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BEIJING, CHINA

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This series includes meeting documents, internal reports, and preliminary technical documents that may later form the basis of a formal publication. A Manuscript Report is given a small distribution to a highly specialized audience.

La présente série est réservée aux documents issus de colloques, aux rapports internes et aux documents techniques susceptibles d'être publiés plus tard dans une série de publications plus soignées. D'un tirage restreint, le rapport manuscrit est destiné à un public très spécialisé.

Esta serie incluye ponencias de reuniones, informes internos y documentos técnicos que pueden posteriormente conformar la base de una publicación formal. El informe recibe distribución limitada entre una audiencia altamente especializada.

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Cybernetic Analysis of Scientific Information Services for Agricultural Development in China

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Abstract

Agricultural science information services often do not produce the response desired by information agencies. Reasons for the failure of the information service are partly problems in the information transfer process by information departments. This article briefly introduces the agricultural science information system in China and suggests that the cybernetic approach may partially settle these problems. The knowledge of systems analysis could sensitize information departments to a variety of factors such as the dynamic nature of the agricultural science information transfer process and the fact that the process is interactive rather than unidirectional. Information departments should often analyze their audience, set clear strategies, regularly and systematically gather feedback and evaluate the impact survey and actively modify future activities to orient information services to users' needs. The application of these theories could increase the effectiveness of agricultural information service in China.

INTRODUCTION

Agriculture is the principal occupation of over four-fifths of China's working people. With only 7.3% of the total arable land area but almost a quarter of the total population in the world, China manages to be nearly self-sufficient in food production.

Since 1978 the most dramatic changes have been in rural areas where a drive to virtual de-collectivization has taken place with profound direct effects on the million rural dwellers. Many of the most striking changes in the countryside have been at the micro-level, especially with the rapid spread of the production responsibility system. This system creates inherent economic incentives and greatly stimulates the producer's enthusiasm. It has also inspired farmers to master more advanced agricultural technology for rural development. Agricultural production has risen by almost 8% annually, and rural incomes have more than doubled since 1981. The proportion of rural poverty has dropped from 31% in 1979 to 6% in 1986. Hunger has essentially been banished (Wittwer, 1987).

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Like most areas of the developing world, China's quantity of land available for agriculture is declining. Although the development of village and township enterprises and rural social services have created employment in various ways, the extent of rural underemployment has become more evident. It was estimated that 32.3% of China's rural work force was in surplus in 1982 (Taylor, 1988). An expanded labor force, given a fixed land supply, is unlikely to yield a substantial increase in production relative to its cost. Thus neither land nor labor increase are likely to boost agricultural production. Most observers turn to technological improvements as the most promising path to agricultural growth.

Changes in material inputs, complementary farming techniques, storage technology, and research, supply, and marketing institutions are all parts of the technological transformations (Hornik, 1988). A continuous stream of new technical knowledge and a flow of industrial inputs in which the new knowledge is embodied represents a necessary condition for modern agricultural development (Hayami and Ruttan, 1971). Agricultural science and technology are playing an increasing role in accelerating economic growth and rural development. From 1970 to 1980 about a 27% increase in total agricultural output is credited to scientific and technological improvement. During the sixth Five-Year Plan, the contribution rate of agricultural innovation to total agricultural increase reached 35% (Lu, 1988). The effective integration of these factors, it is argued, is tied closely to adequate information flow.

Agricultural research institutions and universities are major information sources of agricultural science and technology. These institutions produce and disseminate research findings to researchers, extension workers and farmers. Although the production responsibility system has greatly inspired the demand for information about the utility of research findings from these institutions, little attention has been given to examine and analyze the scientific information service for agricultural development. This paper will first introduce China's agricultural science information system, then analyze the information service by the cybernetic approach, and finally discuss improvement options.

AGRICULTURAL SCIENCE INFORMATION SYSTEM AND ITS SERVICE

The agricultural science information system in China is established according to the agricultural research system. Beginning in 1957, the information system has now developed into a relatively complete and multi-level network. The system consists of the Scientech Documentation and Information Centre of the Chinese Academy of Agricultural Sciences (CAAS), which acts as a national agricultural science information centre, information departments of affiliated institutions of the Ministry of Agriculture, information institutes or departments of provincial academies of agricultural sciences, information departments of research institutes under CAAS and the Chinese Academy of Fishery Sciences (CAFS) and of agricultural universities and colleges, and agricultural information stations (offices) at prefecture and county level (Figure 1).

