for research management. The budgets used in agricultural research are usually based on standard government accounting codes designed for financial control. In most cases budgets are presented in a form that shows who will expend the funds rather than indicating what is to be achieved by the expenditure (Nestel, 1991b). In INFORM, expenditures related to specific activities, or functions, of a research institute are grouped together. For example, where technology transfer is important as a function, all relevant costs

are grouped under this heading. These could include researchers' time spent on extension and training as well as the cost of extension and communication specialists, support staff, relevant publications and activities such as field days.

Keywords are used to analyse research programme content. An adapted version of the FAO CARIS (Current Agricultural Research Information System) was used to develop a thesaurus and coding system for agricultural research. A system of keywords allows users to find detailed information on very specific aspects of research (Nestel, 1991c).

INFORM uses information from five sources. Four of these are usually available at research institutes; the fifth needs to be collected:

- A *staff list* provides information on different categories of research and non-research personnel.
- *Payroll information* is required to calculate the annual cost of research and non-research staff.
- The *institute budget* provides financial information.
- Information on the *research programme* is needed to develop an up-to-date list of research activities.
- Finally, a *time-allocation questionnaire* is the instrument to relate research staff to activities as it provides detailed information on staff participation in different research and non-research activities. This is usually the only new piece of information that is collected.

The information is processed and entered into two databases. A *personnel database* contains one record for each active researcher on the staff. It includes both biographical information and information on the time committed and nature of official activities such as research, management, extension, training and study leave. Within the research category detailed information is included on time allocated to individual research activities. A *research activities or projects database* contains a record for each research activity. This database relates descriptive information on research activities (commodity, discipline, season, duration, agro-ecological zone, etc.) to person–years of staff time and total cost of research. Thus, the INFORM system allows budgets to be viewed from many different perspectives: by discipline, commodity, the targeted agroecological zone or any of the other descriptors included in the system.

For INFORM development, ISNAR has used a commercially available flat-file database software package called Reflex (Version 2.0) produced by Borland International. The package is used for data entry, analysis and output generation (reports, tables and graphs). This software was selected for its ease of learning and use, especially to generate printed tables and graphs for presentation to senior research managers. However, using Reflex is not essential as INFORM is a system designed to use any database software.

Databases can be built at different levels. The basic unit for field work is usually the research institute (with information from substations included). Consolidated databases can be built up from institute databases. In Sri Lanka for example, where agricultural research is conducted in several ministries, aggregated databases were constructed for the Department of Agriculture (10 institutes) and the Research Council (all 19 institutes).

INFORM DEVELOPMENT IN ASIA

INFORM was developed and field tested by ISNAR and its NARS partners from 1988 to 1991. The methodology has been developed step by step with adjustments being made on the basis of field-work experience. ISNAR worked with a number of mostly Asian NARS in the development and institutionalization of the system. Most of the field work was conducted in Sri Lanka as part of a technical assistance project to the Sri Lanka Council of Agricultural Research Policy (CARP) executed by the German agency Gesellschaft für, Technische Zusammenarbeit (GTZ), where ISNAR was asked to undertake work on information systems.

Information was gathered during a series of field visits in 1989 and 1990. Staff from ISNAR, CARP and the Planning Cell of the Department of Agriculture (DOA) collected, entered and analysed data for each of the 19 research institutes in the country. A number of revisions in procedures and methodology were made in the course of the data collection process. These changes improved consistency and quality of the methodology. Towards the end of the data collection process for the year 1989 a workable and effective methodology had been developed.

Results of the 1989 exercise were presented to all 19 directors of research institutes and centres. Each received a report based on the analysis of the databases set up for their institute. For the benefit of managers at the national level (CARP) consolidated databases were developed to provide an overview of research programmes and resources for the NARS as a whole.

Concurrently, in the context of a project funded by the Asian Development Bank (ADB), training in the INFORM methodology was provided to six Sri Lankan staff (and also to staff from 12 other Asian countries). The Sri Lankan group became the core staff to develop and institutionalize INFORM in Sri Lanka. The group conducted a number of training seminars to achieve the objective of having two trained staff at each of the research centres and institutes. This goal was achieved in 1991, although staff changes and turnover require a continuous effort in training.

