SUBJECT: INFORMATION SYSTEMS PROJECT MANAGEMENT

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Information is a *critical resource* in the operation and management of organizations. Timely availability of relevant information is vital for effective performance of managerial functions such as planning, organizing, leading, and control. An information system in an organization is like the nervous system in the human body: it is the link that connects all the organization's components together and provides for better operation and survival in a competitive environment. Indeed, today's organizations run on information.

The term *information system* usually refers to a computer-based system, one that is designed to support the operations, management, and decision functions of an organization. Information systems in organizations thus provide information support for decision makers. Information systems encompass transaction processing systems, management information systems, decision support systems, and strategic information systems.

Information consists of data that have been processed and are meaningful to a user. A system is a set of components that operate together to achieve a common purpose. Thus a management information system collects, transmits, processes, and stores data on an organization's resources, programmes, and

accomplishments. The system makes possible the conversion of these data into management information for use by decision makers within the organization. A management information system, therefore, produces information that supports the management functions of an organization (Davis & Olson, 1985; Lucas, 1990; McLeod, 1995).

Basic concepts

Data versus Information

Data refers to raw, unevaluated facts, figures, symbols, objects, events, etc. Data may be a collection of facts lying in storage, like a telephone directory or census records.

Information is data that have been put into a meaningful and useful context and communicated to a recipient who uses it to make decisions. Information involves the communication and reception of intelligence or knowledge. It appraises and notifies, surprises and stimulates, reduces uncertainty, reveals additional alternatives or helps eliminate irrelevant or poor ones, and influences individuals and stimulates them to action. An element of data may constitute information in a specific context; for example, when you want to contact your friend, his or her telephone number is a piece of information; otherwise, it is just one element of data in the telephone directory.

Computers have made the processing function much easier. Large quantities of data can be processed quickly through computers aiding in the conversion of data to information. Raw data enter the system and are transformed into the system's output, that is, information to support managers in their decision making.

Characteristics of Information

The characteristics of good information are relevance, timeliness, accuracy, cost-effectiveness, reliability, usability, exhaustiveness, and aggregation level. Information is relevant if it leads to improved decision making. It might also be relevant if it reaffirms a previous decision. If it does not have anything to do with your problem, it is irrelevant. For example, information about the weather conditions in Paris in January is relevant if you are considering a visit to Paris in January. Otherwise, the information is not relevant.

Timeliness refers to the currency of the information presented to the users. Currency of data or information is the time gap between the occurrence of an event in the field until its presentation to the user (decision maker). When this

amount of time is very short, we describe the information system as a *real-time* system.

Accuracy is measured by comparing the data to *actual* events. The importance of accurate data varies with the type of decisions that need to be made. Payroll information must be exact. Approximations simply will not suffice. However, a general estimate of how much staff time was devoted to a particular activity may be all that is needed.

Value of Information

Information has a great impact on decision making, and hence its *value is* closely tied to the decisions that result from its use. Information does not have an absolute universal value. Its value is related to those who use it, when it is used, and in what situation it is used. In this sense, information is similar to other commodities. For example, the value of a glass of water is different for someone who has lost his way in Arctic glaciers than it is to a wanderer in the Sahara Desert.

Economists distinguish value from *cost* or *price* of a commodity incurred to produce or procure the commodity. Obviously, the value of a product must be higher than its cost or price for it to be *cost-effective*.

The concept of *normative value* of information has been developed by economists and statisticians and is derived from decision theory. The basic premise of the theory is that we always have some preliminary knowledge about the occurrence of events that are relevant to our decisions. Additional information might modify our view of the occurrence probabilities and consequently change our decision and the expected payoff from the decision. The value of additional information is, hence, the difference in expected payoff obtained by reduced uncertainty about the future event.

Information supports decisions, decisions trigger actions, and actions affect the achievements or performance of the organization. If we can measure the differences in performance, we can trace the impact of information, provided that the measurements are carefully performed, the relationships among variables are well defined, and possible effects of irrelevant factors are isolated. The measured difference in performance due to informational factors is called the *realistic value* or *revealed value* of information.