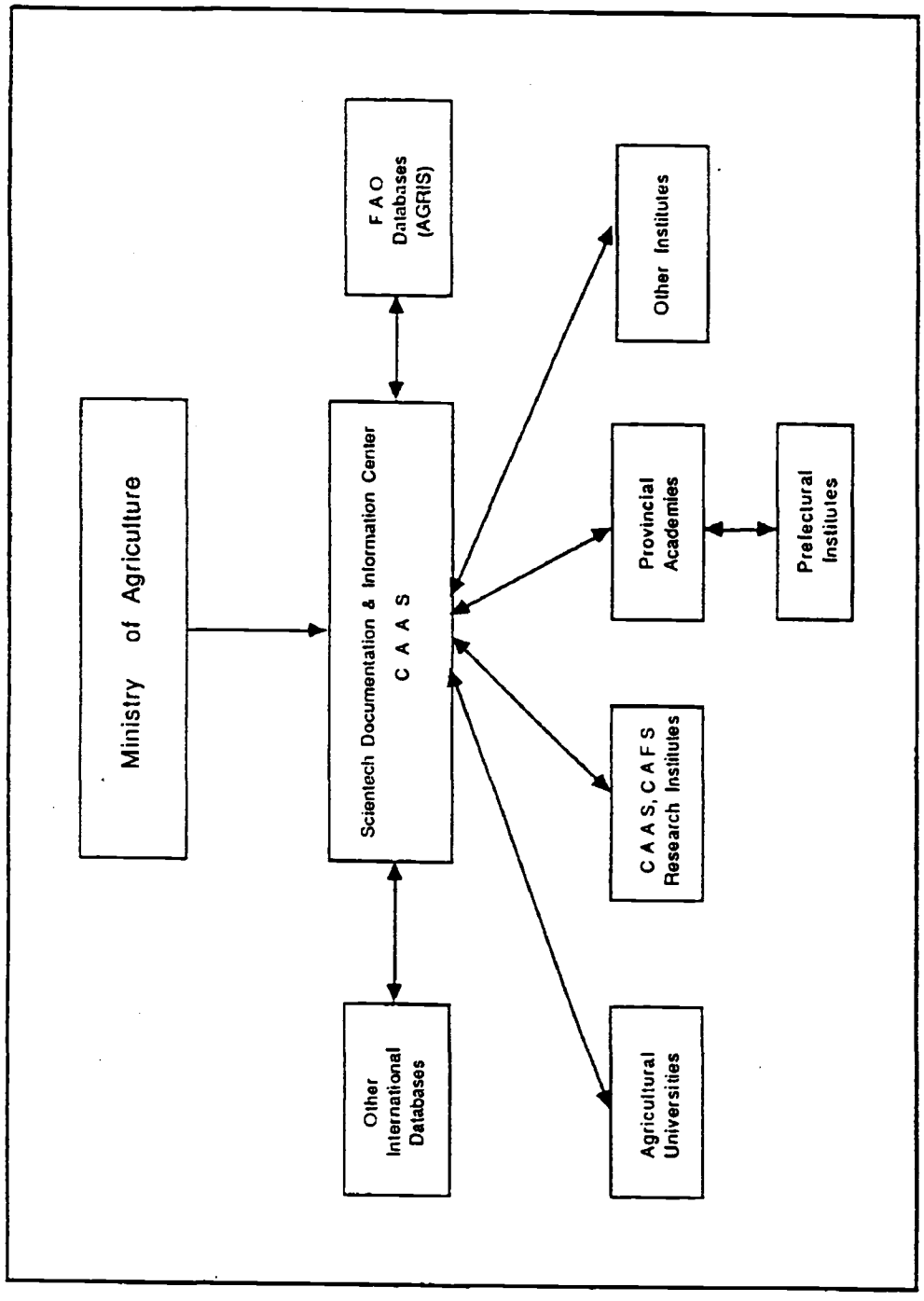

Figure 1 Organizational Setup of Agricultural Science Information System in China

These information departments have functioned well at different levels. The Scientech Documentation and Information Centre (formerly the Scientech Information Institute) of CAAS has made great achievements in organizing and coordinating the national activities on agricultural scientific information, in analyzing the development and progress of agricultural science and technology and production at home and abroad, in special subject information research on strategies for agricultural development, in providing information for key research projects and administrative decision making, in training information specialists, and in information exchange with foreign institutions. Information departments of research institutes under CAAS and CAFS, and provincial academies have established many documentation collection and information services with specialty and locality characteristics. Focusing on strategies for agricultural development and key research projects in local areas and research fields, they have actively provided quality information service. Information departments of agricultural universities and colleges serve teaching, research and technology extension, and translate and produce information materials.