Whereas the 1989 INFORM exercise consisted of an *ex post* analysis showing how resources had been allocated, CARP, DOA and individual research institutes have since decided to use INFORM for planning and management purposes. Since the idea was to use information to influence budget allocations made by the Treasury, a total cost approach was used in the analysis. Changing Treasury budget allocations proved to be difficult, however, because of the very limited time available between data collection and the submission date for proposals to the Ministry of Finance. This time shortage results from the fact that the agricultural year and the financial year are not the same.

Several institutes have started to experiment with additions and improvements to the system. Some are collecting much more detailed information on research costs, particularly on the costs of inputs, labour and travel. Other institutes have expanded the system to include not only research personnel, but also support staff. Developing additional uses of the INFORM system, particularly in the monitoring and evaluation of research, as well as in planning and programming, is a priority area for further development.

In other Asian countries, INFORM has been implemented on a smaller scale. Activities have mostly followed from two training workshops that had been conducted in 1990 in the context of a management information project funded by ADB.

The Bangladesh Agricultural Research Council has established a similar system using different software. In India, the National Academy of Agricultural Research Management (NAARM), which was the co-sponsor of one of the 1990 training workshops, has conducted field work at a number of institutes and is conducting training activities. In Indonesia the Agency for Agricultural Research and Development (AARD) is using the INFORM methodology to integrate information contained in separate unrelated databases on staff, finance, programmes and facilities. AARD used a relational database but has since decided that most of its purposes can be served by the simple format of INFORM.

More limited case studies and national level training activities have been conducted in Thailand, Pakistan, the Philippines and Bhutan.

USING INFORM AT DIFFERENT MANAGEMENT LEVELS

INFORM is flexible and can be used at different institutional levels for a variety of purposes. It is an open system in that additional information can be added. The most important institutional and programme levels at which INFORM can be used by decision makers are:

- National level research managers, planners and policy-makers
- Research institute directors.
- Programme leaders.
- Individual researchers.

Some information is useful at different levels in the institutional hierarchy. For example, information on resource allocation to crops and disciplines or age composition of research staff is relevant both at the national level and for individual research institutions. Other information is relevant mainly to a particular level of analysis. For example, detailed information on size and composition of research teams is mostly important for the institute director.

National level research managers and policy makers

The size of the national research budget and its distribution between ministries, departments, institutes or other functional units is one of the basic outputs of INFORM. Resource allocation at the national level to major commodity groups, individual crops and commodities, disciplines, agroecological and administrative regions can be assessed using INFORM. This information is essential for planning and priority-setting as well as for management purposes.

For example, the 1989 INFORM analysis of agricultural research in Sri Lanka showed that research was done on 107 different commodities. Many of these received very little attention both in terms of research time and in terms of costs. Of 107 crops, 72 received less than 10 per cent of a person–year as staff time input, indicating probably a fragmentation of the programme and an absence of critical mass. For managers, information of this type can be very useful for setting priorities, structuring programmes and ensuring that the resources used on a particular commodity are sufficient to offer prospects of success.

INFORM can also be used to provide information on agricultural research expenditure as a proportion of agricultural gross domestic product (the agricultural research intensity ratio). The World Bank first suggested, in its 1981 Sectoral Policy Paper, that a desirable overall level of expenditure on agricultural research would be 2 per cent of the value of the agricultural gross domestic product (Ag.GDP). But in practice, few developing countries have been able to exceed an aggregate figure of about 0.5 per cent. The data collected for the present analysis indicate that in Sri Lanka the percentage for 1989 was 0.39 per cent overall.

This overall figure disguises big differences between commodities. Sugar has the highest figure, with more than 2 per cent of its contribution to the agricultural GDP invested in research. This reflects government policy to increase the current low level of production to reduce the high cost of imports. In the case of rubber, 1.19 per cent of the value contributed by the crop to the Ag.GDP is ploughed back into research. For tea and coconut, the equivalent figure is 0.5 per cent; for food crops, 0.35 per cent, for rice, livestock and fisheries, 0.25 per cent. Research expenditures by commodity can also be used to calculate 'congruence ratios'. These divide the percentage share of each commodity in total research expenditure by the percentage contribution of that commodity to Ag.GDP. These 'congruence ratios' provide decision makers with information on relative, implicit priorities among commodities and research areas. This information is a starting point for a discussion on changing resource allocations.