For most information systems, particularly those supporting middle and top management, the resulting decisions often relate to events that are not strictly defined and involve probabilities that cannot be quantified. The decision-making process often is obscure and the outcomes are scaled by multiple and

incomparable dimensions. In such cases, we may either attempt to perform a multiattribute analysis or derive an overall *subjective value*. The *subjective value* reflects people's comprehensive impression of information and the amount they are willing to pay for specific information (Ahituv, Neumann, & Riley, 1994).

Information as an Aid to Decision Making

Simon (1977) describes the process of decision making as comprising four steps: intelligence, design, choice, and review. The *intelligence* stage encompasses collection, classification, processing, and presentation of data relating to the organization and its environment. This is necessary to identify situations calling for decision. During the*decision* stage, the decision maker outlines alternative solutions, each of which involves a set of actions to be taken. The data gathered during the intelligence stage are now used by statistical and other models to forecast possible outcomes for each alternative. Each alternative can also be examined for technological, behavioural, and economic feasibility. In the *choice* stage, the decision maker must select one of the alternatives that will best contribute to the goals of the organization. Past choices can be subjected to *review* during implementation and monitoring to enable the manager to learn from mistakes. Information plays an important role in all four stages of the decision process. Figure 1 indicates the information requirement at each stage, along with the functions performed at each stage and the feedback loops between stages.

Classification of Management Information Systems

There are various types of management information systems. Mason and Swanson (1981) describe four categories of management information systems: (1) databank information system, (2) predictive information system, (3) decision-making information system, and (4) decision-taking information system. The classification is based on the level of support that the information system provides in the process of decision making. Sachdeva (1990) comprehensively presents these four types of systems:

Databank Information System. The responsibility of this information system is to observe, classify, and store any item of data which might be potentially useful to the decision maker. Examples of the kind of data that might be recorded in such a database for a given village, region, or area are as follows:

- Number of farms
- Number of units of arable land (hectares, fedans, acres)
- Average farm size

 Amounts of selected farm inputs applied annually
 Production per year on a unit of land for selected crops

A second example of data that might be recorded in a database (this time involving data internal to the organization) is as follows:

 Number of extension staff by category and assigned to a particular village, region, or area

 Number of work hours devoted by staff to selected concerns for a particular village, region, or area