Besides, agricultural scientific information networks have been established in different research fields, disciplines and levels. The networks have effectively organized technical communication, promoted research achievements, investigated special subject information, and disseminated the information through network publications.

With the spread and perfecting of the production responsibility system in rural areas, more and more farmers are eager to seek technology as well as marketing information. Many information networks at the grassroots levels have been formed with a total staff of 60,000 throughout the country. They collect, analyze and disseminate production and marketing information, which surely accelerates the technology diffusion process from research institutions to end-users of different levels and categories.

In order to effectively disseminate agricultural scientific information, many information journals have been published. In 1985 there were 56 information journals (two indexing journals, 26 abstract journals, 27 reporting journals, and one special subject information research journal), in which two indexing journals---*Bibliographies of Chinese Agricultural Science and Technology* and *Bibliographies of Foreign Agricultural Science and Technology* reported on about 70,000 documents, 26 abstract journals included about 35,629 abstracts, the reporting journals published 5,000 papers, and the information research journal systematically reported achievements of information research projects.

The information departments of agricultural research institutes also produce more than 2,000 kinds of periodical and non-periodical information materials for internal information exchange, such as selective subjects abstracts or bibliographies, collections of research achievements, proceedings, translations, newsletters, etc. According to national economic development and local agricultural research and production, they compiled and wrote many comprehensive and special topic literature reviews and information research reports. These information materials have played such roles as "ear" and "bridge" for agricultural production, research and education.

Agricultural research institutes and universities also publish journals and magazines to disseminate their research findings to scientists, extension workers and farmers. These publications are also channels for them to receive feedback about research findings and publications, which helps future research and publication planning. These publications include learned journals, professional journals, specialized journals and farmer magazines. They have played an essential role in the diffusion of farming innovations to farmers. The lack of extension workers in rural areas has been an obstacle for technology diffusion. It was reported that there were 6.6 agricultural technicians per 10,000 farmers. These publications can partly bridge the communication gap between research institutions and farmers. There are about 400 kinds of agricultural journals and magazines in China. About 2.1 million copies of agricultural journals and magazines were distributed in 1985 (He, 1987).

In recent years, agricultural science information services have been extended in many ways. They provided strategic information for decision-making and planning departments to determine policies of agricultural science and technology, to select technological solutions, and to plan research projects. They also systematically translated articles about and introduced foreign agricultural innovations, new materials and equipment to accelerate agricultural research and production in China. Many projects on special subject information research have been conducted. These projects usually analyze the progress and experience of special subjects in agriculture and propose development strategies in China.

Information departments provide such services as document circulation, information consultation, user training, conducting agricultural technology exhibitions and technology markets, and serving agricultural scientists with document searching, acquiring, training, photocopying and delivering, which economize research time and resources to speed up the research process.

New information technology has been introduced into the agricultural science information system in China. Computer information retrieval has been provided for searching abstracts and bibliographies on such tapes as CABI, AGRICOLA, and AGRIS. New research efforts are being made to store and retrieve agricultural information in the Chinese language with computers. With the support of IDRC, seven regional information centres have been set up.

CYBERNETIC ANALYSIS OF AGRICULTURAL SCIENCE INFORMATION SERVICES

Agricultural research institutes and universities in China are in the business of development-oriented agricultural research. Scientists have in the past decades done much in developing agricultural production and science. However, they have also been criticized for failing to address the needs of farmers and for failing to study the impact of their work on agricultural development. About one third of the agricultural innovations developed have not been accepted by farmers (*China Statistics Yearbook*, 1986).

A farmer's failure to adopt specific innovations in farming is often attributed totally to the farmer's resistance to accept change, or to ineffective extension, or to expensive inputs. However, as various studies have shown, the failure to adopt the recommended technology on the part of peasants is more often the result of institutional and structural factors such as price, market and land distribution. And it may also be, up to a certain degree, the result of the inappropriateness of the technology itself to the farmer's needs and preferences. Many researchers in rural communication (Esman, 1974; Fett, 1972; Hacelock, 1971 and Rogers, 1983) have pointed out that one of the factors that most contributes to these situations is the information transfer process itself. Most of this process has been one-way communication, allowing almost no feedback from clientele (extension workers, farmers). In the one-way communication transaction, where the information is from scientists to clientele. The communication strategy has been based on the assumption that scientists know exactly what the client needs.