INFORM also allows decision-makers to compare actual resource allocation with established research priorities. The Sri Lanka data showed that resource allocation was mostly in line with CARP priorities for the four major commodities: rice, rubber, tea and coconut. Divergences from espoused priorities were found in the case of some crops that received considerable donor support and crops that appear to have potential but are currently neglected (Figure 2).

A different type of information relates to the use of the budget by functional categories. This would include salaries for researchers and different categories of support staff and operational costs. In Sri Lanka, salaries, wages and benefits accounted for more than 64 per cent of the national agricultural research budget for the system as a whole. For food crop institutes in the Ministries of Agriculture and Fisheries, the average was 81 per cent. For plantation crops research, the institutes personnel expenses were only 48 per cent of the total budget (Figure 3).

The high proportion of total budgets used for personnel at many institutes severely restricted the share of funding available for other purposes. In this context, there was a very sharp contrast between the food crop research institutes and the plantation crop institutes. Figure 3 shows the budget per scientist for each of the institutes. Highest funding per scientist is at the Coconut Research Institute, the Rubber Research Institute, the Sugar Research Institute and the Tea Research Institute. The contrast is particularly sharp in terms of operational (non-personnel) budgets, where the plantation crops institutes had eight times as much funding per scientist as did the food crop research institutes in the Department of Agriculture (DOA). Salaries in the former group are also significantly higher.

This information raises questions on the structure of funding of the system, on the structure of expenditures between personnel and operating costs and on the allocation of system resources among system objectives.

National-level research managers require information on human resources, indicat-

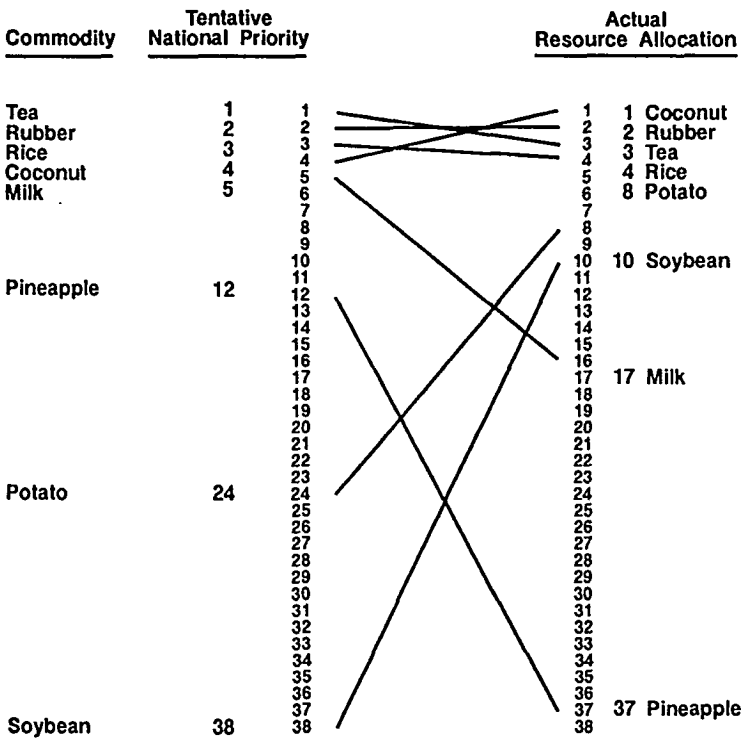

Figure 2. A comparison of the ranking of actual resource allocations for research with tentative national priorities in a NARS. Only eight of 45 commodities are shown. Source: Nestel (1991a) p 32.

ing the number of staff by sex, age, degree and discipline or specialization. This information is used for national manpower planning and human resources development. In addition INFORM provides information on the deployment of personnel: staff time allocated to research, administration, extension and training.

As a final example, INFORM can be used to trace specific research activities at different institutes through the use of keywords, for instance to find the cost of all research projects dealing with biological nitrogen fixation.

Research institute directors

Institute directors, whose support is critical in collecting information, may use much of the information presented above at the level of the individual institute. The information included in a national consolidated database also presents institute directors with the possibility of comparing the characteristics and performance of their institute with those of others. A few examples are presented in the following paragraphs.