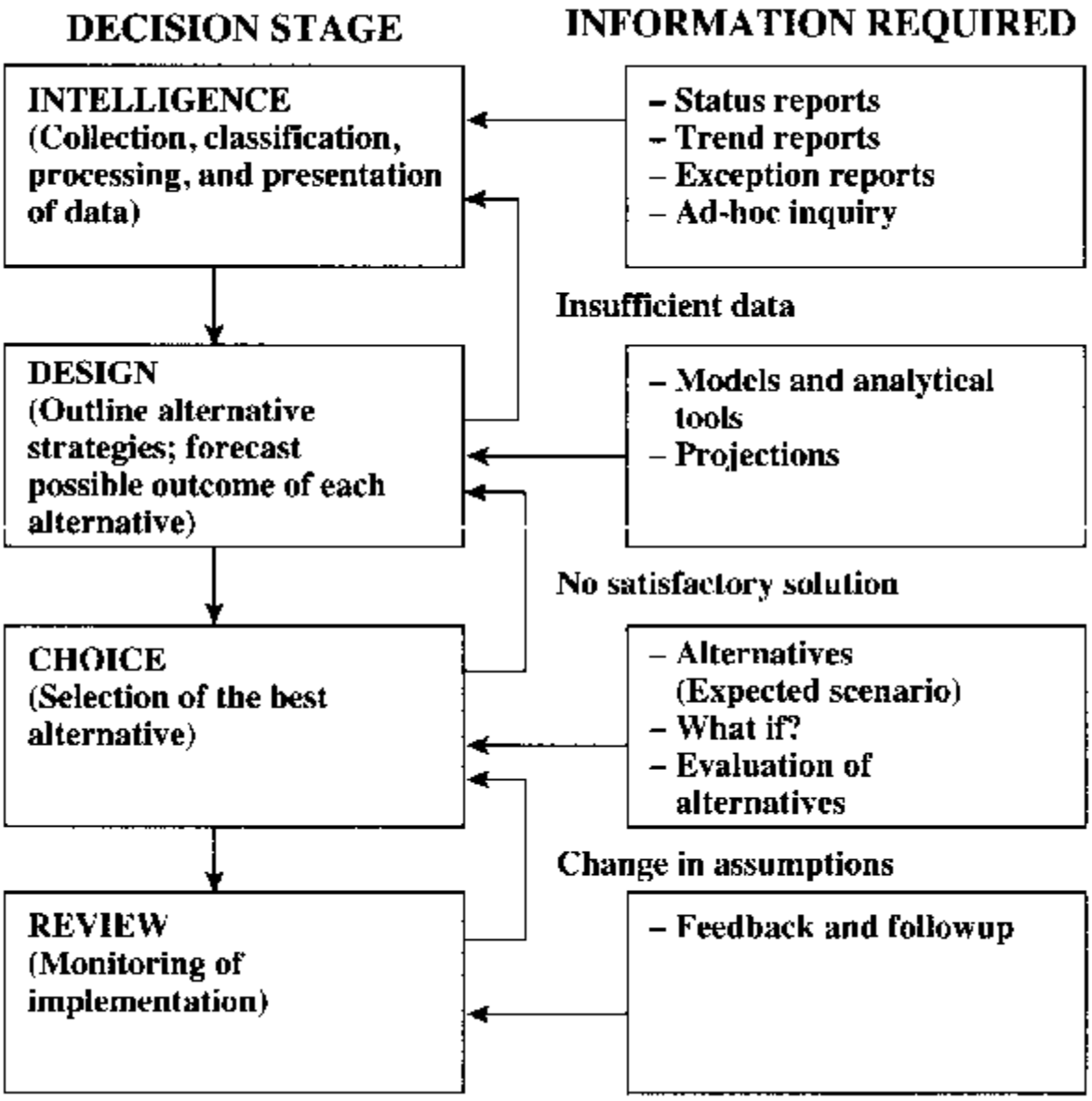
 Total extension salary costs and other expenses by village, region, or area

 Number of demonstrations conducted for selected farm technologies by village, region, or area

 Number of on-farm trials conducted for selected farm technologies by region or area

 Number of radio, TV, and print media releases regarding selected farm technologies by time period and region or area

Figure 1. Role of information in the decision process.



Each of these databases can be summarized and converted to single tabular presentations of information of interest to management. When information from two or more time periods is compared, trends can be observed.

Predictive Information System. This system moves beyond pure data collection and the determination of trends over time. Predictive information systems provide for the drawing of inferences and predictions that are relevant to decision making. If data from the above examples were to be used in this way, it is possible to obtain information useful for making predictions or for drawing inferences. For example, tables containing the following information for a given village, region, or area might be produced:

 The ratio between the number of farms and the various categories of extension staff members

 The ratio between the amount of farmland and the various categories of extension staff members

 Amount of extension financial operating resources allocated per year to selected farmer problems or concerns

 Amount of extension financial resources, both salary and operating expenses, allocated per year to selected extension approaches to solving different farmer problems or concerns

Information obtained from these kinds of analyses is normally summarized in a two-way tabular format. And likewise, the information often is compared over time. Managers can then use such information to make predictions, for example to forecast costs of particular undertakings for budgeting purposes or as a basis for predicting results if a given change is made, such as change in the number of demonstrations with a given change in staffing.

Decision-Making Information System. This system goes one step further in the process of decision making and incorporates the value system of the organization or its criteria for choosing among alternatives. An extension organization's values are many and varied. They include concerns for resolving farmer problems, increasing and providing for stability of farmer incomes, and improving the quality of farm life. But they also including and providing for stability of farmer incomes, and improving the quality of farm life. But they also include an intent to provide well for staff members (training, adequate salaries, etc.) and to aid in the process of bringing about rural economic development.

Table 1. Information Groups in India's Agricultural Extension System.