An important factor, pertinent to the development of successful agricultural innovation, is thus the clientele's feedback about farming innovations and their own problems. These messages have to be examined, analyzed and incorporated into the process of developing new technology if they are to be acceptable to situational needs. Information departments of agricultural research institutions should not just work for the production and distribution of agricultural information, but serve a communication function where contact with clients provides the opportunities to obtain feedback about research information and the impact of information services. This paper suggests the cybernetic approach to study the agricultural science information service in China.

Cybernetics is the study of the feedback loop as a basic mechanism underlying system regulation and control. Wiener (1961) defined it as "the science of control and communication." Control is made possible by the process of communicating information between the various components of a system. One component, the control centre, will transmit information to another, with the goal of producing a desired change in the on-going behavior of the latter object. The second component will then transmit information back to the control centre, indicating that the information has been received and providing data for the need of additional messages to produce the desired response by that component.

Buckley (1967) distinguished five necessary stages in the process of control for any cybernetic system (Figure 2). They are:

1. A control centre establishes certain desired goal parameters and the means by which they may be attained;

2. These goal decisions are transformed by administrative bodies into action outputs, which result in certain effects on the state of the system and its environment;

3. Information about these is recorded and fed back to the control centre;

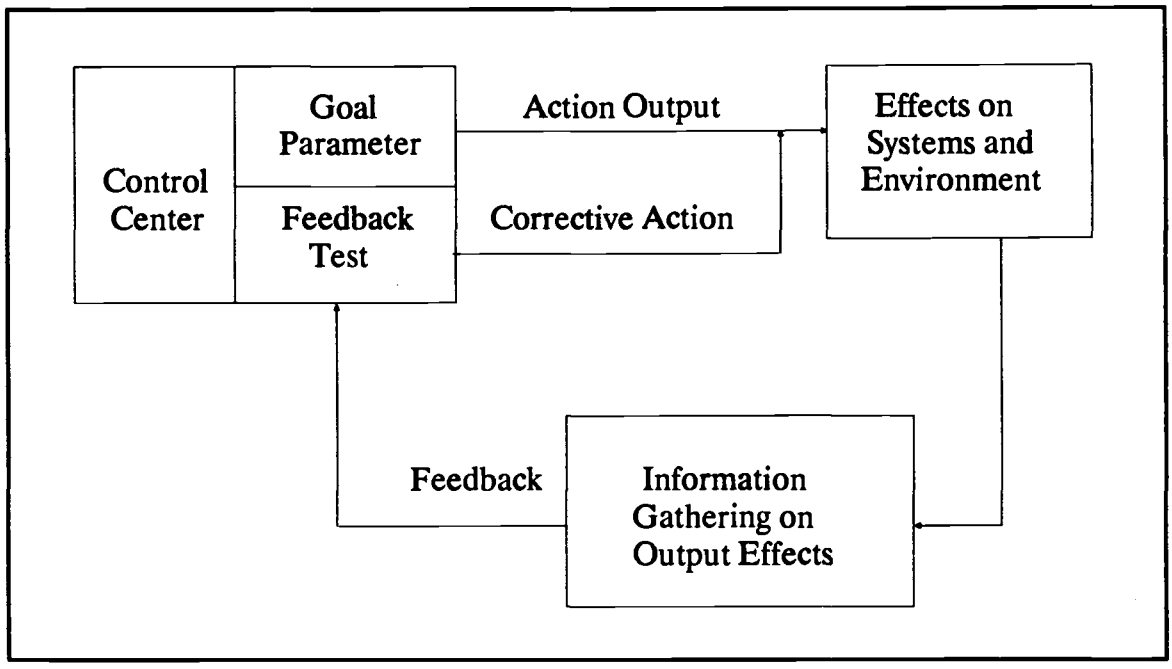

Figure 2. Graphic Representation of the Cybernetic Process

4. The latter tests this new state of the system against the desired goal parameters to measure the error or deviation of the initial output response; and

5. If the error leaves the system outside the limits set by the goal parameters, corrective output action is taken by the control centre.