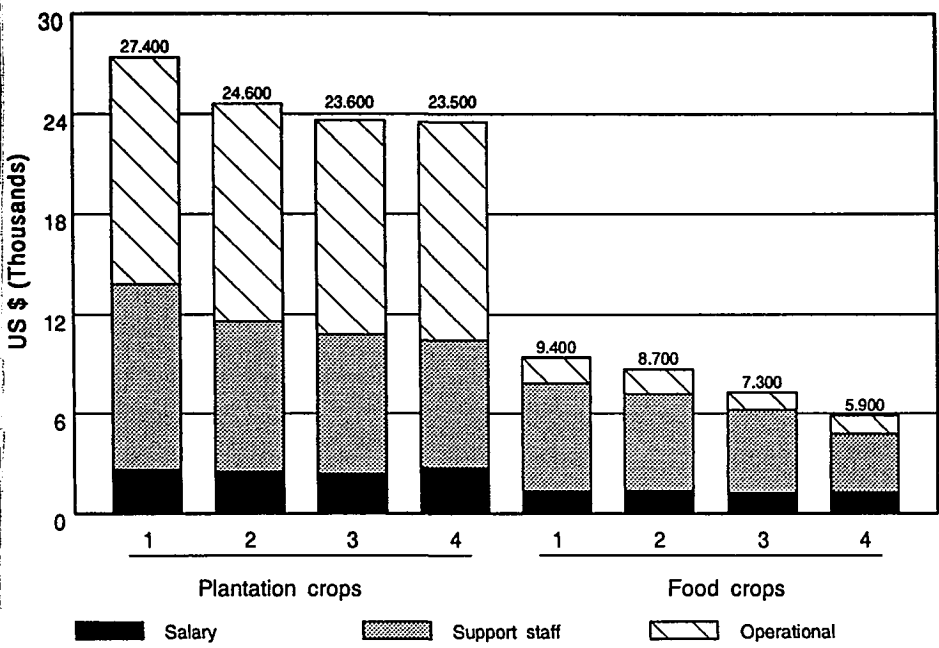

Figure 3. Annual budget per scientist for four plantation crop and four food crop research institutes in Sri Lanka 1989. Source: Nestel (1991a) p 21

A human resources profile for the institution with data on age, sex and qualifications provides essential information on recruitment, retirement, career development and training. Detailed information on personnel activities is essential for human resource management. Tables and forms are produced with information on each of the professional staff: involvement in research and non-research activities, teamwork and multidisciplinary work. This provides the director with essential data for, amongst others, personnel assessment.

Data on resource allocation to commodities, themes, disciplines and regions may help answer the question of whether resource allocation is in line with the institute's mandate. Information can be included in the system to show progress in the implementation of research activities. This will provide a basis for monitoring and evaluation.

Researchers and programme-leaders

At the programme or department level the system can be used in the process of research programme formulation. Current time allocation to projects can be evaluated and changes can be planned and entered in the database. Researchers can use keywords to search the database and find out what types of research projects are being conducted at other institutes.

Issues and implications

In the course of developing and field testing INFORM, a number of issues have arisen that have implications for future work in this area. One issue relates to *terminology*. Initially, INFORM work was referred to as MIS work or information systems work. In both cases the word 'information' has presented problems. Because 'information' was in the title, and because computers were involved, some users thought INFORM belonged in the computer department. For other users, the term information sounded more like an activity for the library, or for the information and documentation department. Sometimes INFORM has been put with statistics, because numbers are involved. A specific effort was needed to make users understand that INFORM is a management tool.

This brings us to a second issue, the *institutional 'home'* for INFORM. Where should INFORM best be placed and who should have main responsibility for it? Preferably not the computer department or the library. Probably the best place for a management tool such as INFORM is the office of the director. Alternatively, if there is a planning unit or a monitoring and evaluation unit at the institute, these would be appropriate homes for INFORM as well.

Another issue relates to *flexibility*. Starting small and developing the system in a pragmatic manner is important. For instance, if it turns out to be difficult to gather and analyse detailed financial information in the early stages of the process, researchers' time allocation may be used as a proxy for resource allocation. In subsequent rounds more details on the costs of inputs and overheads may be added. A modular approach is appropriate for system development.