Levels	Groups	Types of Information Needed
Central	Extension commissioner, joint commissioners, directors, joint directors, etc. of the directorate of extension, ministry of agriculture	(1) Information on human resources, plans, and budgets for various extension services (2) Statewide monitoring and evaluation of activities completed
State	Director of agriculture, additional director, joint directors, etc. of the state department of agriculture	(1) Districtwide information on extension programmes, activities, expenditures, etc (2) Research-extension linkages and coordination with other allied

		departments such as animal husbandry and horticulture
District	District agricultural officers (DAOs)	(1) Information on extension resources and constraints at subdivision and block levels (2) Training requirements of staff at subdivision and block levels
Subdivision	Subdivisional agricultural officers	(1) Field demonstration programmes, activities planned and implemented by subject-matter specialists (SMSs) (zone) at the block level (2) Technical programme and constraints identified at the block level
Block (county)	Agricultural extension officers	(1) Performance of VEWs in terms of achievements in extension activities (2) Field-level problem of assessment of beneficiaries' response to various extension programmes

Information regarding these various attributes helps managers to make more enlightened decisions. Examples of ways that an extension organization uses information from a decision-making information system are as follows:

 Change in specific farm outputs (yields, practices) following selected extension activities

 Change in staff productivity following selected interventions (in-service training, better transport, etc)

 Comparison of relative costs and relative effectiveness of alternative extension delivery methods

 Analysis of economic returns to farmers who adopt recommended practices as compared to those who do not

Decision-Taking Information System. Examples of decision-taking information systems are not usually found in an extension organization. This is a decision

system in which the information system and the decision maker are one and the same. Management is so confident in the assumptions incorporated in the system that it basically relegates its power to initiate action to the system itself. Airplanes carry automatic pilot systems, which are an example of a decision-taking system. Once activated, the system itself keeps the plane on course and at the proper speed and altitude (according to parameters determined by the pilot). Another example of decision-taking information systems is found in modem factory production. In automobile production, continuous inventories of parts are maintained by computer as cars move down an assembly line. Orders are placed automatically by the computer when additional parts are needed. This is done without the intervention of a manager.

The choice of an appropriate management information system (MIS) category primarily depends on the nature of the decisions it supports. While unstructured decisions may use MIS-category (I), the highly structured ones, such as production schedules in an industry, may use MIS-category (iv). Further, Banerjee and Sachdeva (1995) observe that "as the deep structure of the decision problem becomes more and more understood, we may move to higher level of MIS i.e., from MIS-category (I) to MIS-category (ii); and MIS-category (ii) to MIS-category (iii); and so on."

Role of MIS in the management of agricultural extension programmes

National agricultural extension systems, especially in developing countries, tend to be very large. For example, in India, the national agricultural extension system employs about 125,000 people. Extension managers at various levels need relevant information in order to make effective decisions. In the absence of such information, they act only on the basis of their intuition and past experience. Data that have been processed, stored, and presented properly will aid them in analysing situations and to make effective decisions.

As suggested above, at every phase of the management process, managers need information in order to make effective decisions. This we call *management information*.It does not include purely functional information or technical information, such as packages of practices for rice or wheat cultivation. Management information is the information required by managers as they make their decisions, such as the number of extension personnel employed by category, their training requirements, career development plans, job descriptions, budgets, forecasts, benchmark surveys, reports on socioeconomic conditions of people served, and existing facilities (Ramesh Babu & Singh, 1987).

The main purpose of management information systems is to provide management information to decision makers at various levels in the

organization. Specifically, in an agricultural extension organization, MIS is needed:

1. To plan the most effective allocation of resources, for example, the allocation of extension personnel under a T & V extension system, the need for communications and training equipment and facilities, mobility, the amounts of required operational resources

2. To choose between alternative courses of action, whether to conduct a study on the impact of the T & V system with the resources on hand or hire an expert to investigate

3. To control day-to-day operations, for example, comparing the actual results achieved and those planned under the T & V system.

Design of a MIS in an agricultural extension organization

The following are suggested steps to follow when designing a MIS for a national agricultural extension system.

Step One: Assessing Information Needs for Planning, Monitoring, and Evaluation

An investigation needs to be conducted into the types of decisions that extension managers have to make. For example, village extension workers (VEWs) seek solutions to their problems from their supervisors. In turn, supervisors need to be in a position to resolve these problems and to document how problems were solved for future reference.