If the cybernetic approach to agricultural information service is adopted, information departments should act as control centres using information gathered about information users and their environment to reduce errors in information services. These errors may be actual mistakes in information materials or such things as misperceptions of user characteristics and their perceptions of the usability of information materials.

User Analysis

User analysis is the process in which one finds out as much as possible about users of the information service. Basically, we must ask, "Who are they?" The reason why one wants to study the users is that the possibility of perfect communication is zero. However, by proper analysis we can maximize the fidelity of the information exchange.

In communication theory, it is generally recognized that the more similar two individuals are, the greater the probability for accurate transfer of information. In the language of communication researchers this notion is known as the homophily-heterophily distinction. Accurate communication is always easiest if two individuals are very homophilous with regard to the attributes or characteristics most relevant to the topic under discussion. Thus one way to maximize the fidelity of the information transfer in information service is to have individuals with backgrounds very similar to

the information producers. This is often not simply that the person who has the information is different from the person who does not. An alternative is to determine who the users are and to orient the information to their needs in terms of their particular backgrounds (Barnett, 1979).

Users of agricultural science information services are researchers, extension workers and farmers. Information departments of agricultural research institutions mainly serve researchers at their institutions, and pay less attention to extension workers and farmers. Most of them have not done user analysis in a regular and systematic way, so their information service depends on one-way communication and they receive few responses from the audience. Information departments should analyze the information needs of different categories of their users to orient information services to their needs.

Setting Strategies

Strategy is the plan for structuring the activities of a unit or system to achieve specified goals and objectives within an environment (Cowell, 1986). Why do information departments provide information service? What goals are they designed to meet? Before any actual information service takes place, one should answer the following questions: What information services are currently being used which may meet the stated goals? Is a new information service really necessary? Assuming that the new information service is necessary, use the user analysis of potential audience to determine its level of expertise, the current situation, and the future result of the information service.

The next step is to pretest the information service and get reactions of the intended audience. The information departments should use these preliminary evaluations to make adjustments in text before dissemination. At this point, only the strategy has been defined and the mechanism to reach the goal created. Strategies for information service would generally include clear statements of the goals of the information service, user analysis, an evaluation of the impact and utility of information for the recipient, and the integration of relevant feedback into both institution and department planning.

Most information departments do not use any strategies employing the components of the proposed cybernetic strategy. No strategy is in use that systematically obtains feedback from the users and then incorporates useful results into decision-making and program planning. Little attention has been given to development strategies of information service programs of different disciplines and levels of agricultural science and technology (He, 1987).

Communication by Control Centre

The next stage is for the control centre, information department, to exert influence on the other components of the system in an attempt to achieve the goals. This is always done by the exchange of information. In this case, the exchange takes place through information services. Thus the specific behaviors performed during this stage are collecting, managing and publishing, and distributing information materials to the intended audience.

Information departments have spent much of their resources to collect and manage the information materials published at home and abroad. Because of financial constraints, it is impossible for each department to subscribe to many publications. But there is little cooperation between these departments, or high fees for inter-library loans, which limit the information flow into the institutions. It is vital that they should cooperate with each other to acquire the maximum amount of information for the audience.

An efficient information service also depends on how the information department manages its information materials. Because of technical and financial limits, computers are little used for information management. Much of information retrieval is still done with printed publications and subject cards.

Another element of information output for an information department is publishing research findings. Most publications acquire manuscripts from their own institutes and evaluate them through an internal refereeing system or editorial board, which reduces the external information input into the institution. Some editors can not actively communicate with authors and guide them. These factors extend the time lag between manuscript acceptance and publishing.

Dissemination as an output function for both the information department and the institution, can, through communication, attract feedback regarding the impact of information service and research results. Many information departments receive little feedback about the effectiveness of their services. In China, most journals, magazines and newspapers are subscribed and distributed through post offices; it is difficult for information departments to know exactly who and where their audience is. Most publication programs are supported by special funds of their institutions and subscriptions. These departments produce and disseminate publications based on their own internal priorities and needs and perceptions of readers' needs rather than on those actually expressed by clients. More attention is given to producing publications than to disseminating them. Some agricultural publications are distributed free of charge with less consideration of readers' needs. Recently, subscriptions to most publications have been declining, and 80% of them are in debt (Guan, 1986). Considering the low living standard of farmers, the main objective of these publications should be to increase the social and economic efficiency in rural areas, not to make a profit. So more support should be given to provide agricultural publications at low prices.