Flexibility relates also to the issue of whether INFORM should be implemented in *centralized or decentralized* fashion (top-down or bottom-up). A bottom-up approach starting at the individual institute level is necessary to obtain the support of institute directors; without this it is unlikely that good data can be collected. A potential problem is that different institutes may do things their way. As a result information from different institutes is no longer comparable and cannot be aggregated into a consolidated database. A centralized system has the advantage of providing consistency and comparability more easily. On balance, it is possible to use individual institute work as the basis of the system, but coordination to ensure comparability is essential.

Choice of software is an issue that has stimulated much discussion. ISNAR has used a flexible, easy-to-learn and-use software package. This has been important to introduce the system to the non-computer specialist. It also allows flexibility as the user can easily add or change data. Programmable, relational databases, on the other hand, have the option of providing menus to help the user and may have data validation and protection features to keep the novice user out of trouble. A pragmatic approach is required, especially as software is becoming more user-friendly.

Training is important and experience has shown that a single 2-week training course is not sufficient. Participants in such events usually have to learn a variety of concepts and skills. For many participants, management and finance are new areas. Also, many have not used a personal computer before. Immediate follow-up is therefore necessary to ensure application and institutionalization.

Experience with training has also shown that it is important to distinguish two target groups: 'doers' and 'users'. The first group comprise middle-level staff to be

involved with data collection, inputting to the computer and producing reports, tables and graphs for use by the second group, which is composed of directors and senior managers. It is very useful to have a separate, short workshop for users to convey an understanding of what the system is about and what it can do. Involvement of senior managers is also important as the system needs a number of 'patrons' in the NARS: people with authority who support using this type of system.

Whether INFORM should be viewed as *a tool or a process* is an important question. It is a tool in that it specifies what types of information must be collected. It provides a format for calculating different types of output and it organizes the output in convenient forms for analytical purposes. It is a process in that in application it forces the user to deal with how to collect the information and how to use it for performing different management functions. The development of a generic tool with fairly wide adaptability can only take place in a real situation where organizational structure and institutional processes such as planning, budgeting, monitoring and evaluation have to be taken into account.

The *institutionalization* of INFORM, or of any management information system, requires more than learning a tool. To realize its potential, the system needs to be tightly integrated into a research institute's management and planning processes. This requires considerable investment by researchers as well as managers. Better information is essential for improved institutional processes and better decision-making. In this way INFORM can contribute to making national agricultural research more effective and efficient.

REFERENCES

Caiden, N. (1988). 'Budgeting in developing countries: a review of recent literature', *International Journal of Public Administration*, **11**(3). 251–269.

Corbett, D. C. M. (1989). 'A current research information system for the management of agricultural research', *R&D Management*, **19**(3). 251–263.

Esman, M. J. (1988). The maturing of development administration', *Public Administration and Development*, **8**. 125–134.

Gijsbers, G. (1991). *Methods and Procedures for the Development of INFORM*. INFORM Guidelines Part 2, International Research for National Agricultural Research, The Hague.

Mook, B. (1988). *Management Information Systems*, Mimeographed document, International Service for National Agricultural Research, The Hague.

Nestel, B. (1991a). *An Overview of INFORM*, INFORM Guidelines Part 1, International Service for National Agricultural Research, The Hague.

Nestel, B. (1991b). *Revenue and Cost Codes for INFORM*, INFORM Guidelines Part 3, International Service for National Agricultural Research, The Hague.

Nestel, B. (1991c). *A Minithesaurus of Keywords for Use with INFORM*, INFORM Guidelines Part 4, International Service for National Agricultural Research, The Hague.

Pardey, P. G., Roseboom, J. and Anderson, J. R. (1991). *Agricultural Research Policy: International Quantitative Perspectives*, Cambridge University Press, Cambridge.

Schick, A. (1971). 'The road to PPB: the stages of budget reform', In Fishel, W. L. (ed.), *Resource Allocation in Agricultural Research*, University of Minnesota Press, Minneapolis, pp. 261–288.

Siffin, W. J. (1976). 'Two decades of public administration in developing countries', *Public Administration Review*, 6. 61–71.

Sumner, N. R. and Curtis, A. A. (1988). *REMISS: Research Management Information System*, CSIRO Division of Land and Water Resources, Canberra, Australia.