State-level managers also need information to resolve problems. They are concerned with implementing extension programmes district by district. They need information on staffing, transport, research-extension linkages, staff training activities, and successes (or lack of them) in solving technical problems. Feedback is needed from field staff and farmers on farmer problems and on which recommended practices are helpful. State-level managers need to know something about the amounts, kinds, and combinations of media support (i.e., print, radio, television) that have been used for various efforts. They need to know if external factors have limited the success of particular efforts such as supply of credit or farm inputs and they need some assessment of farmers' responses to extension programmes (Raheja & Jai Krishna, 1991, p. 84).

Step Two: Deciding the Levels of Information Groups, Information Frequency, and Content

The number of information groups within an agricultural extension organization has to be decided because each group potentially will require a different type of information. As an example, in India, the reorganized national agricultural extension system can be grouped as shown in Table 1.

Data processing consists of identifying each item of data and systematically placing it within a scheme that categorizes data items on the basis of some common characteristic or feature. Data not organized into a meaningful pattern can serve almost no useful purpose to those who must use them to make decisions. A computer can help in processing the data effectively. Rao (1985) suggested the use of computers in agricultural extension in India. He proposed that computer programmes be focused on district and subdivisional levels. In that way, information collected can be viewed in terms of the crops that are likely to be grown, agroclimatic conditions, soil types, irrigation facilities, resources of the farmers, and availability of various farm inputs.

Documentation (storage and retrieval) involves storing items of information in an orderly manner. Storing information means recording it on storage media from which it can be made available when needed.

Storage media are materials such as ordinary office paper, magnetic tapes, magnetic disks, microfilms, film strips, and a few other devices. Once the information is recorded on these storage media, the system can generate, on demand, information required for making decisions, solving problems, or performing analyses and computations. Information retrieval refers to the ability to take different types of data in the storage media and to array information in some desired and meaningful format. A properly designed storage and retrieval system matches the related variables efficiently and accurately. In some cases, it even suggests alternative courses of action for management to take.

Presentation of information should be in a form and format suitable to the needs of extension managers. Generally, information is presented in reports, statistical summaries, analyses, and so forth in the form of text, figures, charts, tables, and graphs. The presentation of information should be precise, clear, and appealing.

Step Three: Ensuring System Flexibility and Adaptability

Flexibility means the ability to retrieve information from a system in whatever form it may be needed by decision makers. Therefore, data need to be collected in some detail so that they can be rearranged or summarized according to the needs of managers. But system design should not be too complex because it must first serve the needs of the lowest levels of management (i.e., subdistrict) that are likely to be instrumental in collecting important components of the original data. In addition, the system also must

serve the needs of the district, regional, state or provincial, and national levels. Therefore, considerable care must be taken in assessing what types of information are required by management at the different levels. At the same time, effort must be made to ensure that the information collected meets acceptable standards of accuracy, timeliness, and coverage for each level.

Need for automation

An automated MIS system contains data just as a manual system does. It receives input, processes input, and delivers the processed input as output. Some input devices allow direct human-machine communication, while others require data to be recorded on an input medium such as a magnetizable material (specially coated plastic flexible or *floppy* disks and magnetic tapes). The keyboard of a workstation connected directly to a computer is an example of a direct input device. Use of automation makes it possible to store immense quantities of information, to avoid many of the errors that find their way into manual records, and to make calculations and comparisons that would be practically impossible in a manual system.

Organization of a database

Data are usually generated at the field level through transaction-processing systems, but once the data are captured, any echelon along the organizational hierarchy may use them, provided that information requirements have been well defined, appropriate programmes have been implemented, and a means has been arranged for the sharing of the data. This would imply that the same data can be used by different sets of programmes; hence we distinguish between the database (a set of data) and the applications (a set of programmes). In a decision support system (DSS), this set of programmes is the *model base* (Keen & Morton, 1978).

The term *database* may refer to any collection of data that might serve an organizational unit. A database on a given subject is a collection of data on that subject that observes three criteria: comprehensiveness (completeness), nonredundancy, and appropriate structure. Comprehensiveness means that all the data about the subject are actually present in the database. Nonredundancy means that each individual piece of data exists only once in the database. Appropriate structure means that the data are stored in such a way as to minimize the cost of expected processing and storage (Awad & Gotterer, 1992).