Gathering Feedback

The information that is returned to the control centre is called feedback. This information is gathered by the control centre about the effects of the output on the system, i.e., how effective the information service is in meeting the established goals. Positive feedback is information that affects a system so that any change causes further change, which causes a loss in stability in the system. Negative feedback causes a regulatory action that tends to bring the system back to its previous equilibrium. There are several ways to gather feedback. Information departments can engage in on-going and immediate dialog with readers during the information service process. Systematic attention to discretionary feedback from readers and a concerted effort to obtain data through

direct inquiry can produce a similar, mutually acceptable solution and a collective relationship with the users.

In recent years, information departments have provided SDI services mainly for agricultural researchers and have received on-going feedback from them. But for the current awareness service, it is a little difficult for them to get immediate feedback. Although the "letter to the editor" is the most common form of feedback provided at the discretion of the audience, very few institution publications indicate that information users are encouraged to submit comments about the publications and information they contain. Some information departments occasionally enclose a short mail form with publications so readers may conveniently reply to them. However, a very low response has been achieved in this manner. Because most publications are subscribed and distributed through post offices, information departments can not do direct inquiry of readers. This is an area of the information transfer process worthy of future communication research.

Evaluation and Corrective Action by the Control Centre

Evaluation is a process of actively seeking information which relates the actual outcome of an activity to the planned outcome. If the degree of discrepancy from the planned outcome is significant, a corrective action should be taken by the control centre. This enables the information department to modify future activities so that the actual output comes close to the expected. In this sense, evaluation affects the information department cybernetically by providing alternative or supplemental information to whatever feedback is involved.

Because information departments have more control over evaluation than volitional feedback, they should evaluate the impact of the information services by direct inquiry. However, information departments do not perform self-evaluation or do communication research into ways of making information service more effective. Information flows from institution to user are emphasized but seldom evaluated for their effectiveness. Information flows from user to institution are informal and unsystematic. Information service is seldom followed up with an evaluation impact.

DISCUSSION

It is a frequent mistake to assume that information which is available in the literature is available to the users. We forget that this literature must first be located, read and understood before it can be used. Effective information service in this sense depends on presenting the information in a form that is acceptable to the users and which will produce the intended action. We scientists and information specialists should not be satisfied that our work ends when we publish and disseminate a scientific paper, an annual report, or a conference proceedings. All the work, all the money, and all the time spent on research and publishing has been wasted if the publication remains on the shelf unused. It is time for us to investigate the system for producing, disseminating and using agricultural science information and, if necessary, to design new information services that will actively take the needs and feedback of users into consideration.

Agriculture science information services in China have contributed a lot to scholarly communication between agricultural researchers and in technology transfer to extension workers and ultimately to farmers. However, they mainly depend on one-way communication and information-oriented policy to disseminate agricultural science information, and pay inadequate attention to its effectiveness and feedback. Although many social and economic factors affect the agricultural information transfer process, we can still do a lot to improve in this field.

Before beginning any information service program, information departments should analyze their potential audience to maximize the fidelity of information exchange. By analyzing their different sets of past experiences, attitudes, knowledge and values to communication events, we can distinguish and classify their information needs. For agricultural scientists, extension workers and farmers, different information strategies should be applied. National or regional agricultural science information centres should work together to establish databases of current agricultural research projects to reduce repetitious research work and to improve the quality of research. Information departments should provide more services to extension workers and farmers to accelerate the transfer of research findings into agricultural productivity. Besides the printed media, electronic media should be used to stimulate the diffusion of agricultural innovations.

The steep rise in cost of publications and the increasing amount of new documents necessitates appropriate and effective resource sharing. Local institutions can pool their resources and acquire a good amount of literature with a delivery system. Coordination of publishing activities between these departments should be established to produce quality publications and reduce the time lag of publishing. The same attention should be given to information dissemination activities, such as exhibiting at professional meetings, technology markets, collecting and renewing mailing lists. Both user and staff of information services should strive to improve the efficiency of information service. Information departments should take steps to increase the flow of feedback into the system and to seek ways to integrate useful information into program planning and decision-making. Their work should not be restricted to collecting and disseminating agricultural science information, but be involved in problem-solving and the decision-making process by providing strategic information and feedback. A systematic evaluation should be established about the effectiveness of agricultural science information service to modify future activities.

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