The idea of a large corporate database that can be flexibly shared by several applications or model bases has been realized by means of software packages specially devised to perform such tasks. These packages, called *database*

management systems (DBMSs), are available in the market under different trade names such as ORACLE, SYBASE, INGRES, FOXBASE, and dBASE.

Networking and interactive processing

The two principal blocks that facilitate development and use of MIS are DBMS and *telecommunications.* The former makes data integration possible, while the latter brings information closer to the end users, who constitute nodes in a telecommunication network. The notion of telecommunications implies that some geographical distance exists between the computer site and the users' locations and that data are electronically transmitted between them. Remote applications may be executed between two floors in the same building, two offices in the same city, two offices on the same continent, or two places on opposite sides of the globe (Martin, 1990).

System alternatives and evaluation: Centralization versus decentralization

A completely centralized information system handles all processing at a single computer site, maintains a single central database, has centralized development of applications, provides central technical services, sets development priorities centrally, and allocates computer resources centrally. The system's remote users are served by transporting input and output data physically or electronically.

A completely decentralized system may have no central control of system development, no communication links among autonomous computing units, and stand-alone processors and databases at various sites. Each unit funds its own information-processing activities and is totally responsible for all development and operation.

An advantage of centralized information systems is that they provide for standardization in the collection of data and the release of information. There also are some*economies of scale. A* centralized system reduces the need for multiple hardware, software, space, personnel, and databases. It may be possible to recruit more qualified personnel in a central facility.

Observations indicate that user motivation and satisfaction are increased under a decentralized environment. This is attained because users feel more involved and more responsible, systems are better customized to their specific needs, and they usually get better response time in routine operations as well as in requests for changes.

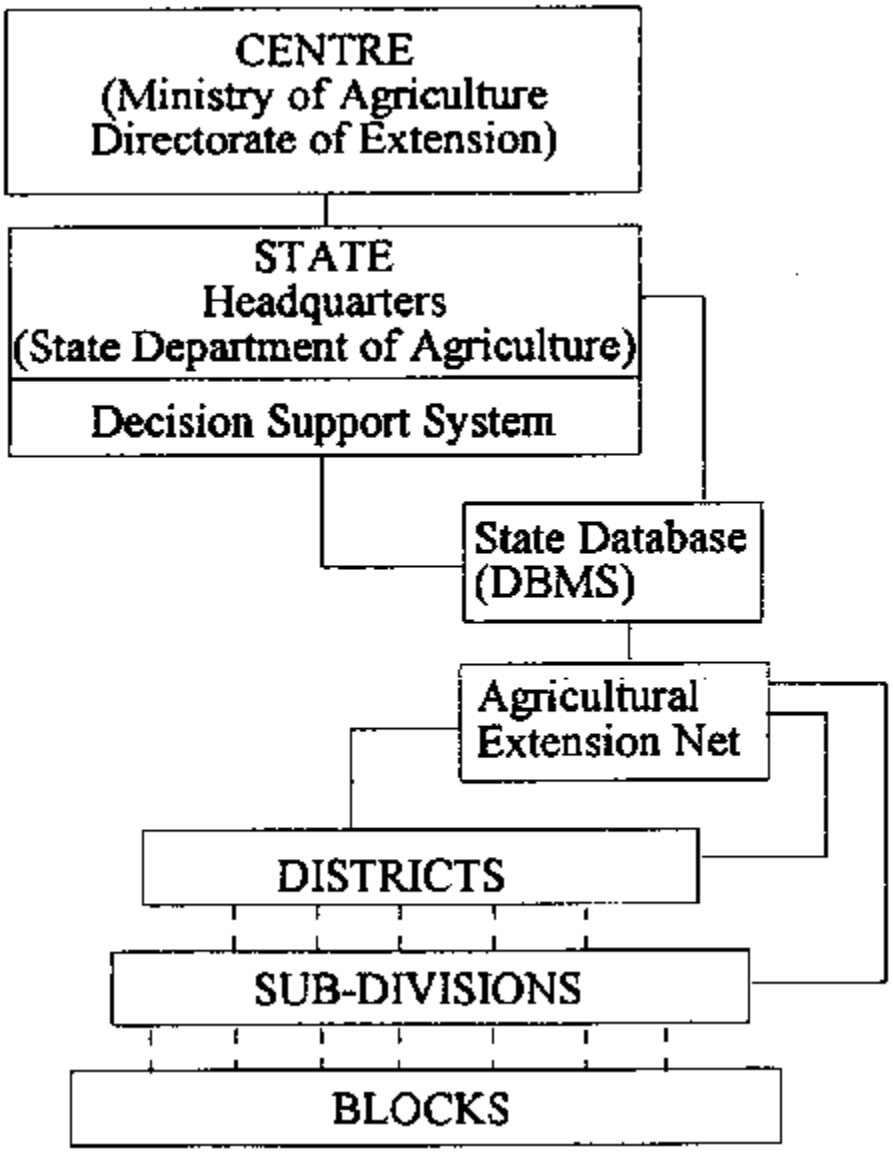
It is likely that for national agricultural extension systems, neither a completely centralized nor a completely decentralized system is desirable. While it may be

useful to decentralize hardware and software resources at different locations, the development of applications and provision of technical services may better be centralized.

End-user computing

The widespread use of personal computers and computer-based workstations has brought with it the age of end-user computing. End-user computing is a generic term for any information-processing activity performed by direct end users who actually use terminals or microcomputers to access data and programmes. The manager as end user may be provided with powerful software (like DBMS) for accessing data, developing models, and performing information processing directly. This has brought computing directly under the control of the end users and eliminates their dependence on the information systems specialist and the rigidities of predesigned procedures. They may now make ad hoc queries of information and analyse it in various ways. They may write programmes, or may often use ready-made programmes stored in the computer, using the computing power of a local PC or the mainframe to which it is connected.

Figure 2. A typical MIS for a national extension system.



Illustrative computer-based MIS

A national agricultural extension system is a nationwide system managed by the national government. In India, agriculture is a state subject under the division of powers between the national and the state levels. Nevertheless, the national government supplements the financial resources of the states and provides coordination at the national level. The state's administrative machinery is divided into districts, districts into subdivisions, subdivisions into blocks. A block is a group of villages and the basic unit for the administration of an agricultural extension programme. Data collected at the block level need to be integrated at higher administrative levels to provide an integrated view at the district and state levels to support planning, monitoring, and decision making.

Keeping in view the requirements of the extension system and the budget constraints of the states, a typical design of the computer-based MIS is shown in Figure 2.

However, the actual design may vary with the size of the state and other considerations. An integrated database for the entire state may be supported by a mainframe/minicomputer at the state headquarters. Suitable programmes for the analysis of data may be designed to provide an interactive decision support system at the state level. Each district and subdivision may be provided with a mini/micro computer, depending on the volume of data to be handled. The computers in the districts and subdivisions may be networked with the state computer. The local data may be stored and processed in the district/subdivision, and the shared data with appropriate level of aggregation may be transmitted to the state headquarters to update the integrated database. The districts and subdivisions would have direct access to the integrated database with proper authorizations assigned to them through their passwords. The blocks may have only the input-output terminals connected to the subdivision computer to feed data to the subdivision and make on-line inquiries as and when necessary.

Summary

In this chapter, we have defined and described the basic concepts of a management information system. The characteristics of good information, namely, relevance, timeliness, accuracy, cost-effectiveness, reliability, usability, exhaustiveness, and aggregation level, have been described. The role of information systems in the process of decision making and the value of information have been explained. Four types of MIS, namely, databank information system, predictive information system, decision-making information system, and decisiontaking information system, have been presented. The role of MIS in management of agricultural extension programmes and the conceptual design of a MIS in an agricultural extension organization have been described.

Basic computer concepts have been explained. The advantages and disadvantages of centralized versus decentralized systems have been examined. The need for organizing databases and their integration and the need for programmes for decision analysis to evolve a decision support system have been explained. An assessment of hardware, software, and networking requirements for a typical computer-based MIS for a national agricultural extension system have been illustrated.